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Funding and financing heat networks in Scotland

Neil Thomson, Hamish Davidson, Justin Smallman
EY
March 2025

DOI: http://dx.doi.org/10.7488/era/5740

1 Executive summary

1.1 Background

Over 72% of buildings in Scotland still rely on mains gas as their primary heat source. Scotland must further decarbonise heating in homes and buildings to achieve its climate change targets. The Scottish Government's 2021 Heat in Buildings Strategy identified clean heat networks as a strategic decarbonisation technology. However, given the significant levels of capital investment required to transform Scotland's buildings and limited public sector budgets, additional investment will be needed from the private sector.

1.2 Aims

This study examines present and potential future financing models in the heat network sector ("the sector") and identifies suitable levers and actions for incentivising private finance. Findings are based on a series of interviews with stakeholders, including operators, funders, advisors and public sector representatives, as well as desk-based research. We draw comparisons and insights from other relevant utility sectors and from other countries (the Netherlands, Germany, Finland, Sweden and Estonia) as well as England and Wales.

1.3 Findings

1.3.1 Challenges facing the sector

In Scotland and across the UK, the heat network sector has typically been funded by early-stage financing from developers and significant levels of subsidy from the public sector. These public subsidies have encouraged private investment in the sector and supported the roll out of heat networks across Scotland.

The most impactful barriers in the sector are demand uncertainty, revenue instability and the evolving regulatory environment. This limits investment appetite, restricting the roll out of heat networks at scale in Scotland. The barriers are illustrated in Figure 1.

Figure 1: Heat network deployment barriers. Source: EY analysis and stakeholder feedback

1.3.2 International comparisons

- **Maturity** – Scotland, the rest of the UK and the Netherlands have a developing heat network sector. Germany is expanding its market. Sweden, Finland and Estonia have mature markets where the sector is tried, tested and trusted.
- **Regulation** – Many of the developed and mature markets are unregulated: they use self-governing frameworks and technical codes. This is coupled with high levels of local governance, greater pricing transparency and consistent contractual delivery and routes. These markets can focus on consumer pricing that supports investment and stimulates the sector's development. Additionally, mandatory connections are being used in some circumstances in other countries, to make projects more investible and create demand assurance, which encourages private investment.
- **Ownership profiles and private finance** – The more developed markets (including Sweden, Finland and Estonia) have a mixed degree of public ownership. More mature markets are likely to have a higher level of private finance penetration. In Finland, public sector ownership remains at a high level, whilst still seeking investment from the private sector. In Germany there's a growing commitment to re-municipalise infrastructure and reverse privatisations. In the Netherlands, where over 90% of sector finance is private, the government proposed legislation to part-

nationalise the sector in 2022 to mitigate concerns around the affordability and reliability of the sector.

The developed markets are mainly regulated by standard frameworks. These markets can access private finance due to the established nature of the sector. However, the technology has been embedded in the culture of these countries for much longer and so regulators can focus on price transparency and fairness for the end user rather than a framework for developing the market.

- **Financial levers –** Most of the comparator countries have adopted a range of financial levers. Many have applied a similar approach to Scotland, including the continued use of capital grant funding, project development funding or individual grants for expanding and upgrading heat networks. Grant funding is still widely used in the less mature sectors. As the sector matures, intervention rates reduce or there is greater requirement for a higher degree of renewable heat sources to be used**.** Additionally, state-owned infrastructure banks have been investing in the sector to help refurbishments or provide debt financing for expansion.

1.3.3 Utility sectors

Various regulatory regimes and financial support mechanisms have been used in other sectors to stimulate private sector investment in the development of new infrastructure. The Scottish Government must consider the costs and practical challenges of pursuing financial support mechanism models that are not being adopted in England and Wales:

- **Contracts for Difference (CfDs)** have proved very successful in securing the necessary investment in a wide range of renewable energy technologies. This approach could provide revenue support to heat networks to incentivise the transition to more sustainable forms of heat generation. In particular, CfDs could support heat networks that use decarbonised heat sources (e.g. heat pumps), which are likely to have a higher cost than conventional gas boilers or heat networks using waste heat. Therefore, as well as providing revenue certainty, a CfD has the potential to subsidise the increased cost of decarbonised heat for end users.

- **A Regulated Asset Base (RAB) model**, alongside periodic price reviews, can protect consumer prices whilst also encouraging ongoing capital investment, supporting asset maintenance and providing predictable revenue streams. The model would, however, involve significant administrative and resource cost. Prior to the sector maturing, a RAB model might not result in financially viable heat networks without additional capital or revenue support.

- **The Renewable Heat Incentive (RHI) model** is a well understood revenue support mechanism previously used in the energy sector. Similar to CfDs, an RHI model would subsidise the cost of heat for consumers if it was based on the amount of heat generated (as opposed to consumption of heat). It would therefore contribute to the cost of deployment, helping to address the increased cost of installing this technology and at the same time, mitigating demand risk. A cap on payments could also be introduced to avoid over-incentivisation. However, the value for money of previous schemes has been questioned.

1.3.4 Market feedback

The private sector views heat networks as an attractive investment opportunity but there are areas of uncertainty that must be resolved, including the need for greater clarity on the development of future regulation. To facilitate private investment, stakeholders highlighted the need for continued grant funding support to de-risk project cashflows. They also emphasised the importance of clear regulation on key topics, including heat zoning, mandatory connection policies, planning and building regulations, as well as a definitive policy direction on phasing out gas boilers.

1.4 Recommendations

We recommend that the Scottish Government:

1. Maintains capital funding support for the sector, either via existing programmes, or new bespoke capital schemes. Explore opportunities for extending the timescales for drawing down grant funding.
2. De-risking future revenues is key to unlocking heat network development – private capital is available for projects, but they need to be financeable. More detailed analysis of a revenue support model, such as CfD or a RHI equivalent, is merited. However, the Scottish Government must address the challenges of establishing such schemes, including the significant administrative and resource implications of previous schemes.
3. Explores the benefits of implementing a RAB model, following further regulatory developments and the creation of an established asset base (over 10-15 years). However, consider the complexity and feasibility of this model.
4. Continues to work closely with the Scottish National Investment Bank (SNIB) and the UK National Wealth Fund to explore investment opportunities, create a shared understanding of each party’s objectives and ultimately unlock the capital that has been made available to invest. Both organisations are committed to investing into the sector.
5. Maintains and increases support for pre-construction projects, via the Heat Network Support Unit (HNSU) and specific development funding programmes.
6. Monitors the implementation of the UK Government’s zoning approach and, where appropriate, leverage best practice from the Department for Energy Security and Net Zero (DESNZ). This should be used to complement Scotland’s existing zoning approach.
7. Reviews its approach to regulation to help reduce regulatory uncertainty. Where appropriate, this should include leveraging best practice from England and Wales.
8. Continues to work with the UK Government on rebalancing electricity and gas prices. However, this will not eliminate the price difference between electricity and gas.
9. Develops a national Heat Network Strategy setting out a clear long-term vision for heat networks in Scotland.

Contents

2 Glossary / Abbreviations table

£/€ bn	Billions of £/€	LCCC	Low Carbon Contracts Company
£/€ m	Millions of £/€	LCITP	Low Carbon Infrastructure Transition Programme
ACM	The Netherlands' Authority for Consumers and Markets	LHEES	Local Heat and Energy Efficiency Strategies
AMP	Asset Management Plans	MWh	Megawatt hour
ASHP	Air source heat pumps	NFFO	Non-Fossil Fuel Obligation
CAA	Civil Aviation Authority	NIB	Nordic Investment Bank
CAP	Competitively Appointed Provider	NWF	National Wealth Fund
CCC	Climate Change Committee	ODI	Outcome delivery incentive
CCUS	Carbon Capture, Utilisation and Storage	OFTO	Offshore Transmission Owners
CfD	Contract for difference	ORR	Office of Rail and Road
CXC	ClimateXChange	RAB	Regulated asset base
DBFO	Design, Build, Finance and Operate	RAV	Regulated Asset Value
DESNZ	Department for Energy Security and Net Zero	REMA	Review of Electricity market arrangements
DHLF	District Heating Loan Fund	RESCo	Regional Energy Services Company
DHN	District heat network	RHI	Renewable Heat Incentive
DPC	Direct Procurement for Customers programme	RIIO	Revenue = Incentives + Innovation + Outputs
EfW	Energy from Waste	ROC	Renewable Obligation Certificates
EY	Ernst and Young LLP	rUK	Rest of the UK
FOAK	First of a Kind	SFT	Scottish Futures Trust
GHNF	Green Heat Network Fund	SHNF	Scotland's Heat Network Fund
HN	Heat network	SNIB	Scottish National Investment Bank
HNDM	Heat networks delivery models	SPV	Special Purpose Vehicle
HNES	Heat Network Efficiency Scheme	SRO	Scottish Renewables Obligation
HNIP	Heat Networks Investment Project	T&SCo	Transport and storage infrastructure
HNSA	Heat Networks (Scotland) Act 2021	TWh	Terawatt hours
HNSU	Heat Network Support Unit	UK	United Kingdom
KfW	Germany's infrastructure bank	WCW	Dutch Collective Heat Supply Act
KPI	Key Performance Indicators	WPG	Germany's Local Heat Planning Act

3 Introduction

3.1 Research aims

This report examines the heat network sector (also referred to as “the sector”) and will contribute to the Scottish Government’s ambition to accelerate the pace and scale of heat network rollout in Scotland. The report:

- Summarises current financing models, structures, and barriers in the sector and establishes a baseline for the Scottish heat network landscape
- Draws comparisons and insights from relevant utility sectors
- Draws comparisons with international heat networks and their financing models
- Provides insight into how heat networks are currently viewed by the private and public sector
- Recommends suitable financial levers, models and policies for the sector

3.2 “Heat Network” definition

The definition of a “heat network” in the Heat Networks (Scotland) Act 2021 (HNSA) covers both district heat networks and communal heat networks. A district heat network distributes heat from one or more sources to more than one building. In a communal heating system heat is supplied to one building comprised of more than one building unit (for example, a block of flats).[1]

The majority of the findings in this report refer to district heat networks, but we have included both communal heating and district heating in our definition of a heat network.

Heat networks can be powered by a range of different technologies. Historically, heat networks have often utilised fossil fuels, including gas boilers. As a result, many legacy networks still rely on fossil fuel-based technology. Our analysis considers these legacy networks; however, we recognise that the Scottish Government is committed to supporting the roll out of clean heat networks and supporting the reduction in emissions from the sector. This is important context for the conclusions in this report.

3.3 Methodology

Our findings are based on extensive desk-based research conducted by sector specialists. The analysis also draws on insights from a series of interviews with sector stakeholders, including operators, funders, advisors and public sector representatives. This information has been used, together with our own sector experience and evidence from existing literature, to set out the existing baseline position in Scotland (and the rest of the UK) and to develop our recommendations for suitable financial levers, models and structures for the heat network sector in Scotland. Finally, the stakeholder feedback also informed our approach for drawing comparisons with other utility sectors and international comparators. Our stakeholder engagement methodology and questions were agreed with CXC and the Scottish Government Steering Group. The engagement exercise consisted of 20 meetings

[1] Heat Networks (Scotland) Act 2021

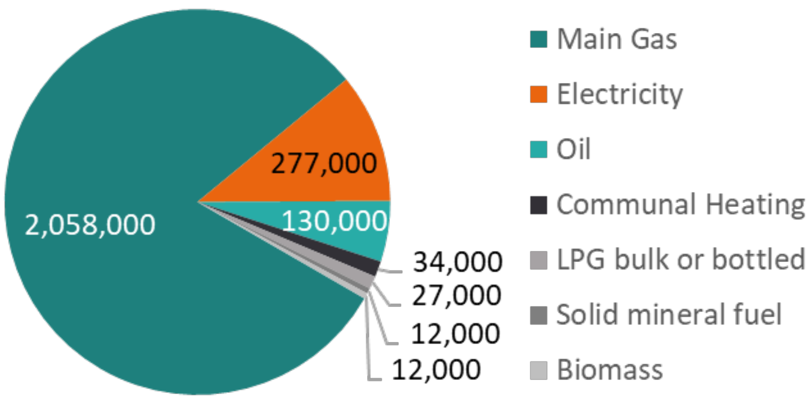
and Microsoft Teams calls. In advance of the sessions, participants were issued with the questions and given the opportunity to share feedback either in writing or verbally.

3.4 Policy Context

Scotland's ambitious climate change targets are to achieve net zero greenhouse gas emissions by 2045. To deliver this, Scotland must instigate a step change in decarbonising the heating of its homes and buildings. Domestic buildings account for 15% of Scotland's total greenhouse gas emissions and around 27% of its total energy consumption[2]. The scale of this decarbonisation challenge is significant – Figure 2 shows that in 2022, over 72% of Scotland's homes relied on mains gas as their primary heating fuel[3].

The Scottish Government's 2021 Heat in Building Strategy identified clean heat networks as a key strategic technology which is tried and tested and can be scaled up.

Figure 2: Breakdown of primary heating fuel vs number of homes



Source: Scottish House Condition Survey 2022

The Heat Networks (Scotland) Act 2021 established statutory targets for heat supplied by heat networks, requiring that they supply 2.6 Terawatt hours (TWh) of output by 2027, 6 TWh by 2030 and 7 TWh by 2035. In 2022, the Scottish Government estimated that heat networks supplied 1.35TWh of output[4]. To meet Scotland's ambitious statutory targets, a significant acceleration in deployment is necessary.

The public sector plays an active role in the sector's development, both at the national and local level. Local Heat and Energy Efficiency Strategies (LHEES) are local authority-led plans to decarbonise heat and improve energy efficiency, including rolling out heat networks in suitable locations. Momentum is building, with Scottish local authorities publishing their LHEES strategies, which include establishing the role of heat networks as a key decarbonisation measure.

The capital investment required to transform Scotland's buildings (between now and 2045) is expected to be in the region of £33bn[5]. Given the size of this investment and the limited nature of public sector budgets, significant levels of finance will need to come from the private sector.

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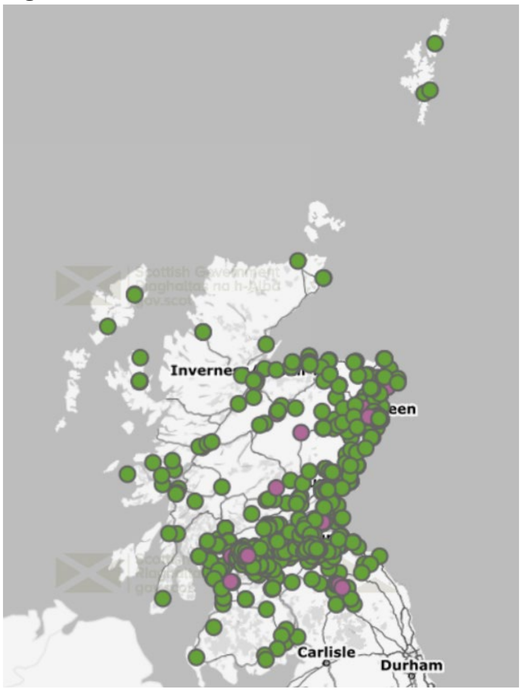
[2] Scottish Energy Statistics Hub
[3] Scottish House Condition Survey 2022
[4] Heat Networks Delivery Plan: review report 2024 - gov.scot
[5] Heat In Buildings Strategy: Achieving Net Zero Emissions in Scotland's Buildings

4 Current financing structures and models in Scotland's heat networks

4.1 Scotland's heat network sector

Heat networks distribute heat from a central source, avoiding the need for individual heating systems (such as gas boilers). There are over 1,090 known heat networks (the majority being communal heat networks) supplying heating and cooling to domestic and non-domestic properties[6]; however, most of the larger networks with significant heat loads are in Scotland's larger towns and cities. Although recent projects have introduced clean heat sources, the sector still relies on mains gas as its primary heat source[7].

Figure 3: Heat networks in Scotland



The number of heat networks, both district and communal, is increasing across Scotland. Figure 3 illustrates the distribution of heat networks in Scotland, but the sector is still immature, especially compared to counterparts in Europe, where heat networks have played a central role in heat infrastructure since the 1940s.

Sector growth has been slow, and in recent years, the focus has been on a series of "demonstrator" projects, across a range of sizes and driven by early adopters in both the private and public sectors.

4.2 Scottish and UK regulatory landscape

There is an emerging focus on the regulation of heat networks within Scotland and the rest of the UK. For the first time in the UK the sector is set to become regulated, like many other utility sectors. Given the decarbonisation requirement and recognising the growing importance and potential of heat networks, the Heat Networks (Scotland) Act 2021 (HNSA) created a regulatory framework for the sector in Scotland.

The regulation of consumer protection (including for heat networks) is reserved to the UK Government. In 2024, the UK Government and Ofgem jointly consulted on regulations to establish an authorisation system to protect heat network consumers under the Energy Act 2023. Ofgem will be the future regulator of that consumer protection regime across

[6] 2. Overview of policy & regulatory landscape - Heat Networks Delivery Models - gov.scot (www.gov.scot)
[7] Heat In Buildings Strategy: Achieving Net Zero Emissions in Scotland's Buildings

England, Scotland and Wales. Ofgem's will also be responsible for heat network licences and authorisations in Scotland, as set out in the HNSA.

The HNSA includes a series of measures to support the sector and promote growth. These are summarised in table 1 below, alongside the relevant UK position. The UK Government has proposed a regulatory regime but has yet to introduce secondary legislation. For those measures not in force in Scotland, these will also be introduced by the secondary legislation.

Table 1: Scottish and UK regulatory landscape

Scottish landscape[8]	England & Wales landscape
Zoning, permitting and licensing • **Zones** (in force) – Local authorities are required to identify, consult and designate zones suitable for heat networks. The Scottish Government can also designate some zones. • **Building assessment reports** (in force) – Owners of non-domestic public sector buildings must assess whether their buildings are suitable to connect to a heat network. • **Permits** (not yet in force) – Heat network operators may need a permit to build and operate a network in a designated zone, providing operators with exclusive access to the zone. • **Consents** (not yet in force) – Operators will require a consent for each network, ensuring developments take place in areas that will have the most benefit, with the opportunity for community engagement. • **Licensing** (not yet in force) – All heat network companies (including existing operators) will need a licence to operate in Scotland. A licence will give heat network developers certain rights and powers – such as compulsory purchase, road works and surveying rights – to help reduce construction time and costs.	**Zoning, permitting and licensing** • **Heat network zones** – Zoning proposals will differ in England and Wales. The UK Government (via its Heat Networking Zoning Authority) will designate areas as heat network zones, where heat networks providing decarbonised heat offer the lowest cost solution for consumers. In these zones, certain buildings may be required to connect to the networks through mandatory connection measures. • **Authorisation** – As a regulated activity, all heat networks will be required to be authorised by Ofgem to be able to supply heat to their network. This will be across Scotland, England and Wales, and may duplicate some of the Scottish licensing and consenting requirements. • **Licensing** – Operators will be granted a licence by Ofgem that give them rights and powers, including specific permits, for example for street works, and allow use of land when building and maintaining heat networks as electricity.
Consumer protection • The regulation of consumer protection (including pricing, transparency and quality of services) is reserved to the UK Government. Consumer protection ensures end users have the opportunity to switch heat network suppliers and have the right to challenge poor quality service. This is critical in order to attract future customers and allow operators to develop new projects and grow existing networks. • Ofgem will also establish "step-in" rights, to protect customers in the event that the operator does not meet these minimum standards or needs to be replaced.	

[8] Heat networks - Renewable and low carbon energy - gov.scot

Scottish landscape[8]	England & Wales landscape
Technical standards • GB-wide technical standards will be regulated through a Heat Network Technical Assurance Scheme (HNTAS), designed to ensure minimum levels of network performance and efficiency. Ofgem, as the regulator, will award a license to a technical standards Code Manager.	

The HNSA and the new UK Energy Act both aim to introduce legislation that has the potential to align the regulatory landscape across the UK. However, our stakeholder engagement process found that significant regulatory uncertainty currently exists, including the diverging timetable for introducing legislation and the lack of clarity regarding the differences in proposals between Scotland, England and Wales. Without further developments on specific regulatory areas, such as permitting/zoning, this uncertainty will remain. We also acknowledge that there is a complex regulatory landscape, with input required from both the Scottish and UK Governments to clarify the balance between devolved and reserved powers. These observations are further developed in section 4.4.

The HNSA has created an opportunity for Scotland to benefit from a robust regulatory framework that builds trust for consumers and creates certainty for operators. In order to stimulate sector growth, the market requires further clarity on the ongoing process to regulate the sector and more detailed information regarding the introduction of secondary legislation. This should provide clarity regarding investment opportunities, reduce the complexity of the dual regulatory frameworks and make Scotland a more attractive investment proposition.

The sector is also impacted by other Scottish regulation, including the New Build Heat Standard, which requires new homes and buildings to install clean heating systems, rather than relying on mains gas. Additionally, the National Planning Framework 4 includes policies which states that development proposals (within or adjacent to a heat network zone) will only be supported if they connect to an existing heat network.

4.3 Existing financing models in the sector

In Scotland and across the UK, the sector has typically been funded by early-stage financing from developers and significant levels of subsidy from the public sector. The Scottish Government has supported clean heat networks through:

- Grant support (also in the form of repayable assistance), including:
    - Scotland's Heat Network Fund (SHNF) – The SHNF offers capital grant funding to support the roll out of new clean heat networks and communal heating systems, as well as the expansion and decarbonisation of existing heat networks across Scotland.
    - Low Carbon Infrastructure Transition Programme (LCITP) – From 2015 until it was replaced by the SHNF in 2022, LCITP provided grant funding support to several heat networks, including Queens Quay and Torry heat network.
    - Both programmes also provided project development and commercialisation support.
- Loans via the District Heating Loan Fund (DHLF) – Managed by the Energy Savings Trust, the fund provided capital loan funding to support low emission small scale district heating in Scotland until it closed in April 2024.

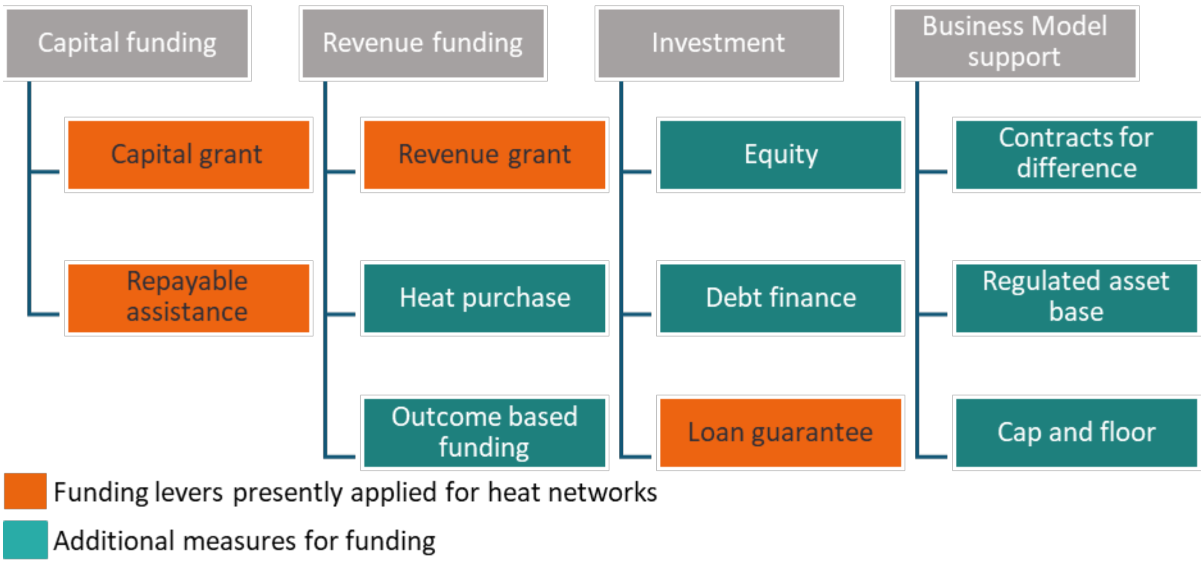
- Non-domestic rates reliefs – since April 2024 heat networks (where 80% of the thermal energy in any given year is generated from renewable sources) have been eligible for a 90% rates relief.[9] There is also a 50% rates relief if a premises is wholly or mainly being used for a district heating network.[10]
- Many demonstrator projects also benefitted from historical UK Government revenue support through the Renewable Heat Incentive (RHI), now closed to new applicants.

These public subsidies have encouraged private investment in the sector and supported the roll out of clean heat networks across Scotland. Many clean heat demonstrator projects have been self-funded by operators (or funded through bespoke delivery vehicles). However, grant funding is required to bridge funding gaps and enable projects to achieve the internal rate of return – often referred to as a hurdle rate – required by operators. This is more important for clean heat networks than for fossil fuel-based systems, where the requirement for public subsidy is less pressing given the lower capital costs.

The hurdle rate is different for each operator and project. It is impacted by an operator's cost of capital and project specific risks, but our analysis indicates that, at the time of this report, it tends to range between 8% and 12% (although this range will be impacted by several external factors and will vary on a project-by-project basis). This is explored further in section 0.

Grant support is among several financial mechanisms (or "financial levers") which the Scottish Government has historically used. Such support could continue to de-risk heat network projects and help incentivise private sector investment. Figure 4 highlights some of the key mechanisms used to date and others which are considered further in this report. A summary of each mechanism can be found in Appendix B.

Figure 4: Funding levers the Scottish Government could deploy to attract private investment



Source: SFT and EY analysis

[9] Heat Networks Delivery Plan: review report 2024 - gov.scot
[10] District Heating Relief - mygov.scot

In order to understand how a step change in private investment might be instigated, it is important to highlight the key factors which drive investor confidence, namely:

- Certainty of demand
- Revenue stability
- A stable regulatory environment
- A clear understanding of project risks with shared ownership and mitigation strategies

These factors and wider deployment barriers are explored in the following section.

4.4 Heat network deployment barriers

4.4.1 Overview

The analysis contained in this section includes feedback from our stakeholder interview exercise, as well as our own professional observations. While many of these barriers are well understood in the market, key stakeholders confirmed that they continue to present significant live obstacles for private sector operators and investors, limiting their investment appetite and restricting the roll out of heat networks at scale in Scotland. Following stakeholder feedback, we have grouped these barriers (shown in figure 5) into four categories:

- Financial
- Regulatory and policy
- Technical
- Social and market barriers

Figure 5: Heat network deployment barriers

Source: EY analysis and stakeholder feedback

Within these categories, we present the barriers in order of importance (based on the strength of stakeholder feedback). It is important to note that whilst our report is primarily focussed on financial barriers and the private sector, many of these non-financial barriers add further uncertainty and therefore need to be taken into consideration. All these barriers – financial and non-financial – must be addressed in order to instigate a step change in private investment.

4.4.2 Financial barriers

Heat networks involve significant levels of financial risk and uncertainty, making it extremely challenging to forecast a project's cashflows, thereby deterring private investment. These financial risks are highlighted below:

4.4.2.1 Demand uncertainty

Demand uncertainty is the biggest factor inhibiting private sector investment. For a heat network to be financially and commercially viable, it should generate a minimum level of committed revenue in order to meet the operating costs of the network and contribute to the repayment of the initial capital investment. This can be challenging if it is unclear when and how many buildings will connect to the network, their heat offtake requirements and the resulting revenue that will be generated.

For many Scottish “demonstrator” projects, demand and revenue risk have been reduced by securing anchor loads via public sector buildings, which require large heat offtake requirements and therefore to provide some revenue certainty. Developers and investors prioritise the de-risking of revenue flows as it provides greater certainty in a project’s ability to service the repayment of any debt or shareholder loans and/or equity return. As a result, securing longer term supply agreements with customers is a critical step in securing additional investment.

Operators stated that investment decisions are not speculative – the extent of committed revenue and certainty of connections are critical considerations to a potential developer and/or investor. To date, projects have typically been funded using balance sheet finance of the project sponsors (corporate finance) in the form of shareholder loans and equity, rather than more conventional third-party debt finance in the form of limited or non-recourse debt finance. When a heat network project reaches critical mass with mature connections and revenues, this provides an opportunity to refinance and secure more competitive finance terms due to reduced lending risk.

4.4.2.2 Long development and construction times

Many heat network projects have significant development and construction timescales, which present barriers to funders. In some cases, projects can take two or more years to develop and several more years to construct. This results in significant development and commercialisation costs, requiring high levels of upfront finance.

Historically, as a means of mitigating these development costs, the public sector offered support through the Heat Network Support Unit (HNSU) and specific grant funding programmes. However, stakeholders identified a misalignment between the grant funding drawdown profile (the existing grant funding programmes have shorter funding windows, typically four years) and the long construction cost profile (upwards of 5-7 years). This means that operators have had to condense the delivery programmes to meet the grant drawdown deadline or seek additional sources of financing.

4.4.2.3 High capital costs

Heat networks require significant levels of capital investment. Several recent Scottish heat network projects have had capital cost estimates of between £10m and £50m[11]. This barrier is exacerbated in times of high inflation and cost uncertainty. The high levels of capital investment are commensurate with other utilities such as water, gas and electricity. All require significant investment in underlying infrastructure prior to connection with residential, commercial and public sector buildings.

Large capital projects are often regarded as higher risk and therefore more challenging to finance. Due to cash flow uncertainties, this sector has historically relied on significant levels of grant funding. Public support (including Scottish Government programmes such as LCITP and SHNF) has been essential for improving private sector returns and sharing the risk of the high capital costs. When this support is unavailable, operators mitigate this risk in other ways, for example, by seeking increased connection fees for end users.

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[11] Heat Network Projects Quarterly Report : Scottish Government Supported Heat Network Projects – September 2024

4.4.2.4 Diverse delivery models and procurement approaches

The lack of standardisation in procurement approaches and delivery models adds complexity, time and cost to a project's development timeline. Projects develop bespoke approaches that are not necessarily repeatable for new projects. This inhibits the market's ability to understand the investment landscape and reduces confidence. Investors are far more likely to pursue projects where there are standard procurement approaches and tried and tested delivery models, where the risks are understood.

4.4.2.5 The availability and access to financing

Debt lenders have been reluctant to invest in the sector due to the risks noted above. Current stakeholder feedback confirms that this remains the case. Typically, large infrastructure projects would look to include both equity and debt to optimise financing costs and spread the risk on investment. However, heat network projects typically struggle to demonstrate that they will have sufficient free cashflows to service the cost of debt. As such, debt lenders will seek to invest their funds in alternative sectors where they have more confidence in the cashflows. If these other sources of financing cannot be brought into the sector, the ability to roll out new projects at scale will be limited.

4.4.3 Regulatory and fiscal challenges

Although the financial barriers are significant, they must be considered alongside regulatory and fiscal challenges. These have created uncertainty in the market and have negatively impacted the private sector's investment appetite. Stakeholder feedback highlighted the importance of these areas in unlocking Scotland's heat network ambitions. However, as we discuss below, the Scottish Government does not have the ability to resolve all these issues.

4.4.3.1 Regulatory uncertainty

The Heat Networks (Scotland) Act in 2021 introduced powers to regulate the Scottish heat networks market for the first time. The Energy Act 2023 was passed by the UK Parliament in October 2023. Differences in implementation, content and timing of regulation between Scotland and the rest of the UK are negatively impacting investor sentiment and creating uncertainty. Developers and funders are also looking for clarity on the future GB-wide consumer protections and technical and service specifications for operators.

Without further clarity on the future secondary legislation in Scotland, operators stated they are more likely to focus resources outside Scotland – for example, in other UK areas – where there is more demand for larger urban heat network opportunities.

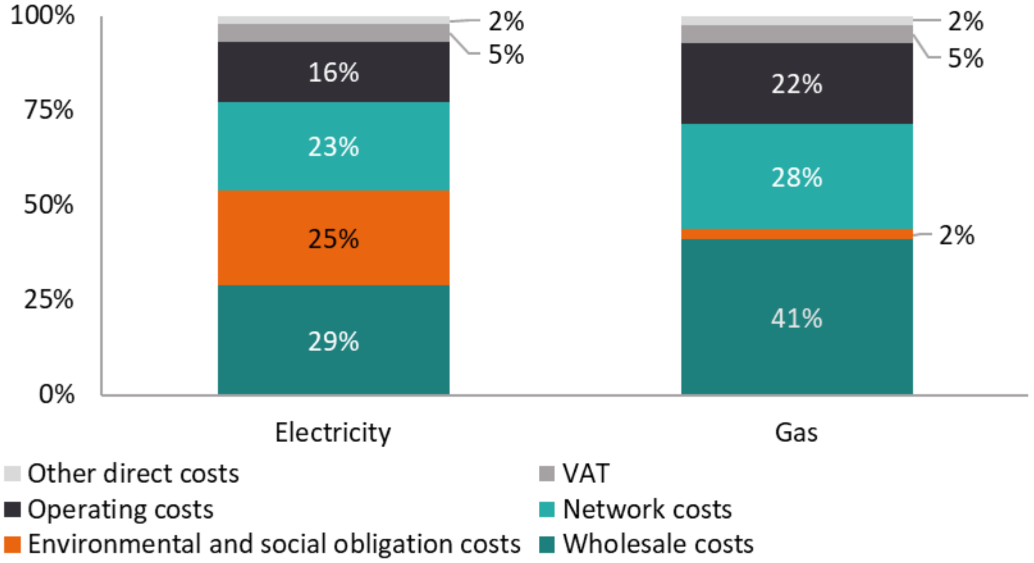
This uncertainty also extends to other relevant policy areas, such as the phasing out of domestic gas boilers, which presents barriers to operators. The Scottish Government has introduced the New Build Heat Standard, which states that by 2045, all homes in Scotland will need to have converted to a clean heating system. Across the rest of the UK, there is political uncertainty about this phase out. No equivalent legislation is currently in place, meaning heat networks operators are unclear when customers will be required to adopt low emission heating solutions.

4.4.3.2 Structural pricing considerations

Reducing the gap between the price of electricity and the price of gas may help support the rollout of low carbon heat networks. Under the current domestic[12] electricity pricing model, electrified low carbon heating solutions are unlikely to offer cost savings to consumers when compared against traditional gas boilers.

Historically, electricity has been more expensive than gas, partly due to the greater proportion of environmental and social obligation costs (green levies) placed on electricity (23%) compared to gas (2%), as shown by the figure 6 below.

Figure 6: Breakdown of domestic electricity and gas bill



Source: Ofgem

The UK Government is currently consulting on the "Review of Electricity market arrangements" (REMA), which includes proposals for reducing electricity costs for consumers. Removing these levies from existing energy tariff structures would reduce the running costs of electrified heating solutions and encourage the uptake of low carbon heating.[13] However, there are many complexities involved in this change and the impact of rebalancing these costs must be understood further before it can be proven to be an effective mechanism for reducing electricity costs.

In addition to the impact of the levies, electricity prices (and gas prices) also include significant distribution and transmission charges (network costs). Electricity bills could be reduced by permitting heat networks connected to the electricity grid to pay lower network charges (recognising their ability to use electricity at times of low demand).

Regardless of these potential mechanisms, relatively low gas prices will continue to disincentivise the rollout of low emission heat networks, as they make any change to an alternative heat source appear more expensive. This is proving to be a significant barrier in the private sector.

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[12] Heat networks are often driven by non-domestic pricing arrangements. Green levies on non-domestic bills represent a smaller proportion of the total costs but are still a driver of higher electricity prices.

[13] Review of gas and electricity levies and their impact on low carbon heating uptake (climatexchange.org.uk)

4.4.4 Technical challenges

Operators and funders pointed to several heat network-related technical barriers which create further uncertainty and investor reluctance. The high-level technical challenges noted below are not an exhaustive list but rather provide important context for the rest of this report.

4.4.4.1 The need for density

In high density urban areas where there are large levels of heat demand, heat networks often provide the lowest cost low carbon heating option. The alternative is for properties to use individual air source heat pumps (ASHPs), which would place greater electricity demands on the grid and may result in higher customer costs and increased operational costs. Scotland has several areas where there is significant scale and suitable density levels for heat networks. However, operators noted that there are a greater number of large urban areas with multiple opportunities in England. This naturally provides significant competition for investment that might otherwise be made in the Scottish locations, especially for operators (operating both in England and Scotland) exploring opportunities across the UK. Additionally, smaller scale communal heating solutions may be appropriate for lower density areas; however, we do not explore this in detail as it is outside the scope of the report.

4.4.4.2 Technical complexity

Many of the existing heat network projects utilise different heat sources and technological solutions, including things as basic as pipework sizing. As projects increase in size, this lack of standardisation can present challenges for heat networks integrating and/or scaling up.

4.4.4.3 Decarbonisation challenges

Historically, many heat networks across the UK (and internationally) have been powered by carbon-based heat sources. However, operators consistently noted that customers now expect heat networks to use low emission heat sources. Low carbon technology is typically more expensive, and technologically complex than legacy carbon-based fuel sources and this therefore represents an additional factor impacting the commerciality of new projects.

4.4.5 Social and market challenges

The sector also experiences wider challenges in the development of the market for heat networks.

4.4.5.1 Consumer experience and scepticism

Operators and funders highlighted recurring customer concerns, including security of supply, pricing and consumer protection, that provide challenges to operators attracting potential domestic consumers to their heat networks.[14] Additionally, countries with a long history of operating heat networks, have an established culture of valuing and trusting the technology meaning consumers better understand the benefits. These factors have

[14] The Future of Heating: Meeting the challenge (publishing.service.gov.uk)

supported the development of international heat networks and have resulted in reduced levels of negative consumer experience and scepticism.

4.4.5.2 Lack of standardised commercial models

The lack of a standard delivery and operating model for heat networks results in developers and public sector partners (e.g. local authorities) having to invest significant time and resources developing proposals for their projects. This is explained further in section 4.5. This additional time and complexity increase development timescales.

4.4.5.3 Supply chain – the sector has a limited number of heat network developers

There are a limited number of private sector operators in Scotland, which in turn have a limited supply chain. The current developer landscape includes a number of balance sheet backed developers (SSE, EON, Vattenfall) and some infrastructure fund backed developers (Hemiko, 1Energy and Bring Energy).

This places a high dependency on a very small number of corporates relative to the scale of the heat network opportunities in the wider UK. Additionally, local authorities have a significant role to play in developing networks but they have limited in-house capacity and resource and therefore, rely on a small number of financial, technical and legal advisors.

4.5 Heat network delivery models – summary/overview

To address some of the barriers restricting the roll out of heat networks at scale, the Scottish Government is exploring a range of levers, including financial, technical and regulatory, and considering the optimum delivery models to support the sector. Although this report does not undertake a detailed assessment of these models, our overview provides context for the financial levers explored further in this report.

In 2022, the Scottish Government commissioned the Scottish Futures Trust (SFT) to undertake analysis on potential delivery models that could accelerate the pace and scale of heat network deployment in Scotland. The subsequent Heat Networks Delivery Models (HNDM) report, published in February 2024, identified four models that warranted further detailed development and consideration, namely:

- Regional Heat Partnership / Regional Energy Services Company (RESCo) model
- Local authority-led joint venture
- Local authority-led delivery, with Scottish Government stake
- Centrally-led delivery

Following the HNDM report’s publication, Scottish Government has collaborated with SFT to further develop the Regional Heat Partnership and Centrally-led models.

5 Overview of international experience

The Scottish Government can draw insight from comparable European and other international markets. It can be particularly helpful to consider how these sectors are developed, financed and regulated. To develop this insight, we have reviewed approaches in countries with high levels of market maturity, as well as those with characteristics similar to Scotland's.

Our analysis is primarily based on five international examples, referred to in this section as the "comparator countries". As shown in Figure 7, these are the Netherlands, Germany, Finland, Sweden and Estonia. During our shortlisting process, we considered jurisdictions such as the USA, Canada, Belgium, Ireland, Latvia and Poland, but found a lack of relevant data from which meaningful conclusions could be drawn. Our analysis will refer to these other countries where relevant.

Figure 7: Comparator Summary

Comparator Shortlist
Netherlands
Germany
Finland
Sweden
Estonia

Source: EY Analysis

Denmark has a mature and successful heat network sector and is often considered a valuable source of insight for Scotland. It is deliberately excluded from our analysis as the Scottish Government has a detailed understanding of the factors that have contributed to its success. These factors include cultural acceptance of heat networks and high consumer trust. Additionally, it has established regulatory levers such as mandatory connections.

This section provides an overview of:

- The history of comparator countries' heat networks with a brief market overview
- The availability and impact of public financing levers
- The regulatory structures
- The market ownership profile and level of private finance penetration
- The financial composition of heat network assets

0B provides supplementary information for each international example.

5.1 History of international heat networks and market overview

Figure 8 summarises the maturity of each country's heat network sector, based on the definitions developed by Department for Energy Security and Net Zero (DESNZ)[15]:

- Emerging – the market is still a nascent sector with lots of growth opportunity
- Expanding – the sector is established but is continually growing
- Consolidating – the market is mature and technology is being refined, updated or refreshed

[15] DESNZ (BEIS) "International review of heat network frameworks" (2020)

- Refurbishing – the market is very mature and heat network technology is on the n^{th} generation, but the networks are aged and require significant replacement and/or refurbishment

The comparator countries have a range of heat network maturity levels, with Finland and Sweden widely acknowledged as having mature and well-established sectors, while the Netherlands has an emerging heat network sector with many similar characteristics as Scotland.

DESNZ classified the UK and therefore by implication, both Scotland and the rest of the UK as emerging markets. 0B provides a brief historical overview of each international comparator.

Figure 8: Maturity of international heat networks

Emerging	Expanding	Consolidating	Refurbishing
Scotland	Germany	Sweden	Estonia
rUK		Finland	
Netherlands			

Source: DESNZ (BEIS) “International review of heat network frameworks” (2020)

5.1.1 Key findings

The Nordic countries (Sweden and Finland) and Estonia are in the “consolidating” and “refurbishing” categories. In each country, the sectors are mature and the technology is tried, tested and trusted.

Overall, the Nordics have been leaders in district heat networks since the 1940s. The 1970s oil crisis stimulated a transition to alternative fuel sources and acted as a catalyst for rapid expansion in the sector. This early adoption is a significant factor driving the higher degrees of maturity in their district heating networks. Familiarity of the technology has supported the cultural acceptance. By 2015, 46% of Sweden’s heat networks were supplied by biomass and only 7% utilised oil or gas[16].

Heat networks are common in Germany, with the first pilot system having gone live in the 1950s. The sector has grown over the last decade with significant numbers of large-scale heat networks. Therefore, the market has surpassed the initial emerging phase of high growth but strives to continually expand toward becoming a mature market.

Germany is in the expanding category. Compared to Scotland, Germany has been using heat networks for much longer and the initial rapid growth phase has taken place. There is now a focus on continuing to add connections to existing networks.

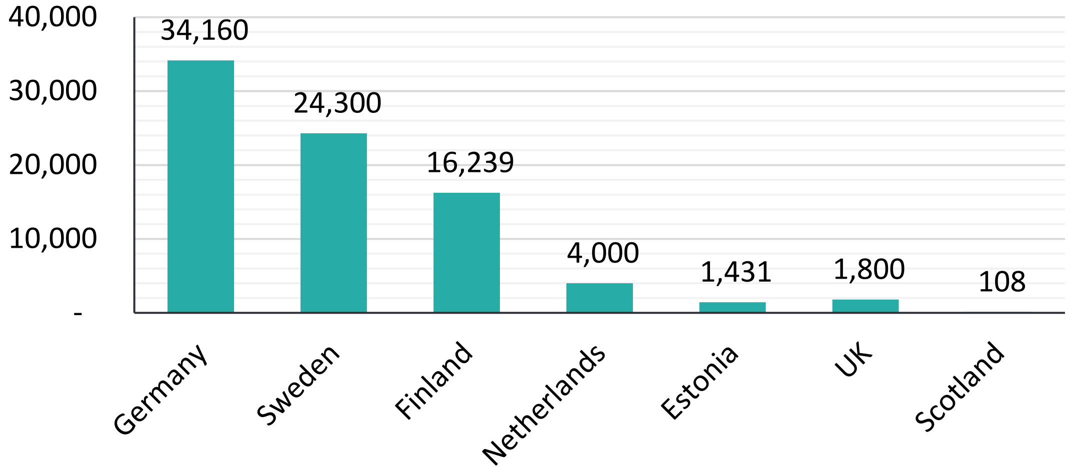
Although the Netherlands implemented its first heat networks in a comparable time frame to Germany (Utrecht in 1923, followed by Rotterdam in 1949) this early adoption was not built upon, and no new networks were constructed in the 1950s and 1960s. However, there has been a moderate uptake of district heating schemes since the late 1980s[17]. The market

[16] CXC “Lessons from European regulation and practice for Scottish district heating regulation” (2018)
[17] DBDH.org (2022) - District Heating History - DBDH

is therefore relatively small but undergoing rapid change driven by a political commitment to decarbonise heat and reduce emissions from buildings. Therefore, there are strong similarities between Scotland and the Netherlands both in heat network market size and nascency and the Government's ambition to decarbonise heat in buildings using district heating.

The scale of heat networks in most of the comparator countries differs significantly from Scotland. Figure 9 illustrates the cumulative length of heat networks in kilometres in each country[18]. While country size plays a role, Germany has nearly 35,000km of heat network infrastructure, whilst Estonia, although highly developed, is limited by its comparatively smaller size. Notwithstanding that, Scotland's relative position to the comparator countries is clear.

Figure 9: Cumulative kilometres of heat networks



Source: EY analysis

Across Europe, the maturity of the sector varies, with countries such as Sweden, Finland and Estonia building on the successful implementation of decades worth of investment in the sector. The sector is still emerging in Scotland, like the Netherlands, where it does not demonstrate many of the characteristics of the more mature countries, such as cultural acceptance of heat networks and scale in the market. This provides important context for the following section reflecting on the appropriateness and availability of financial levers.

5.2 Impact of public financing levers

Public financing levers significantly influence the implementation and expansion of heat networks internationally. Financial levers serve as catalysts for innovation, growth and the adoption of low carbon technologies.

Table 2 provides an overview of the financial mechanisms that aid the development and expansion of heat networks. The levers include capital grants, tax exemptions and incentives, revenue grants, individual connection grants and decarbonisation incentives (for

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[18] Euroheat & Power "DHC Market Outlook 2024" (2024), CXC "Lessons from European regulation and practice for Scottish district heating regulation" 2018, Ministry of Economic Affairs and Communications "Possibilities of efficiency in heating and cooling in Estonia" (2016)

example, grant funding for decarbonised technology). Each country is discussed further in Appendix B.

Table 2: Summary of public financial levers used by international comparators

Country	Financial Levers
Rest of the UK	• Capital grant funding • Feasibility study support • Revenue Grants (existing heat networks)
The Netherlands	• Capital grant funding • Individual connection grants
Germany	• Capital grant funding and operating cost support • Feasibility study support • Low carbon installation subsidies
Finland	• Tax incentives
Sweden	• Individual connection grants • Tax exemptions
Estonia	• Investment support • Energy cost compensation • Individual connection grants

Source: EY Analysis

In addition to the financial levers shown above, most comparator countries also benefit from a state-owned infrastructure bank investing in their district heating sector. State-owned infrastructure banks operate on similar terms to commercial lenders but may have the ability to adopt an increased risk appetite. This enables them to support heat networks in circumstances where commercial banks cannot. Additionally, EU member states benefit from access to EU funding where there are no bespoke heat network funding pots.

Recent investments reflect a growing appetite to engage across different markets with varying levels of maturity. For example, banks like the Nordic Investment Bank (NIB) provide investment support to help refurbish existing heat network assets across the Nordics and Baltics, while Germany's infrastructure bank (KfW) is providing grants to help continue the transition to a more mature market in Germany.

Stakeholder engagement confirmed that both Scottish National Investment Bank (SNIB) and National Wealth Fund (NWF) have ample capital to deploy. The issue was reported to be a lack of investible projects.

0 provides a summary of state-owned infrastructure banks and relevant examples across the chosen countries.

5.2.1 Key findings

As illustrated by Table 2, most of the comparator countries have adopted a range of financial levers. Many have applied a similar approach to Scotland, including the continued use of capital grant funding, project development funding or individual grants for expanding and upgrading heat networks.

Grant funding is a common financing lever, especially for the countries who are growing their heat network sectors. For example, in 2022 Germany introduced a €3bn fund to support the development and construction costs of new decarbonised heat networks (where 75% of the heat is sourced from decarbonised heat sources)[19]. This provides grant funding up to 40% of the eligible capital costs. The fund also provides feasibility support to projects. Additionally, the Netherlands is using a €400m fund to support the capital costs of new heat networks. The analysis shows that capital grant funding continues to be popular as an effective funding lever available before the sector reaches maturity. Regarding the UK market, there is continued funding from the Green Heat Network Fund (GHNF), with £288m initially made available and an additional £485m allocated in December 2023. The GHNF is expected to run until 2028, however operators expect that this will continue past 2028.

Another common lever in more mature countries is using individual grants or connection grants to incentivise connection to heat networks. For example, KfW helps deliver anchor loads to networks by offering increased grant support to local authorities for the connection of public sector buildings. Examples of individual incentives include the Estonian Business and Innovation Agency grant, which offers up to €10,000 for small residential buildings to connect to existing networks.

Estonia also offers a phased compensation scheme for the use of heat networks versus existing carbon-based alternatives. The Estonian Government provided compensation of 80% of the additional costs faced by heat network users because of increased energy prices.

Finland is developing a tax credit scheme which projects will be able to benefit from after they become operationally profitable. This has the aim of making project cashflows more appealing to investors, helping increase early returns by reducing the tax expense.

It is clear that many countries are promoting the use of grant funding to varying degrees. Significant levels of support are provided in jurisdictions with less mature sectors, while more mature countries use and develop other forms of support. The use of grant funding in Scotland and the rest of the UK is well established. Similarly, the Netherlands with its less mature sector also provides significant grant funding programmes. In Germany (an expanding country), grant funding continues to be a well utilised financial lever but intervention rates have decreased from predecessor programmes. Additionally, there is a requirement for a much larger proportion of the heat to be from renewable sources. The example of other emerging countries in Europe indicates that the market in Scotland will continue to rely on grant funding, even if the intervention levels decrease (like Germany) or grant funding is targeted at specific areas of sectors.

5.3 Regulatory structures

Our international comparator countries employ a range of regulatory structures (regarding operation, pricing and decarbonisation requirements) and national oversight. These range from self-governing municipality frameworks with a limited role for national regulators to nationwide regulatory frameworks governing the entire heat networks market. Whilst regulatory landscapes differ, the varying regimes offer interesting lessons for heat networks in Scotland.

[19] Solarthermalworld.org (2022) - Fund of EUR 3 billion for decarbonising German district heating | Solarthermalworld

Table 3 provides an overview of the international regulatory landscape and each country's approach to mandatory connections. Detailed findings for these countries are shown in 0.

Table 3: Overview of international regulatory landscape

Country	Regulated/Unregulated	Mandatory Connections
rUK	Regulation in development	No*
The Netherlands	Regulated	Yes
Germany	Unregulated	No
Finland	Unregulated	No
Sweden	Regulated	No
Estonia	Regulated	Yes

*DESNZ is currently shaping its policy approach to mandatory connections. It is expected mandatory connections will be enforced on certain buildings in defined zones to be connected to heat networks by a given deadline[20]. However, details are yet to be fully confirmed.

5.3.1 Key Findings

Across our comparator countries, many of the developed and mature markets (e.g. Finland and Germany) are unregulated. The heat networks have a self-governing framework and abide by technical codes and industry standards but no third-party regulatory oversight. Municipalities have their own governance procedures; they are self-governing with greater pricing transparency, consistent contractual delivery and contractual routes. The evidence suggests that these countries focus on consumer pricing and that introducing standardisation supports investment and stimulates the sector's development.

Mandatory connection to heat networks is used in some of the comparator countries, establishing base heat loads and reducing demand uncertainty. Mandatory connections are primarily applied to new developments, but barriers exist to using them in the retrofit market. For example, in relation to timing of connection for retrofits: where buildings may have recently installed new carbon-based technologies, connection to a heat network may not be considered for many years until their heat source needs replaced. Finland decided to repeal mandatory requirement having concluded they could be deemed anti-competitive given other decarbonised heating options are also used successfully.

Clear government policies on decarbonisation and the phasing out of carbon-based fuels are evident among the comparator countries. Germany's Building and Energy Act 2020 requires municipalities to have heating (including heat networks) powered by 65% renewable energy from January 2024 onward and to phase out existing oil and gas heating systems. The German Government is incentivising the transition via KfW and offering bonus support for an accelerated switch to heat networks or other renewable sources. Similarly, the Netherlands has banned new developments from connecting to the gas grid from 2028 via amendments to Gas Act 2018.

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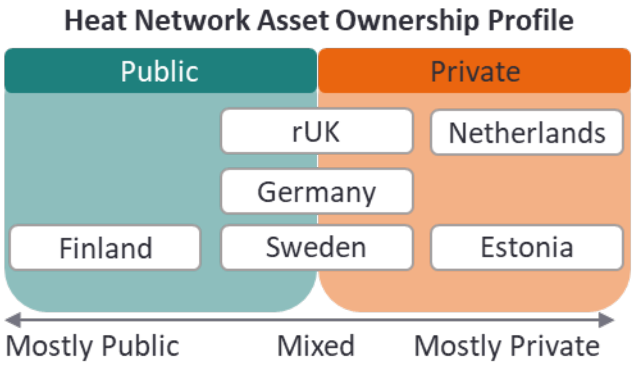
[20] Burges-Salmon (2024) - [The Heat Network Zoning Consultation: Will you be required to connect?]

5.4 Market ownership profile and private finance penetration

Our comparator countries also tend to have different ownership structures, with ownership split between the public and private sector in different ways.

Figure 10 below shows the current profile of heat network ownership across each country, with Finland's ownership largely public, the Netherlands and Estonia mostly private, and rUK, Germany and Sweden demonstrating mixed ownership structures.

Figure 10: Asset ownership profile



Source: EY Analysis

5.4.1 Key findings

Ownership profiles differ across the selected comparator countries with several observable themes. For some comparator countries, there is a high proportion of private sector finance. For example, in the Netherlands more than 90% of heat networks are managed by the private sector. This has helped to scale up investment. Established heat networks offer attractive, stable investments to institutional investors looking for long term consistent returns – as evidenced by Dutch pension institution PGGM investing in Swedish networks.

In other countries, including Finland, public sector ownership in the sector is at a high level. However, they are still seeking investment from the private sector to support established municipally owned heat networks, where budget restrictions limit upgrades and refurbishments. This ownership profile provides an interesting reference point for Scotland, as it allows the sector to benefit from additional investment.

The analysis shows significant levels of public ownership in many of the mature and maturing countries. In Germany, for example, Berlin's municipality acquired the Berlin heat network for €1.4bn from Vattenfall. This demonstrated a commitment to re-municipalising infrastructure and reversing privatisations to gain more influence over the city's district heating and gas supply. The municipality believes the Berlin network to be profitable and that it will play a significant role in moving toward climate neutrality.

In the Netherlands, the high levels of private sector ownership have resulted in the Dutch government proposing legislation in 2022 to part-nationalise the sector. Municipalities will have the opportunity to own up to 51% of networks, thereby bringing market ownership into the public sector. The proposal is designed to mitigate concerns regarding the affordability of heat for end users, the reliability of the services and the need to safeguard public sector climate change ambitions and public values. However, this initiative has led to significant concerns from several operators who feel that it will lead to a significant downturn in private sector investment[21]. During our stakeholder interviews, one European operator warned that this move will make the Netherlands “uninvestable”.

Overall, more mature markets tend to have a greater level of private finance penetration due to reduced risks and more stable operations. However, public sector ownership still allows local government to maintain more control regarding price and climate targets. Operators in the Netherlands indicated that the introduction of legislation to restrict private sector investment (and therefore control over the heat networks) can have a significant negative impact on the market and reduce investment security in the private sector. Under the new Dutch model, the incentives for private companies to invest in public projects are small and short term, as the private sector will lose control of the decision making while retaining significant levels of financial risk. Scotland should consider the impact that future regulatory changes may have on private sector investment appetite while balancing this with its broader objectives of reducing fuel poverty and supporting clean heat networks.

5.5 Financial composition of heat networks

The upfront capital expenditure expected revenue receipts and cash flow for other asset classes can be estimated with enough certainty to attract debt financing. In contrast, heat networks under development tend to have multiple expansion options and uncertainty around which end users will connect and when. This means costs or revenue inflows are not certain enough to allow a traditional project finance approach.

Rabobank, a Dutch multinational bank, highlighted that district heating companies self-financing their heating grids is a common approach in developing markets like the Netherlands. Their balance sheets typically include a mixture of debt and equity. Additionally, they also identify that traditional project financing is much harder to implement as it requires a significant portion of a project’s cashflows to be secured (by having contracted demand), which is an inherent problem for heat networks. Rabobank also stated that whilst large credit worthy companies may be able to raise finance to fund heat networks and reduce their equity component of a project, smaller less bankable heat network developments may require government guarantees over any debt to help improve their attractiveness to private sector.[22]

The stakeholder engagement sessions also reflected the view that corporate balance sheet financing will remain the main source of financing in developing markets in the near-term. Mature markets like Sweden, Finland and Estonia, benefit from more traditional forms of debt financing because they are well established and understood by lenders. For example, the NIB provided a €12m loan repayable over 10 years to help finance the heat network in Pirkanmaa, Finland.[23] These mature markets can also access EU financing to reduce dependence on carbon-based fuels. For example, the Finnish energy company Helen Ltd

[21] Dutch state set to take control of district heating schemes - DutchNews.nl

[22] Rabobank “Effects of the New Collective Heat Supply Act Determine Investment Climate for District Heating Sector” (2023)

[23] Nordic Investment Bank “NIB finances investments in electricity distribution and district heating in Finland” (2023)

received a €150m loan in April 2024 via REPowerEU[24] for building a new heat pump plant and converting fuel use from coal to biomass pellets.

Consequently, developing heat networks are often funded purely from equity financing until they reach operational profitability. Only once stable profits are achieved can network operators consider refinancing and attracting debt lenders to expand their networks. Private Equity firms often take an equity stake in a heat network, but the composition of their fund could be a mixture of institutional debt and equity.

5.6 Conclusions

Our comparator countries present a mix of maturity levels, various ownership profiles, regulatory structures and financing levers. Those with more developed sectors have a mixed degree of public ownership and the ability to access private finance. They are mainly regulated by standard frameworks within the municipalities with regulators adopting a back seat approach. However, these countries with less regulation have had the technology embedded in their culture for much longer. Therefore, the regulators can focus on price transparency and fairness for the end user rather than a framework for developing the market.

Scotland has the opportunity to overcome the barriers faced by the sector by adopting solutions that have been successful elsewhere, including regulation, clear direction on decarbonisation and financing levers:

- **Regulation:** Standardised and practical regulatory frameworks help to ensure consistency across the market. They make it simpler for operators to undertake projects by reducing project complexity. Additionally, standardised frameworks and agreements provide greater certainty and transparency regarding control and responsibility of heat network assets. This provides operators with confidence over the assets.
- **Decarbonisation**: All of the countries on our shortlist are actively moving away from fossil fuel heat networks and incentivising clean heat networks through policy choices. For example, sector development may be encouraged through connection subsidy or a phased ban on carbon-based alternatives. Additionally, mandatory connections provide a baseline for investment cases, making projects investible as demand assurance can be satisfied. Equally, contracted revenues obtained as part of the demand assurance may provide enough certainty to encourage private investment into heat networks.
- **Financing levers:** Comparator countries have provided financial incentives for connecting to existing heat networks offering further incentives for accelerated uptake. Capital grant support is the most common lever used by international comparators across all market maturities as it can make the investment decision for expansion of heat networks more viable. Similarly, when networks are seeking connections, individuals need to be incentivised to connect. For example, by bridging the gap on cost to their current heat sources, particularly when there are no

[24] European Investment Bank “Finland: EIB makes loan to replace Helsinki’s fossil-based heating plants with renewable energy” (2024)

regulations requiring individuals to connect. Additionally, state-owned infrastructure banks can be used to leverage these solutions as the market develops. For example, if connection fees are mandatory, a connection fee facility could be rolled up into the overall financing solution as there will be enough clarity on contracted revenue cashflows to reduce demand assurance risk.

The key considerations can be summarised as follows:

- simple and standardised frameworks to ensure consistency within the regulations
- clear direction on decarbonisation
- the use of mandatory connections (such as on new developments) to provide certainty
- public financing levers to develop projects and also to incentivise individuals to connect.

6 Review of financing mechanisms in selected utility sectors

6.1 Introduction

The UK utilities sector is a multifaceted industry that provides essential services for the protection and maintenance of modern daily life and commerce. These services include the provision of electricity, gas, water, telecommunications and transport. Each segment and subsector of the utility sector is integral to the economy's stability, growth and societal well-being. Regulation of such sectors ensures that individuals, and businesses have access to the critical resources they require at a reasonable cost.

Each UK utility sector is governed by a specific regulator responsible for consumer protection (including pricing), safety, reliability and sustainability, ensuring a well-developed network of public services provided under regulatory regimes, as outlined in Appendix C. The primary regulators include:

- The Office of Gas and Electricity Markets (Ofgem)
- The Water Services Regulation Authority (Ofwat) in England and Wales
- The Office of Communications (Ofcom)
- The Office of Rail and Road (ORR)
- The Civil Aviation Authority (CAA)

The global shift towards net zero, with an emphasis on clean heating systems, requires the development of regulatory regimes to incorporate new energy solutions.

Regulatory oversight will remain crucial for balancing the objectives of climate change mitigation with continued access to reliable and affordable utility services. As a result, heat networks are planned to be subject to formal regulation across England, Wales and Scotland by 2024/25 in line with primary legislation introduced as part of the Energy Act 2023 and the Heat Networks (Scotland) Act 2021.

6.2 Purpose

This section of the report examines the origins and current characteristics of other regulated utility sectors. We also explore if specific aspects of the regulation of other sectors can inform the regulatory and financial environment, which will help accelerate the development of heat networks in Scotland.

To aid in understanding how potential heat networks regimes may develop, we outline how the sectors have historically been financed and how the regulatory structures have facilitated the deployment of capital.

6.3 Methodology

We performed analysis to identify regulated utilities which offer a good comparator to heat networks. This included examining the characteristics of a long list of 39 regulated sectors covering electricity, water, telecommunications, rail and air regulation against the criteria listed in Appendix D. Based upon the preliminary analysis, we progressed 17 utilities for further examination which is discussed in Appendix K.

Further to the completion of the detailed analysis (Appendix K), we determined that offshore wind electricity generation, household water & sewerage undertakers and Carbon Capture, Utilisation and Storage (CCUS) demonstrated relevant attributes for heat networks. The key characteristics of each sector are summarised in Appendix E. This includes risk profile, type of sector the utility operates within and the investment time horizon for each utility.

These three utilities are used to understand how the utility sector is regulated and how investment supports ongoing development. They are also used to explore how heat networks might be regulated and how regulatory approaches impact levels of financing. Each sector is analysed separately below before evaluating how aspects could be applied to heat networks. A summary of regulatory timelines for these sectors is shown in Appendix F.

6.4 Offshore wind

6.4.1 Overview

The UK's offshore wind sector is rapidly expanding and plays a pivotal role in the nation's transition to renewable energy. Between the UK's first offshore wind allocation round (AR1 2015) and AR 6 (2024), a total of 21 GW of offshore wind capacity has been supported by Contracts for Difference (CfDs). CfDs are explained in more detail below.

6.4.2 Regulatory Structure

Following the Energy Act 2004, Ofgem has continued to regulate the sector and is adapting its approach as offshore wind projects continue to be deployed, offering new support mechanisms. Ofgem's regulation of offshore wind is structured around several key elements. It is designed to promote the development of the sector whilst ensuring efficiency, competition and the protection of consumers interests. Regulations cover, licensing, support mechanisms, grid connection, market oversight and consumer protection. Further details can be found at Appendix G.

Ofgem's remit also extends to the provision of Innovation Funding to support the transition to net-zero energy systems. This includes support to accelerate technological advancements, improve efficiency and reduce costs.

6.4.3 Regulatory Financing Mechanisms

Offshore wind is characterised by large upfront capital expenditure, availability risk (wind variability) and exposure to a competitive and volatile electricity market. All these factors impact the sector's ability to secure much needed investment. The investment time horizon is around 15 years commensurate with the term of a CfD. Unlike the deployment of heat networks, offshore wind is not exposed to demand risk as it operates on a wholesale basis whereby electricity is exported directly to the national grid.

CfDs provide long-term stable and predictable revenue for offshore wind developers, thus making offshore wind attractive to investors, creating optimised financing structures that can reduce the overall cost of capital. A CfD has the effect of providing a fixed price for each MWh of electricity that the project generates over a specified period (typically 15 years) referred to as the "Strike Price". The Strike Price typically reflects the price per MWh a developer considers necessary to achieve its applicable return on investment over the period of the CfD. CfDs are awarded through a competitive auction process (Allocation Round) administered by the Department of Energy Security and Net Zero (DESNZ).

The Strike Price is different to the actual market price, known as the "Reference Price", which is calculated based on the average market price per MWh over a given period. When the Reference Price is lower than the Strike Price, a top up payment of the difference in price is made by the Low Carbon Contracts Company (LCCC) to the offshore generator. Conversely, if the Reference Price is greater than the Strike Price, then the generator must pay the difference to LCCC.

CfDs were originally introduced in 2013 and replaced the Renewable Obligation Certificate (ROC) regime, which was the main support mechanism for renewable energy prior to CfDs. CfDs are an evolution of the support mechanism for renewable energy projects that increases competition and whereby the Strike Price better reflects the underlying levelised cost of the technology.

6.5 Household water & sewerage undertakers

6.5.1 Overview

The household water and sewerage sector in the UK provides essential water supply and wastewater services to residential and commercial customers. The sector operates as a natural monopoly and is therefore highly regulated across England and Wales and Scotland.

6.5.2 Regulatory Structure

6.5.2.1 England and Wales

In England and Wales the sector is regulated by Ofwat. The regulator aims to ensure high-quality services, fair pricing, compliance with environmental standards, and the financial viability of water companies. The regulatory structure has evolved over time to address priorities such as infrastructure investment, customer service improvement and environmental concerns.

Key changes include the introduction of competition to drive efficiency, periodic price reviews by setting price limits and service targets, increased customer engagement, and innovation funding. These changes aim to create a more outcome-based regulatory regime that encourages water companies to be customer-oriented, efficient, and forward-thinking in their operations and investments, ensuring high standards of water quality and environmental stewardship.

6.5.2.2 Scotland

Scottish Water is regulated by the Water Industry Commission for Scotland (WICS), which ensures value for money and efficiency without a profit motive. This aligns with Scottish Government policies on affordability and public ownership. WICS is governed by the Water Industry (Scotland) Act 2002, as amended by the Water Services etc. (Scotland) Act 2005 and the Water Resources (Scotland) Act 2013.

WICS' role is to set charge caps, monitor performance, facilitate retail competition for non-household customers, and support the Hydro Nation vision. Price reviews are conducted every six years. Reviews set price limits based on Scottish Water's business plan, customer input, and factors such as debt service and operational efficiency, with a transition away from the RAB model since 2010.

WICS also sets efficiency targets and, while independent, can be influenced by Scottish Ministers on financial matters, potentially impacting long-term infrastructure maintenance if charges are set too low. Scottish Water receives government loans or grants for large capital projects, reducing reliance on customer charges. However, this funding depends on the impact on the Scottish Government's balance sheet, requiring careful management for long-term sustainability. Further details on this can be found at Appendix H.

6.5.3 Regulatory Financing Mechanisms

6.5.3.1 England and Wales

The water and sewerage sector relies on long-term investment provided by the capital markets, typically in the form of shareholder equity and bond finance. Most utilities are highly geared and therefore very sensitive to adverse changes in credit ratings (via Moody's, S&P and Fitch). Nearly all utilities aim for an investment-grade credit rating to secure optimum lending terms with the primary objective of lowering the company's Weighted Average Cost of Capital (WACC).

Ofwat's regulation and associated pricing reviews provide a stable financial environment for investors. They ensure reliable demand due to the monopolistic nature of the customer base despite some revenue risk from bad debt. The application of a Regulated Asset Base (RAB) model (discussed below) along with the submission of Asset Management Plans (AMPs) that contribute to periodic price reviews, is designed to incentivise investment in infrastructure and services whereby the water companies are required to manage risks related to capital programmes, asset maintenance and operational costs similar to those in the heat network sector.

6.5.3.2 Regulated Asset Based (RAB)

The RAB model regulates water company prices while ensuring infrastructure maintenance and service quality. The RAB represents the value of a company's capital assets based on historical costs, depreciation, and new investments. Ofwat uses the RAB value to set allowed revenue requirements, applying a WACC to determine the maximum revenue companies can charge, incentivising efficient investment and continual infrastructure improvements. This model is effective in the water sector due to the manageable number of operators, encouraging companies to invest efficiently and include new investments in future revenue streams.

6.5.3.3 Periodic Price Reviews

Ofwat's price reviews, conducted every five years, determine the revenue water companies can earn. They take into both capital and operational expenditures into consideration to set price controls and encourage large-scale investment projects. The submission of AMPs contributes to the periodic price review process, which includes performance incentives through Outcome Delivery Incentives (ODIs), rewarding companies for meeting targets and penalising underperformance, aligning financial interests with high-quality service delivery. The periodic pricing reviews, coupled with limited demand risk provides greater revenue certainty for investment.

The latest Asset Management Plan (AMP8) for 2025-2030 focuses on climate change, emissions reduction, water quality improvement, leakage reduction, and reliable services. It also introduces innovative funding solutions such as the Direct Procurement for Customers (DPC) programme to support significant infrastructure investments.

6.5.3.4 Innovation funding

Although there are many external innovation funds available to water companies, Ofwat has established its own Ofwat Innovation Fund. The aim of this £200m fund is to encourage collaborative initiatives and partnerships within the water sector to tackle the larger challenges the sector faces such as climate change, leakage and affordability.

6.5.3.5 Scotland

Whilst Ofwat regulates the water sector in England and Wales, privatisation of the sector has resulted in high debt leverage which can give rise to value leakage to shareholders and risk of under investment of infrastructure. Thames Water, England's largest water company, has requested that Ofwat approves an increase in water bills of up to 40% by 2030.

Scotland has sought to mitigate these specific risks through the water services being publicly owned. Services are operated by Scottish Water which remains accountable to the Scottish Government and its customers. This helps to ensure profits are reinvested in the infrastructure rather than distributed to shareholders. WICS is an Executive Non-Departmental Public Body whose principle statutory functions are to:

- Determine charge caps;
- Monitor Scottish Water's performance, encouraging efficiency and sustainability;
- Facilitate competition by encouraging the entry of retail water and sewerage providers for non-household customers in Scotland; and
- Support the Scottish Government's vision of ensuring that Scotland is a Hydro Nation and meet their obligations under the Water Resources Act 2013.

Water charges are set by WICS and remain relatively stable as profits are reinvested. The domestic charges are linked to council tax bands, with prices increasing as bands increase. Historically charges were calculated using a version of the RAB model. However, since the price review in 2010, WICS has moved away from the RAB based model towards looking at business requirements as the basis for setting prices.

6.5.3.6 Price Reviews

Similar to Ofwat in England and Wales, WICS performs Strategic Reviews of Charges to set price limits for the next regulatory period, usually every six years. The Strategic Reviews of Charges is initially based upon Scottish Water's long term business plan. This encompasses short and long-term infrastructure investment requirements, debt repayments and operating costs. WICS subsequently evaluates the business plan, with a focus on Debt Service Cover Ratio (DSCR), alongside multiple other factors including inflation, investment needs and operational efficiency to determine annual price caps for customers. These may be adjusted annually within the limits set by WICS to account for inflation or other changes.

Although a proxy RAB continues to exist to act as an internal comparator to England and Wales water sector, Scottish Water's customer-focussed business plan helps align Scottish Water with Scotland Government objectives.

6.5.3.7 Government Grants and Incentives

Scottish Water receives loans or grants from the Scottish Government to finance large capital expenditure projects. These reduce reliance upon customer charges, improving affordability for households and businesses. While government-backed loans could offer more favourable terms than private market financing, such a mechanism could impact the Scottish Government balance sheet (borrowing requirement). This impact could mean funding is not granted for infrastructure development and maintenance projects and instead a short-term increase in customer prices would have to be required. As such, any borrowing is carefully managed to ensure long term financial sustainability for both Scottish Water and Scottish Government.

6.6 Carbon Capture, Utilisation and Storage (CCUS)

6.6.1 Overview

CCUS is an emerging sector in the UK, crucial for achieving the net zero emissions target by 2050. The government is actively developing a regulatory framework to support its deployment. This framework, shaped by legislation such as the Energy Act 2023, aims to ensure CCUS projects are financially viable, environmentally effective and resilient. It provides regulatory oversight from bodies like Ofgem, the Oil and Gas Authority, and the Department for Energy Security and Net Zero (DESNZ).

6.6.2 Regulatory Structure

The UK's CCUS sector is in its infancy and, to date, no significant facilities have been developed. As a result, it is referred to as a First of a Kind ("FOAK") project. To facilitate the development, financing and deployment of CCUS technology, a robust regulatory landscape is required, coupled with effective funding support mechanisms. This includes the need to address the revenue uncertainty associated with demand risk from emitter connections. Further details on this can be found within Appendix I. The proposed regulatory framework aims to enable the sector's development while contributing to net zero goals, with current proposals including a RAB-based model with revenue support to encourage initial investment and asset maintenance, anticipating evolution as technology and risks develop.

6.6.3 Regulatory Financing Mechanisms

Similar to the water and sewerage sector, the proposed regulatory RAB model for entities developing, owning, and operating CCUS transport and storage infrastructure (T&SCo) aims to provide long-term reliable revenues in order to secure the private sector funding necessary to construct the infrastructure and meet ongoing operational costs. The allowed revenue is determined similarly to other RAB models. DESNZ will initially administer this for CCUS before Ofgem takes over shortly after commercial operations begin. Despite the significant resources and time required to administer a RAB model, it is considered appropriate and effective for attracting private sector investment in T&SCo projects due to the anticipated limited number of such projects. Further details on how a RAB model operates can be found at Appendix H and Appendix I.

6.6.3.1 Revenue Support Agreement

Due to the uncertain uptake of CCUS technology in the early years, there is significant risk that T&SCos may not generate sufficient allowed revenue under the RAB model. To mitigate this risk, the regulatory structure includes a revenue support agreement, like CfDs in sectors such as offshore wind, until the market matures. The Low Carbon Contracts Company (LCCC) is the proposed counterparty to this agreement, responsible for covering any shortfall in actual revenue compared to the forecasted allowed revenue, thereby mitigating demand and revenue risk until the sector matures.

The CCUS regulatory framework addresses risks associated with FOAK projects by combining previous regulatory support mechanisms and encouraging investment through long-term, predictable revenue for equity investors supported by a contract with LCCC. The RAB model ensures continual maintenance of assets by increasing allowed revenue to cover maintenance costs, promoting adequate net revenue and visibility for future projects. However, this amalgamation of support mechanisms is still in development and remains untested until large CCUS projects begin construction.

6.7 Integration of regulatory models with heat networks

For each model described above, the aim has been to provide an economic and financial environment that stimulates private sector investment and develops new infrastructure. Furthermore, it should be noted that such regimes and financial support have evolved over time depending on the maturity of the sector and UK Government’s priorities and policies.

Each energy or utility sector is very different, with unique characteristics necessitating a bespoke approach to both regulation and financial support mechanisms. Such differences can include the maturity of the sector or technology intervention, including FOAK projects such as CCUS, nature of service provision (e.g. wholesale versus retail) such as electricity and water, the extent and maturity of regulation and the quantum of investment required.

Furthermore, each sector will be heavily influenced by legislation, such as Section 92 of the HNSA that sets targets for the combined supply of thermal energy by heat networks, to reach 2.6 TWh by 2027 and 6 TWh by 2030.

6.7.1 Offshore Wind – Contract for Differences (CfDs)

The purpose, mechanism and award process for CfDs is very well understood and has proved very successful in securing the necessary investment in a wide range of renewable energy technologies, in particular Offshore Wind.

CfDs have evolved over time. Its predecessor was ROCs, which were in place between 2002 and 2017, and before that the Non-Fossil Fuel Obligations (NFFOs) and Scottish Renewables Obligation (SRO) launched as early as 1990.

CfDs’ primary purpose, like that of its predecessors, is to provide price assurance to the developer and associated investors in relation to each MWh of electricity generated and sold to the grid. In the majority of cases, the projects utilise proven technology such as Solar PV, On-Shore and Off-Shore Wind, together comprising c.96% of the CfD allocation within AR 6.

Construction and availability risks are both borne by the developer. While offshore wind generation can be reliably estimated, heat networks depend on gradually increasing connections over time, introducing demand uncertainty. With Solar PV and On-Shore and Off-Shore wind generation, capacity broadly remains the same over the operational life of the asset. For these reasons, a CfD may not be an appropriate mechanism at this moment in time for managing the demand risk associated with heat networks, which is currently a key inhibitor to the deployment of more private sector funding.

CfDs could however play a role in providing revenue support to those heat networks seeking to utilise decarbonised heat sources (other than industrial waste heat or heat from energy from waste plants). This type of mechanism could incentivise the transition from fossil-based heat sources (e.g. gas boilers) to more sustainable forms of heat generations (e.g. heat pumps). At present, residential customers are unlikely to be able to afford the increase in the cost of heat compared to conventional gas boilers or heat networks using waste heat.

6.7.2 Household water & sewerage undertakers – RAB-based Model

The RAB model utilised in the water sector, in conjunction with the associated price reviews, has proven to be an effective mechanism for encouraging investment and securing funding from the capital markets. This approach provides a tried and tested framework for recovering the costs of the investment over a period of time. This in turn encourages utilities to embark on much needed infrastructure development. Ofwat is also looking at new mechanisms such as Direct Procurement for Customers (DPC) for much larger scale capex projects.

Integral to the regulation and application of the RAB based model, is management of the inter-generational risk of customer charges. This means today's customers should not feel any greater financial burden from new investment than the customers in the future. In the water sector, utilities still bear the risks associated with inflation, construction and operation costs, interest rates and to a lesser degree demand and bad debt risk within England and Wales.

The RAB model is widely used across sectors where revenue forecasting is relatively stable due to low demand risk. However, demand risk is highly uncertain for heat networks as a result of the uncertainty of connections. A key risk for potential investors is the heat network sector's inability to manage demand risk and therefore a RAB model-based approach may not be a viable solution in the short term to incentivise investment. A RAB model could, however, play a key role in the regulation of the sector once it achieves critical mass and the impending regulation of the sector has had sufficient time to evolve and prove effective in the sector.

Key considerations for any RAB model are the resources and time required to regulate a sector effectively. The model and associated regulation works effectively in the water sector not least due the limited number of water utilities (11). Given that the heat network sector will comprise thousands of heat networks of various sizes, a RAB model may not be practical for all projects unless projects are first consolidated on a regional basis, or are subject to a minimum MW size requirement prior to utilising a RAB model. We do understand, however, that the impending regulation of the heat network sector will focus on tariffs (regarding Value for Money) and customer service, but it is unclear whether this will extend to a RAB-based model approach.

6.7.3 Carbon Capture, Utilisation and Storage (CCUS) – RAB Model and revenue support

The CCUS programme comprises T&SCo projects and carbon capture technologies developed at industrial and Energy from Waste (EfW) facilities. They are at a very early stage in the development cycle and as such referred to as FOAK projects. Furthermore, CCUS projects are not only exposed to technology and construction risk (i.e. the technology is considered unproven at such scale) but also are exposed to significant demand risk as industrial and waste emitters decarbonise over time. Such connections to the T&SCo infrastructure are therefore uncertain. Heat network technology is relatively tried and tested, but the issue of timing and quantum of connections is the same dilemma for both the heat network sector and CCUS. The CCUS sector has had to adapt its regulatory framework to address the issue of "demand risk" not mitigated by utilisation of a RAB model alone. A combination of RAB model and revenue support helps mitigate demand risk within CCUS.

This could potentially be largely replicated within heat networks, in particular to support the upfront capital expenditure. However, were this method to be adopted, extensive regulatory and legislative discussions would be required to ascertain a suitable counterparty to the revenue support mechanism. Furthermore, the positioning of who bears bad debt risk would need to be established. However, this risk is generally accepted within the water sector and arguably should be no different for heat networks. While this combination of regulatory support is planned for CCUS, it remains an untested regime with the potential for inefficiencies. This is particularly the case for heat networks given the limitations of a RAB model identified above.

Alternative regulatory structures for heat networks could include offering grants to offset upfront costs and revenue support mechanism to mitigate demand risk. This and other combinations of mechanisms, such as a cap on payments to reduce the risk of over-incentivising, could incentivise investment in heat networks without too great a departure from regulatory norms.

6.7.4 Renewable Heat Incentive (RHI) specifically for heat networks

It may be possible to develop a RHI specific to heat networks. This could bridge the price gap between gas and electric networks whilst encouraging investment. The RHI was a UK Government financial support scheme designed to encourage the uptake of renewable heat technologies. Since 31 March 2021 it has been closed for new applicants. A similar type of incentive for the deployment of heat networks would aim to promote the development and expansion of the sector and could include the features listed in Table 4.

Table 4: Summary of features for a potential RHI-type heat network incentive

Feature	Description
Tariff payments	Operators or users could receive periodic payments based on the amount of low carbon heat generated and supplied per MWh, which could be guaranteed for a period of time (usually quarterly payments over 20 years) to improve financial viability of projects.
Eligible technologies	The incentive could cover a range of renewable heat generation technologies that can be integrated into heat networks.
Tiered tariffs	A tiered tariff structure to encourage efficient operation which pays a higher rate up to a certain level of heat output and a lower rate beyond that could be implemented to incentivise operators to size systems appropriately and manage demand.

Feature	Description
Upfront capital support	In addition to ongoing tariff payments, grants or loans to aid cover upfront capital expenditure would reduce the financial barriers to entry.
Performance standards	To qualify for the incentive, certain performance and efficiency standards would have to be met.
Metering and monitoring	Accurate metering of heat production and consumption would be required in order to calculate incentive payments.
Support for innovation	Additional funding could be made available for projects which demonstrate new technologies or business models helping the sectors development.

An RHI-type incentive in heat networks would aim to stimulate market growth and help achieve net zero emissions through the integration of carbon-based fuels to renewable energy. It could provide a financial impetus for the adoption of heat networks and making them an attractive option for developers, local authorities and consumers particularly if coupled with grants.

7 Stakeholder insight

This section summarises stakeholder feedback from the stakeholder interview exercise. The methodology underpinning this exercise is set out in Section 3.3. Stakeholder feedback also informed conclusions in other sections of this report, including:

- Overall views and attractiveness of the sector
- Key investment risks
- Key initiatives that are required to move to a predominantly privately financed model

The private sector views heat networks as an attractive investment opportunity. However, there are areas of uncertainty that must be resolved, including the need for greater clarity on the development of future regulation. To facilitate private investment, stakeholders highlighted the need for continued grant funding support (which will help de-risk project cashflows), clear regulation on key areas such as zoning and mandatory connections, and clear direction on future policy banning carbon-based heat systems. Table 5 below summarises the detailed views of each stakeholder group.

Table 5: Stakeholder Engagement Summary

Stakeholder Group	**How attractive is the sector?**	**What are the key sector investment risks?**	**What are the key initiatives that are required to move to a predominantly privately financed model?**
Capital orientated stakeholders			
Operators	Operators see significant interest from private infrastructure investors. However, there are concerns that private sector investment may move to other asset classes if the government does not provide certainty on future regulation and continue to financially support the sector.	The main observations from operators were: • Demand assurance risk – Uncertainty in cash flows due to lack of contracted revenue. • Development risk – Unforeseen issues arising during construction leading to cost overruns and delays. • Lack of regulation around statutory undertaking of rights – A barrier exists for the wide scale roll out when operators need to negotiate with each individual landowner rather than having a licence for the full network. • Scale of expansion – key strategic projects that support the overall development of the sector should be targeted for	• Continued public sector support with extended funding round periods. • Long term political support is required. • Financial support to facilitate connections. • Regulation to address policy gaps including clarity on mandatory connections. • Clearer regulation on the decarbonisation of the sector (e.g. phasing out gas boilers).

Stakeholder Group	How attractive is the sector?	What are the key sector investment risks?	What are the key initiatives that are required to move to a predominantly privately financed model?
		support rather than small stand-alone projects. • Consumer hearts and minds – Low carbon technology is a more expensive alternative than existing carbon-based technology. Consumers need incentives to adopt the technology. • Without continued support, zoning/permitting and regulation are insufficient to improve deployment of heat networks alone. • Operators would prefer aligned regulation between Scotland and UK Government. • The sector is likely to be primarily financed from developers' balance sheets. • Mandatory connections are a key enabler for development. • Grant funding drawdown needs to be flexible to align with project needs.	
Private capital / infrastructure funds	The sector is attractive to investors, with stable recurring cashflows. There is a clear growth opportunity in the UK.	The main observations from private capital stakeholders were: • The pace of regulation needs to increase to bring clarity to the sector. • Limited and smaller investment opportunities: Projects with capital costs exceeding £10m are more attractive investment opportunities for funders. This means that larger city scale projects are typically prioritised by funders. • Local authority communication and collaboration – On local authority led projects there needs to be clear planning and alignment for projects coming to market between all parties. Investors need clarity on the timing of capital deployment to	• Continued grant funding support that matches the needs and requirements of the projects. • Clear regulation around zoning/permitting and mandatory connections. • Clearer regulation on the decarbonisation of the sector (e.g. phasing out gas boilers).

Stakeholder Group	How attractive is the sector?	What are the key sector investment risks?	What are the key initiatives that are required to move to a predominantly privately financed model?
		help them assess investment opportunities effectively. • There is uncertainty regarding the phasing out of carbon based heating solutions (e.g. gas boilers), making it difficult for investors to take a strong position in the sector.	
Policy Banks	The sector is an attractive investment opportunity however the current market is lacking large commercially ready projects where policy banks can invest.	• There is ample capital to deploy but limited commercially ready projects to finance. • Project scale – Project must be of sufficient size (e.g. £25m+ investment) and therefore, there are fewer investment opportunities in Scottish compared to rUK.	• Continued grant funding support is needed that also matches project timelines and requirements. • Providing connection cost funding to enable public sector anchor loads.
Non-capital orientated stakeholders			
Commercial Advisors	Established heat networks are viewed favourably by the private sector. The characteristics are similar to a bond therefore attractive to institutional investors.	Observations from commercial advisors included: • Procurement structures – Operators and investors need clarity on ownership and risk-reward responsibilities in joint ventures with public sector to assess and manage project risks. • Carbon based alternatives are still cheaper for consumers. Consumers need incentivised to adopt clean heat networks needs to improve. • Market uncertainty via a lack of regulatory clarity. For example, clarity on mandatory connections.	• Continued public sector grant support that matches project timelines and needs.
Legal Advisors	Less appetite from lenders in early-stage heat networks due to uncertainty of payback.	Key observations from legal advisors included: • There is market uncertainty due to lack of regulatory clarity. The market needs greater regulatory alignment with England and Wales.	• Continued public sector support in the form of Capex funding and/or revenue support to help provide assurance to lenders in the early stages of a heat network.

Stakeholder Group	How attractive is the sector?	What are the key sector investment risks?	What are the key initiatives that are required to move to a predominantly privately financed model?
		• Demand assurance – Stability of revenue streams is crucial to investors. • There are too many procurement models from lenders' perspective. They want a small list of possible approaches which provides familiarity and reduces development costs. • The current funding windows of grant support are too narrow and do not align to project development needs. • Property rights are difficult to navigate due to the potential disruption associated with construction of heat networks.	• Public sector support for facilitating connection fees. • Clear regulation around zoning and mandatory connections.

Private capital and operator stakeholders were also asked specific questions regarding financial returns, types of financing, key financial metrics and shareholder structure. A summary of responses for each subcategory is provided below.

- **Rates of return**: Stakeholders gave a consistent view of the minimum internal rate of return (IRR) requirement range for heat network developments. This was between 8% and 12% depending on a project's specific risk profile (which can vary significantly). For example, established trunk/core developments can have lower IRR where demand assurance and contracted revenues are satisfied, while a higher IRR is required on expansions to make the developments feasible and appropriately mitigate risk.

- **Types of financing:** Stakeholders unanimously agreed operators would likely use their own balance sheet for financing the short to medium term. Private Equity funds and infrastructure funds would predominantly continue to use equity to invest in the heat network sector. For the reasons outlined in earlier sections, the existing barriers around demand and revenue uncertainty limits debt investment in the sector.

- **Financial metrics**: Stakeholders noted that they have certain size requirements when investing and deploying capital. For those stakeholders investing in the sector, the minimum investment required ranged from £10m to £25m+. These stakeholders highlighted this can limit their involvement in Scotland as, compared with rUK, there are fewer projects that meet their investment scale requirements. However, stakeholders did say this issue could be mitigated by investing in multiple projects rather one large project.

- **Scale**: Similarly, stakeholders commented that rUK offers more opportunity due to the number of large city scale projects available. Scotland offers significant potential for large city scale networks but the greater number of cities and urban areas in the rest of the UK is more appealing as it offers more connection opportunities and a greater customer base.

- **Shareholder structure**: Private capital and operator stakeholders were open to collaborating with Local Authorities in a Joint Venture structure; however, they flagged key legal areas that would need additional scrutiny. For example, clear roles and responsibilities regarding asset risk and reward.

As illustrated by the stakeholder engagement, stakeholder subgroups all highlighted similar risks and themes and what support mechanisms exist for the heat network sector. The engagement exercise identified key issues and barriers that must be addressed to attract private sector investment. The exercise has therefore helped inform our recommendations as set out in the next section.

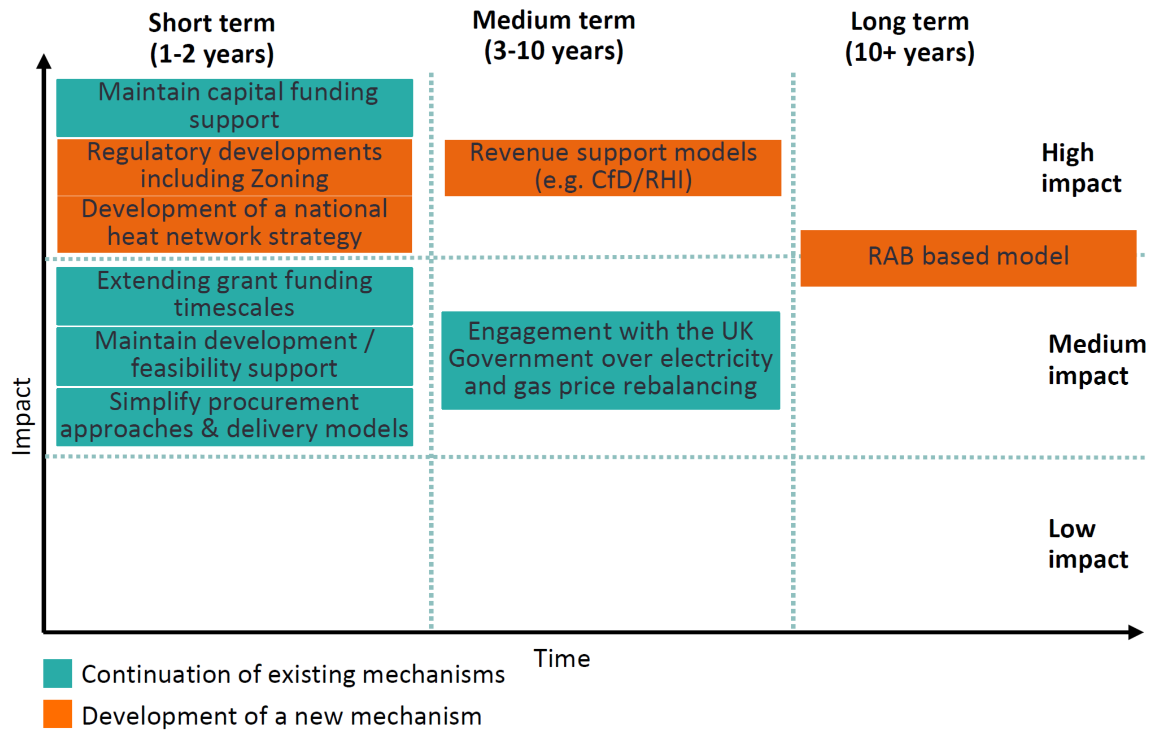
8 Recommendations

8.1 Summary

The evidence from this report indicates that the Scottish heat network sector is still maturing and, in the short to medium term, requires significant financial support from the public sector. In the medium to long term, we also recommend models for securing private sector finance and for scaling and speeding up the roll out of large heat networks in Scotland.

Figure 11 summarises our recommendations, indicating the suggested timeframe and expected impact of each.

Figure 11: The impact of mechanisms over time



Source: EY analysis

8.2 Recommendations for rollout of mechanisms or policy initiatives

The recommendations are explored in more detail below.

8.2.1 Recommendation 1

The Scottish Government should maintain capital funding support for the sector through existing programmes or new bespoke capital schemes. The Scottish Government should also explore opportunities for extending grant funding drawdown timescales.

Timescales – short to medium term e.g. 1-10 years

This recommendation addresses barriers related to high capital costs, demand uncertainty and long development and construction times.

- Stakeholders unanimously agreed that the large-scale deployment of heat networks requires continued public support. There is also precedent from other emerging countries to support the sector in this way.
- Future grant funding programmes must reflect a heat network's significant development and construction timescales. The Scottish Government aims to avoid piecemeal developments and the development of large-scale heat networks can be significantly longer than the existing grant funding windows. Although cross party support for the sector exists, the Scottish Government could consider secondary legislation which extends timescales. This would provide long term certainty to the market. However, we recognise government funding and budgetary restrictions will make this challenging. We also note that current schemes have open funding windows and seek to create as much flexibility as possible for applicants. Further sub-recommendations could also be considered including:
    - Reducing intervention rates. The level of grant support is subject to numerous factors, but any grant support should be sized to provide developers with a reasonable project IRR (noting that this is already standard practice). This will help support a greater number of projects, with lower levels of capital. There is precedent from the GHNF for lower levels of support, but differences between the GHNF and SHNF must be considered (including the varying volume of applications received through both programmes and different assessment criteria).
    - Targeting intervention at specific geographical areas or aligning with local regional strategies. This could include aligning support to regional zoning activity or targeting support at specific geographic areas where there are significant opportunities for future heat networks.
    - Target grant funding in other ways, for example, to support connection fees and/or enabling costs for end users of new residential areas. There is international precedent for this, including grant support to incentivise anchor loads. Further support for the public sector to meet connection fees could also be considered. Public Sector enabling costs are already supported through the Green Public Sector Estate Decarbonisation Scheme.
    - Grant funding could be exclusively targeted at district heating projects rather than smaller communal heating schemes.

8.2.2 Recommendation 2

Our review has found that de-risking future revenues is key to unlocking HN development – private capital is available for projects of this scale, but it must be financeable. Our initial analysis therefore concludes that more detailed analysis of a revenue support model, such as Contracts for Difference (CfD) or a Renewable Heat Incentive (RHI) equivalent, is merited. However, the Scottish Government must address the challenges of establishing such schemes, described below.

Timescale – Medium 5+ years

This recommendation addresses the barriers associated with demand uncertainty.

In section 6 we review the benefits of these models in the context of other relevant utility sectors. However, there are additional factors that the Scottish Government must consider before pursing this further. For example, it must consider the significant administrative and resource costs of establishing such schemes. Additionally, constrained revenue budgets mean that the creation of a new revenue model will represent a significant budgetary challenge for the Scottish Government. Lastly, with differences in regulation, policy and powers, the Scottish Government must also consider how a revenue model could be introduced in isolation from the rest of the UK. Additional CfD and RHI considerations are summarised below:

a. **Contracts for Difference** – Although this is a well-established model, certain complexities must be resolved before it can be deployed in the sector:
    - Calculating a reference price – heat prices are bespoke, and cannot be benchmarked to a national market price, unless there is regulation on the price of heat. This must be explored further before the model can be introduced.
    - Generation versus consumption – a CfD should be based on the generation of heat, rather than consumption of heat. This will help mitigate demand risk, as the model is not reliant on future unknown connections to the heat network.
    - The CfD could also subsidise the additional capital cost of installing expensive clean heat network technology.
    - Additionally, the higher cost of underlying electricity (compared to gas) could be mitigated and passed on to customers thereby reducing price risk. However, before introducing an alternative mechanism to grant funding, the CfD cost (compared to the level of grant) must be further understood.

b. **RHI model** – The RHI model is another well understood revenue support model, which has previously been used in the heat network sector. However, previous RHI schemes have been criticised, for example, the National Audit Office stated the UK Government did not achieve value for money.
    RHI subsidises the cost of heat generated from clean heat networks, compared to alternative forms of heat generation. However, complexities remain that must be addressed before it can be deployed:
    - Generation versus consumption – Similar to CfD, an RHI model would need to be based on the amount of heat generated, rather than consumption of heat, and would therefore act as a contribution to the cost of deployment. It would help to address the increased cost of installing a more expensive heat network technology, and at the same time mitigate demand risk.
    - A payment cap could be introduced to avoid over-incentivisation within the sector.
    - Before adopting an alternative to grant funding, the RHI cost (compared to the level of grant) must be thoroughly assessed.

8.2.3 Recommendation 3

Following further regulatory developments and the creation of an established asset base (possibly 10-15 years), the Scottish Government could explore the benefits of implementing a RAB model.

Timescale – Long term e.g. 10 years +

This recommendation addresses barriers associated with consumer experience and regulatory uncertainty.

- The RAB model (coupled with price reviews) has been shown to be helpful in protecting consumer prices whilst encouraging ongoing investment and maintaining assets.
- However, the cost and resource implications of administering RAB models across a large number of very diverse projects will be significant. This may be mitigated through minimum generation requirements, but this must be explored further. EY and many stakeholders agreed that a RAB model may be appropriate / beneficial in 10-15+ years but only after certain market characteristics are met.
- The Scottish Government must assess the feasibility of developing a Scottish RAB model, which may diverge from the approach in England and Wales.
- A transition from one regulatory mechanism to another could occur in the future. However, for this to occur, the sector must mature and must focus on large scale capital investment. This will impact whether a RAB model alone could be introduced to provide consumer protection or whether it will need to be supported with a revenue support mechanism. Furthermore, the market must be economically feasible (meaning the sector is more mature and financially viable) to regulate the assets themselves prior to introducing a RAB model.
- Importantly, without capital or revenue support, a RAB model will not by itself result in a financially viable heat network. It would therefore need to be coupled with other support mechanisms, as pioneered by CCUS. This reinforces the requirement to pursue short term sector support, including public sector capital funding.

8.2.4 Recommendation 4

SNIB and the UK National Wealth Fund are committed to investing in the sector. The Scottish Government must continue to work closely with these organisations in order to explore investment opportunities, create a shared understanding of each party's objectives and ultimately unlock the capital that has been made available to invest.

Timescales – short term e.g. now -1 year

This recommendation addresses the barriers associated with access to funding.

- The Scottish Government must also consider infrastructure bank restrictions, including who they can support (e.g. local authorities) and minimum lending requirements.

8.2.5 Recommendation 5

The Scottish Government should maintain and increase support for pre-construction projects, via the Heat Network Support Unit (HNSU) and specific development funding programmes.

Timescales – short term e.g. 1-2 years

This recommendation addresses the barriers associated with access to funding.

- To support the sector's development a strong pipeline of projects is required. In Scotland, and across the UK, there are a growing number of pre-construction projects that require commercialisation support.

- All stakeholders commented on the need for improved funding to develop heat networks until there are sufficient cashflows enabling networks to support themselves and attract other forms of funding.
- This could include expanding the role of the HNSU to take a more active development role similar to the UK Government's Heat Network Delivery Unit. However, the HNSU would require additional resources and financial support before it could expand its remit.
- The Scottish Government could also consider engaging with national development banks, e.g. SNIB or the NWF to co-develop development funding programmes.

8.2.6 Recommendation 6

The Sottish Government should monitor the implementation of the UK Government's zoning approach, and where appropriate, leverage best practice from DESNZ. This should be used to compliment Scotland's existing zoning approach.

Timescales – short term e.g. 1-2 years

This recommendation addresses the barriers associated with demand uncertainty.

- Robust zoning regulations, with mandatory connections will help reduce demand risk and support private sector investment. Ultimately this will support the roll out of larger heat networks at scale by reducing demand uncertainty for operators and investors.
- Regional Zones, across local authority boundaries, could be used to identify area of high heat demand, and key heat sources.
- These proposals could leverage the Advanced Zoning Programme (AZP) model adopted by DESNZ, where pilot heat network zones have been identified to supply.
- The HNSA creates the opportunity for local authorities and the Scottish Government (in some cases) to designate zones. This should be explored in more detail, including the number of zones required in Scotland. The Scottish Government could also use this route to create larger strategic zones across Scotland.
- However, zoning proposals must account for heat costs and the risk that consumers are forced to connect to a heat source that is more expensive than alternatives.
- The Scottish Government must also consider that its limited resources will reduce its ability to replicate the regulatory developments in England and Wales.

8.2.7 Recommendation 7

We recommend that Scottish Government reviews its regulatory approach to help reduce regulatory uncertainty, simplify delivery and align with the wider UK framework where appropriate.

Timescales – short term e.g. 1-2 years

This recommendation addresses the barriers associated with regulatory uncertainty.

- The introduction of secondary legislation, including further details on consenting and authorisation, will help to reduce the existing uncertainty in the market.
- The lack of standardisation in procurement approaches and delivery models adds complexity, time and cost to a project's development timeline. The Scottish Government should accelerate its activity to provide more clarity to the market. The UK Government is

also developing its delivery models. The Scottish Government could consider aligning with the UK Government approach to ensure a consistent landscape for the private sector.

- As part of the Advance Zoning Programme for Heat Networks in England, DESNZ issued template delivery model guidance for the procurement of Heat Network delivery partners. The purpose this is to assist project sponsors in the identification of opportunities for the acceleration of the scale and pace of zonal heat network delivery. Template documentation provides greater clarity in the marketplace leading to quicker and more effective procurement processes, improving market appetite and reducing bidder fatigue. The guidance for the promoters of AZP projects sets out the principles of three potential delivery models and sets out the characteristics to consider when determining the delivery model to adopt. This includes Development Agreements, the Golden Share and Co-investor models.

8.2.8 Recommendation 8

We recommend that the Scottish Government continues to work with the UK Government on rebalancing electricity and gas prices; however, this will not eliminate the price difference between electricity and gas.

Timescale – Medium 5+ years. However, the Scottish Government does not have the developed powers to implement this recommendation by itself, and therefore further discussions with the UK Government are required.

This recommendation addresses the barriers associated with structured pricing challenges.

- The UK Government is continuing to explore opportunities for rebalancing electricity and gas prices, to reduce electricity costs and support the affordability of clean heat networks for consumers. This initiative is not a devolved matter, so the Scottish Government should continue to work with the UK Government on the proposals. If unsuccessful, a revenue support model should be considered as an alternative to address pricing risk.

8.2.9 Recommendation 9

The Scottish Government should develop a national Heat Network Strategy setting out a long-term vision for Scotland's heat networks.

Timescales – short term e.g. 1-2 years

This recommendation addresses multiple barriers.

- Not only will this help provide further clarity and confidence to the private sector, but it will also help to educate and explain the benefits of heat networks to the wider Scottish public.
- This view was shared by specific stakeholders and mirrors the recently published Scottish Renewables Heat Network Vision.
- This strategy could also leverage the Scottish Futures Trust (SFT) analysis on sector delivery models which could accelerate the pace and scale of heat network deployment in Scotland.
- Additionally, the strategy should provide:
    - Clarity on national and regional Heat Network implementation, crossing local authority boundaries.

- A strategy for future public sector support, including where and how grant funding, should be targeted. This should also include Scottish Government's external commitment and its ability to invest in the sector.
- Inform the ongoing development and implementation of regulation.
- Plans for engaging with the UK Government on recommendations reserved to the UK Government, e.g. structural pricing plans.

9 Appendices

Appendix A – Financing mechanisms

There are a number of financing mechanisms that the Scottish Government could utilise to help de-risk heat network investments. These mechanisms, or “financial levers”, could increase the attractiveness of heat network projects to private investors and ultimately increase the pace and scale of their deployment. They may achieve this through reducing investment hurdle rates (by decreasing risk), increasing gearing levels to reduce the overall cost of capital and/or improving the project’s IRR to meet the investors’ thresholds. However, the need for these levers and the decision on which (if any) to employ, will vary from project to project and these factors should be assessed as part of the financial structuring of a project.

The financial levers available to Scottish Government can be broadly grouped into the following categories:

- Capital funding;
- Revenue funding;
- Investment; and
- Business model support.

The need for these levers and the decision on which (if any) to employ, will vary from project to project and these factors should be assessed as part of the financial structuring of a project. This section will summarise the key elements of these funding mechanisms and discuss their implications for resource demand, balance sheet treatment and exist strategy.

Capital funding

Capital funding uses capital budgets to provide gap funding for heat networks. This may be in the form of, for example, a capital grant or repayable assistance.

Capital grant

Capital Grants are allocated to fund activities aligned with government priorities, benefiting public or private entities that contribute to specific public outcomes. These grants come with conditions that must be met to avoid repayment obligations. In Scotland, Repayable Assistance is typically preferred over Capital Grants for heat networks, with the possibility of repayment if profitability exceeds expectations. Administering Capital Grants demands significant resources, particularly during application assessment, construction monitoring and post-commissioning for a period of 3-5 years. The treatment of Capital Grants on balance sheets depends on various factors, including the grant's size and terms, which may affect asset classification. After fulfilling all grant conditions, the grantee is released from obligations, but the grantor may benefit from maintaining a relationship for continued data access and to support future expansions.

Repayable assistance

Repayable Assistance functions similarly to Capital Grants, with the distinction that it must be repaid partially or in full if the project exceeds certain performance-related thresholds in the initial years of operation. This mechanism is designed to prevent grantees from benefiting excessively from public subsidies. Managing Repayable Assistance requires additional resource to evaluate and challenge financial returns and reports from grantees. The treatment of Repayable Assistance on the balance sheet is comparable to that of Capital Grants, with the classification determined by the delivery model, the proportion of Repayable Assistance to total capital costs of the project and the terms of risk allocation. The exit strategy involves ceasing monitoring once grant conditions are satisfied, which may take longer than for Capital Grants.

Revenue funding

Certain financial levers utilise revenue budgets to fund heat networks, such as revenue grants, heat purchase agreements (or demand guarantees) and outcomes-based funding.

Revenue grant

Revenue Grants fund activities that support government priorities and public benefits, with both public and private entities eligible as grantees. In Scotland, Revenue Grants have often been combined with Repayable Assistance and, from an investor perspective, can help mitigate revenue risk which is one of the most significant barriers to heat network investment. The grants, which are not typically repayable unless certain grant conditions are not met, can be performance-linked to ensure drawdowns align with financial need. The administration of Revenue Grants can be resource-intensive, as they require stringent monitoring across the project lifecycle. The treatment of these grants on government balance sheets is influenced by several factors, including the grants' size and the delivery model. After fulfilling grant conditions, which may take many years, the grantor's monitoring ceases, but a continued relationship with the grantee can be beneficial for gathering data and supporting future expansions.

Heat purchase

Heat Network developers require a level of assurance to ensure there will be a sufficient customer-base to make their investment viable. This assurance is crucial as it influences the decision to invest and the capacity to future-proof networks for anticipated demand growth. Anchor loads (significant heat demands that are likely to be the first connections to the heat network, typically large public buildings with sustained high heat demand) are essential for making networks investable. The Scottish Government could provide demand assurance through mechanisms such as Heat Purchase Agreements, where public buildings are offered as anchor loads without a guaranteed minimum demand and Demand Guarantees, which involve a "take or pay" commitment for a minimum quantity of heat.

These agreements require resources for due diligence, negotiation and ongoing monitoring, often requiring specialist expertise and governance to effectively manage the associated risks. The balance sheet treatment of these agreements may lead to on-balance-sheet classification of project assets, if risk transfer is diluted. The exit strategy for such agreements is to have a fixed contract term, after which they can be re-procured or renegotiated, with "take or pay" guarantees being time-bound and including withdrawal clauses under certain conditions, such as when sufficient third-party demand is secured.

Outcomes based funding

Outcomes based funding is a financial mechanism that focuses on achieving specific, pre-agreed outcomes rather than outputs. It operates on the principle of "payment by results", where organisations (typically local authorities, though could also apply to a private company) invest in infrastructure to deliver set outcomes. If these outcomes are met, Scottish Government would make regular payments over a set period, reflecting the pre-agreed value of the outcomes achieved. For example, these outcomes may be successful commissioning of the heat network, the number of heat network connections, carbon savings and/or the social value created. This model shares risk between the organisation and the government, however it is resource-intensive, requiring careful project selection, development and ongoing monitoring to ensure that the agreed outcomes are met. While it may not be efficient for smaller projects due to the resources needed for monitoring, Outcomes Based Funding can support infrastructure without being classified on the Scottish Government's balance sheet, if the delivery risk is fully transferred to the grantee. The monitoring period is predefined, often spanning 20-25 years, with revenue payments contingent on achieving these outcomes.

Investment

Equity

Special Purpose Vehicles (SPVs) are often formed for infrastructure projects. SPVs allow for project assets and risks to be held within the vehicle itself and enable investors to make more targeted investments into specific asset classes that align with their desired risk/return profiles. SPVs require one or more shareholders to own the company, appoint its board of directors and provide the necessary funding, typically through equity or shareholder loans as subordinated debt. These SPVs can be solely owned by one entity or jointly owned by multiple organisations, which may include a mix of public and private sector shareholders and can also take the form of corporate joint ventures.

The Scottish Government can participate in SPVs as an equity investor, either independently or in collaboration with private sector partners. This model affords Scottish Government a degree of control over the project's strategic direction and the opportunity to share in the profits, but also exposes government to the associated investment risks. In heat network projects, government might invest in the network's distribution assets and later recoup this investment through 'use of system' fees from other parties utilising the network. Managing such equity investments requires a long-term commitment and specialised expertise in investment structuring, due diligence and governance, ensuring that the government's interests and public funds are appropriately safeguarded. The impact of these investments on the government's balance sheet is influenced by the degree of control the government has as a shareholder, the size of the equity stake and the risk transfer mechanisms in place. In terms of exit strategies, the Scottish Government could sell its equity stake in the SPV once the project reaches a stage of profitable operation, allowing for the recycling of capital into other projects.

Debt finance

Debt finance is a financing mechanism where the government lends money to public or private sector borrowers, who are then obligated to repay the loan with interest according to the terms set out in a loan agreement. There are three key features of debt financing: the seniority of the debt, which determines the order of repayments from project cash flows between debt and equity holders; the security of loans, which may be secured or unsecure; and financial covenants that serve as safeguards for the lender by monitoring the borrower's financial health and triggering repayment in case of covenant breaches.

Scottish Government could establish a revolving loan facility aimed at supporting projects during their riskier construction and early operational stages, with the possibility of refinancing by the private sector once more stable operations are achieved. This approach facilitates the recycling of capital into new projects and aligns with the preferences of long-term investors seeking lower-risk opportunities. Administering such finance requires significant resources for project selection, development and monitoring, with the balance sheet treatment determined by factors such as loan terms, size and risk. The exit strategy allows for the recovery of investments through repayments or refinancing, potentially leading to capital receipts that can be reinvested or the sale of loan portfolios to investors, thus enabling ongoing economic development.

Loan guarantee

A Loan Guarantee by the Scottish Government provides a safety net over debt repayments to lenders, covering either the entire loan or a portion, with the aim of reducing the cost of capital for borrowers, such as heat network developers. This can make investments more feasible and enable access to loans that might otherwise be unavailable due to risk considerations. While initially having limited budgetary impact, provided the risk of the guarantee being called upon is low, there are Subsidy Control implications that may be offset by charging a fee for the guarantee. Implementing a Loan Guarantee scheme requires resources for design, project assessment, due diligence and ongoing monitoring, requiring specialist expertise and governance to manage financial and reputational risks. The balance sheet treatment of a Loan Guarantee is influenced by various factors, including the delivery model and the size and terms of the guarantee. The Scottish Government's exit strategy involves offering guarantees for a specific term with withdrawal clauses, allowing for the possibility of refinancing and withdrawing the guarantee once the project is operational and profitable.

Business Model Support

This section outlines common business model support mechanisms in the UK, such as Regulated Asset Base, Cap and Floor and Contracts for Difference, which could potentially be adapted for heat networks. These Business Model Supports would draw upon revenue budgets to heat networks. While these models are theoretically adaptable, they face significant challenges that require careful consideration to tailor them to the heat network sector.

Regulated asset base

A RAB is a regulatory framework that measures the capital used in a regulated entity, where companies are granted a licence by an economic regulator to charge users regulated prices for services linked to an infrastructure asset (operating on a “user pays” model). The regulator sets or caps the charges that the operator can levy for a certain period, reducing pricing risk for investors and ensuring charges allow for the efficient recovery of costs incurred by the operator in the interest of customers. Charges can be controlled through a revenue cap, which protects investors from both price and market existence/demand risk, or a price cap, which only shields from price risk.

Hybrid RAB models, combining a price cap with government cash injections, are being explored for Carbon Capture, Transport and Storage infrastructure to mitigate market existence/demand risk. The RAB operator's prices are calculated to enable recovery of operating expenditure, depreciation costs and an allowed return on capital, balancing risk reduction for investors with cost-efficiency incentives. Charges are reviewed and reset periodically by the regulator in consultation with the operator and customers, protecting investors from subsidy risk within each regulatory period. If applied to heat networks, a RAB model could significantly shield investors from price and market existence risks. However, current regulatory and policy frameworks for heat networks are not conducive to the model's deployment at this time.

Cap and floor

The cap and floor mechanism aims to offer investors a degree of revenue certainty while maintaining incentives for efficient operation. The floor guarantees a minimum revenue, covering at least operating costs and senior debt service, thus limiting investors' risk and enabling financing. Conversely, the cap sets a maximum revenue, with any excess being repaid, limiting the investors' returns.

A revenue sharing arrangement can be incorporated, where excess revenue is split between investors and user/taxpayers, rather than being fully retained by investors or returned to funders. The mechanism's terms, including cap and floor levels and the applicable period, are contractually agreed, reducing subsidy risk as the support cannot be abruptly withdrawn. This arrangement mitigates price risk and market existence/demand risk by assuring minimum revenue, independent of demand, although it does not protect against cost variability.

Currently utilised by Ofgem for financing electricity interconnectors and considered for electricity storage in the UK, the mechanism is funded by electricity users or, alternatively, could adopt a 'taxpayer pays' model with government involvement. For heat networks, while 'Cap and Floor' offers some risk protection, it requires careful implementation to avoid disincentivising network operators from acquiring new customers or charging competitive rates. Additionally, the 'taxpayer pays' model could lead to significant financial exposure for the Scottish Government.

Contracts for difference

CfDs are a support mechanism that offers investors a fixed, contractually agreed 'strike price' per unit of output. This helps to mitigate potential subsidy risk for investors due to the subsidy being a binding, contractual obligation. The strike price may be fixed or index-linked and CfDs can be signed with the government or a government-backed third party, with funding from taxpayers or users. The 'reference price', generally the market price, determines the subsidy level during each CfD period, with investors receiving a subsidy if the market price is below the strike price, or paying back if it's above. This support incentivises operational efficiency, as investors are exposed to cost variability risk and only receive support once the project is operational.

Although CfDs are used extensively for renewable electricity generation in the UK, applying this mechanism to heat networks poses challenges. It is difficult to define a reference price due to the absence of a wholesale heat market and the localised nature of heat network pricing, which relies on local factors such as the availability of low carbon heat sources and customer demand. Without regulated heat pricing or an accepted methodology for setting a wholesale price, the application of CfDs to heat networks remains complex.

Appendix B – International experience supplementary information

The supplementary narrative below provides a brief historical overview, a summary of the public financing levers available and a summary of the regulatory framework for each country. Additionally, the supplementary narrative is followed by additional information regarding the use of state-owned infrastructure banks.

Rest of the UK (rUK)

Overview

Heat network technology has been in the UK since the 1950s where the Pimlico District Heating Undertaking was the first true district heat network in the UK. The network connected 1,600 council homes to the waste heat generated by Battersea Power Station. However, heat networks fell out of popularity in the 1980s and 1990s as the UK shifted away from high rise flats but regained attention in the 2000s as energy prices increased and financial investment cases became more attractive[25].

Public financing levers:

The UK Government is aligned with international comparators offering up front capital grants in addition to grants for existing underperforming heat networks to encourage efficiency upgrades. These are as follows:

England and Wales have a designated heat network fund, the GHNF which was set up by DESNZ and managed by Triple Point Heat Networks Investment Management[26]. The GHNF is the next iteration of grant funding succeeding the Heat Networks Investment Project (HNIP) loans. The GHNF aims to provide up to 50% of upfront construction costs with the aim of making projects more investable for private sector. The GHNF initially had £288m of capital available but further funds of £485m has been additionally allocated.[27]

DESNZ has also recently published the Heat Network Efficiency Scheme (HNES)[28] which provides both capital grants to part fund installation and revenue grants to fund procurement or mobilisation of external third-party support to carry out Optimisation Studies. This scheme is targeting existing district heating or communal heating projects in England and Wales that are operating sub-optimally and resulting in poor outcomes for customers and operators.

Regulatory structures

Refer to section 4.2 for the UK regulatory structure overview.

Market ownership

The rest of the UK has a mixed market ownership profile with local authority owned, joint ventures and privately owned heat networks. For example, The London Borough of Enfield own the Energetik heat network, a growing network with its own energy from waste plant providing the heat for the network. Vattenfall own Bristol City's heat network and work in

[25] AECOM "The rise of energy-efficient heat networks in the UK's public sector" 2023
[26] Triple Point Heat Networks – "Green Heat Network Fund – guidance for applicants version 8.0" (2024)
[27] Gov.uk - "Full Business Case for Green Heat Network Fund GHNF" (2023)
[28] DESNZ– "Heat Network Efficiency Scheme (HNES) – Guidance for applicants version 5.0) (2024)

partnership with Argent and Barnet council[29]. There are also private equity backed heat network developers such as 1Energy backed by Asper Investment who have four projects under development, including the Bradford Energy Network. Local authority budget constraints will mean a continued role for private sector involvement. For example, the UK Government's routes to market proposals focus on the Concession and Joint Venture models.

The Netherlands

Overview

The Netherlands started exploring district heating in the 1920s, but the sector developed significantly following the 1970s oil crisis which prompted a search for more efficient and sustainable heating solutions. The country has since been expanding its heat network infrastructure, focusing on sustainability and the use of residual heat from industrial processes.

Public financing levers

The Netherlands is expanding its heat network market by providing capital grants for qualifying projects and incentivising individuals to connect to heat network via individual grants.

This includes the Heat Networks Investment Grant (referred to as the WIS programme), which supports the construction of new, efficient heat networks. This €400m programme was open between July 2024 and December 2024 and specifically targeted heat networks that help existing homes transition away from natural gas (capped at €30m available per project). The programme funds up to 45% of capital costs and aims to bridge the 'unprofitable top' of heating network investments (the difference between the eligible investment costs and the operating profit)[30]. The subsidy can never be more than 100% of this 'unprofitable top'. WIS can provide support to full projects as well as individual consumers, as it also provides up to €7,000 for small scale consumer connections.

Regulatory structure

The sector has been regulated in the Netherlands since 2014. The legislation was updated with the 2020 Heat Act 2.0, which outlines the requirements for creating a reliable, affordable and sustainable sector. The Act oversees pricing (including price regulation for smaller customers), licensing, private sector profits and customer protections. The Act also sets price caps to ensure that all heat network operators provide price information in a standard format, allowing for greater transparency to consumers.[31] Regarding tariff setting, the Authority for Consumers and Markets (ACM) ensures that costs for a household with a district heat connection are less than an individual condensing gas boiler.[32]

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[29] Vattenfall (2024) - We're working to deliver low carbon heat to homes and businesses across the UK. - Vattenfall Heat UK
[30] RVO.NL (2024) - "Heat network investment subsidy (WIS)" Heat Networks Investment Subsidy (WIS)
[31] DLA Piper (2024) - The Decarbonisation of Heat - what can the UK learn from the US, Germany and the Netherlands? | DLA Piper
[32] Interreg HeatNet North West Europe (2020) "Netherlands – national policy framework"

The Netherlands is also developing the Collective Heat Supply Act which aims to bring the heat network sector into public ownership. The Act will look to incorporate a ‘cost plus’ model where tariffs are based on actual cost plus a reasonable regulated rate of return[33]. However, the Act still needs to finalise ownership arrangements between heat generating companies and operators.

Additionally, the Netherlands mandates connections. Municipalities are required to prepare heat plans for their respective areas. This specifies that new buildings have to be connected to a heat network for ten years as part of a heat plan.[32] Furthermore, the Dutch Building Code states that a house will get a mandatory connection to a heat network when the network is within 40 metres.

Lastly, the Netherlands amended the Gas Act in 2018 to ban new buildings from connecting to the gas grid and introduced a new incentive scheme (SDE+). SDE+ provides subsidies to companies which generate renewable energy or reduce their CO2 emissions on a large scale. Similarly, the Netherlands will ban new fossil fuel-based heating systems from 2026.[34]

Market ownership

The Dutch heat network market has a large level of private finance penetration with more than 90% of heat networks managed by private heat companies (partly through Public-Private Partnerships) and less than 10% are owned fully by public sector heat companies. For example, Vattenfall (a Swedish state-owned company), Eneco Energy (privately owned) and Ennatuurlijk (Dutch utility company) dominate the market owning approximately 90% of the country’s district heating networks as heat infrastructure has not yet been separated by law from the production and supply of heat (unlike gas and electricity).[35] As such, in 2022, the Dutch government first considered part nationalisation of heat networks via the Collective Heat Supply Act (WCW) with the intention of protecting public interests such as affordability, reliability and sustainability.[36] The intention is that municipalities could own 51% of the network, to help encourage consumers to stop using gas fired central heating. The Dutch government believe more citizens would be willing to switch to heat networks if they are not forced into a model that requires the use of a private sector supplier.

This initiative was met with hostility from operators. Ennatuurlijk withdrew from development of the regional district heating grid Twente, as they were not clear how their assets and investments would be valued at the end of the transition period. Whilst the private sector supports opportunities to give more important roles to local authorities, there are concerns about losing control of the strategy and operations of the heating assets whilst remaining financially responsible for them.

Details and practicalities are still being refined, but it is envisaged that existing private network operators would be given a 20-30 year grace period to recoup their initial investments made before transferring ownership to municipalities[36].

[33] Rabobank “Effects of the New Collective Heat Supply Act Determine Investment Climate for District Heating Sector” (2023)

[34] EIBI (2024) - The Netherlands to ban fossil fuel installations from 2026 - EIBI

[35] Dutch News (2022) - Dutch state set to take control of district heating schemes - DutchNews.nl

[36] Rabobank “Effects of the New Collective Heat Supply Act Determine Investment Climate for District Heating Sector” (2023)

GERMANY

Overview

Germany's district heating has its roots in the late 19th century, but it became more widespread after World War II, particularly in East Germany. Today, Germany continues to invest in district heating as part of its energy transition, with a focus on integrating renewable energy sources and improving efficiency.

Public financing levers

The German Government supports the development of heat networks up front via feasibility, capex funding and additionally operating cost subsidies for renewable projects. Individuals and building owners are also incentivised via grant funding to upgrade heating or connect and further rewarded for an accelerated transition. The levers include legislation where there is €3bn to support the development of 5^{th} generation heat networks[37]. The previous legislation provided funding covering feasibility (up to 60% of costs) and construction (up to 50%). A new BEW fund provides 50% or €600k and 40% of eligible investment/operating cost subsidy, however this is only applicable to projects with 75% renewable heat sources.

Additionally, companies, landlords of rented family homes and condominium owners are now eligible for financing from KfW (Germany's state-owned infrastructure development bank) for installing low carbon heating systems or connecting to existing heat networks. The scheme can provide up to 30% of investment costs (plus an additional 5% for more efficient heat pumps)[38]. A €2,500 fixed support payment for efficient biomass heating systems is included and a speed bonus is applied if existing gas or oil heating systems are replaced by 2028. The scheme also can support individual home-owners with up to 70% of costs and municipalities will also be able to apply for support in late 2024.

Regulatory structures

Germany has the largest scale heat network market in Europe (illustrated by Figure 9) but it is unregulated. Instead, Germany has regulated electricity and gas markets and operates in a similar manner to Finland, with oversight from competition authorities. Standard terms and conditions for supply of heat networks are defined by Federal law.

Additionally, Germany amended the Building and Energy Act 2020 in September 2023[39] requiring municipalities to:

- Phase out oil and gas heating systems
- develop heating plans by 2028, including a regional heating approach
- that all heating systems installed in Germany after 1 January 2024 must be powered by at least 65% renewable energy

[37] Solarthermalworld.org (2022) - Fund of EUR 3 billion for decarbonising German district heating | Solarthermalworld
[38] BMWK (2024) - BMWK - New heating subsidies
[39] DLA Piper (2024) - The Decarbonisation of Heat - what can the UK learn from the US, Germany and the Netherlands? | DLA Piper

Initially the amendments will apply to new builds but extend to existing and under construction properties too.

The Local Heat Planning Act (WPG) also legally obliges district heating companies to decarbonise their networks[40]. Therefore, residents within these areas are removed from the transitioning process with responsibilities outsourced to professional entities such as private companies or municipal utilities. The WPG also requires building owners to switch from fossil fuels to renewable heating technologies and municipalities with a population over 100,000 to have draft heat plans by June 2026 (smaller municipalities by June 2028) identifying which heating technologies are available to connect to[41].

Market ownership

The German heat network market is in transition with several large heat networks becoming municipality owned. For example, in December 2023 Berlin's municipality acquired the Berlin heat network for €1.4bn from Vattenfall, showing how one of Germany's largest heat networks has moved into public sector ownership[42]. The heat network was bought by the state of Berlin as they are committed to re-municipalising infrastructure and reversing privatisations to gain more influence over the city's district heating and gas supply.[43] They also believe the company will be profitable and key in moving toward climate neutrality. The state was able to buy the heat network via a state-owned financing company which received equity from the state budget and loans from Investitionsbank Berlin which the senate backed by a state guarantee.[44]

As it stands, private companies, for example large energy suppliers, hold a significant share of the market and municipalities owning and operating the other significant proportion of the market.[45] The small remainder of the market is made up via large industrial companies who operate their own networks for industrial processes and heating factory buildings. Whilst market share is small, it is significant in industrial areas. Large public buildings also have their own networks, for example, universities, hospitals and other public sector buildings.

FINLAND

Overview

Finland has a long history of district heating, dating back to the 1950s. The country's cold climate makes district heating a practical choice for urban areas. Finnish district heating has evolved to use a mix of energy sources, including a significant proportion of renewable and waste energy and it is considered a key component of Finland's strategy to reduce greenhouse gas emissions.

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[40] DBDH (2024) "The missing actor in the heat market: how to fill the gap in Germany"
[41] Linklaters (2024) - District heating, heat pumps and hydrogen - how Germany plans to decarbonise its heating sector, Ruth Losch
[42] Vattenfall (2024) - Vattenfall completes sale of its heat business in Germany to the State of Berlin - Vattenfall
[43] Berlin (2023) Berlin considers purchase of Vattenfall's district heating business – Berlin.de
[44] Berlin (2023) State of Berlin takes over heating network from Vattenfall – Berlin.de
[45] DBDH "The missing actor in the heat market: how to fill the gap in Germany" (2024)

Public financing levers

The mature Finnish market is upgrading, refurbishing and decarbonising existing networks and is less focussed construction of new networks. The Finnish Government is facilitating the heat transition upgrades by Investing €21.8m across six projects for waste heat recovery, heat pump solutions and energy storage solutions to help move away from carbon-based heating[46]. Similarly, the Ministry of Economic Affairs and Employment has allocated €469m of energy aid from EU funding for renewable projects via the national Recovery and Resilience Plan[47]. However, there does not appear to be a bespoke heat network capital grant fund. Additionally, Finland is providing grant support for end users - €2k-€4 for heat exchangers and €0.5k-€2k for balanced and adjusted heating systems. Furthermore, the Government are introducing a new tax credit scheme to give projects up to €150m worth of tax credits.[48] The idea is once green projects (renewable projects aiding the transition to net zero) become operationally profitable, a tax credit would aid cash flows making the project more feasible and investible.

Regulatory Structures

Finland established a self-governing framework, where there is no official national regulation but instead a clear set of technical codes which form the industry standard[49]. Finland did have legislation with mandatory connections, which was repealed in 2019, as mandatory connections were deemed anti-competitive. Finland has alternative renewable energy heat sources to choose from.

The Finnish government also introduced a €90m scheme to incentivise the move away from carbon-based fuels to biomass CHP networks and €45m to non-combustion technologies (e.g. heat pumps).

Market ownership

The Finnish market currently has a low level of private finance penetration with heat networks being predominantly municipality owned. However, the Finnish Government is seeking foreign investment into the sector, as it recognises public sector budget pressure and the need to attract private sector investment. For example, an important driver behind the introduction of private finance is the requirement to refurbish existing networks as they become old and inefficient.

Private investors note that Finland is very attractive due to the stability of the heat network sector which allows institutional investors to gain comfort and certainty in their investment.[50]

Additionally, Finland has seen private equity infrastructure funds acquire individual networks. For example, the largest heat network owned by Fortum Energy (a state-owned

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[46] Euroheat & Power (2024) - New projects granted Recovery and Resilience Facility Funding in Finland - Euroheat & Power

[47] Finnish Government (2024) - EUR 72.6 million in investment aid granted to 13 clean energy projects - Finnish Government

[48] Bird & Bird (2024) - Significant tax aid for green investments in the pipeline - Bird & Bird

[49] BEIS (2020) – International Heat Networks – Masrket frameworks research – Regulatory document review

[50] Abrdn (2024) - abrdn: Feeling the heat in Finland

energy company) was recently acquired in 2021[51] by a private equity infrastructure investor (Partners Group) demonstrating the shifting landscape.

Therefore, Finland is demonstrating both the need for private investment as local authorities are capital constrained and offers a stable asset class to invest in an established market.

SWEDEN

Overview

Sweden has been a pioneer in district heating since the early 20th century. The first commercial district heating system was introduced in 1948. The oil crisis of the 1970s also accelerated the transition to district heating, which now utilises a high proportion of renewable energy sources. Sweden's extensive use of district heating is often cited as a model for other countries.

Public financing levers

The Swedish market is well developed and mature. The Government are using a range of capital funding, personal grant incentives and tax exemptions to expand and refine the heat network market. For example, the Swedish government can provide small grants up to 60,000 SEK (approximately £4,300) for conversion to a new heating system moving away from direct-acting electricity or gas for single family homes[52].

Additionally, Sweden also provides tax exemptions where renewable energy heating sources are exempt from energy and carbon dioxide taxes.[53]

Regulatory structures

The Swedish district heat market was deregulated in 1996 which brought issues surrounding high prices and lack of transparency. Subsequently, light-touch voluntary regulation was reintroduced via the District Heating Act (2008)[54] and overseen by the Swedish Energy Markets Inspectorate (who also regulate electricity and gas). For example, voluntary initiatives for pricing transparency where the Swedish Competition Authority can investigate any signs of potential market abuse. Additionally, the Swedish Energy Market Inspectorate also have standard contract terms for delivery of district heat networks to ensure a consistent delivery approach across the market.

Whilst there is regulatory oversight, connections are not mandatory in Sweden. Although Swedish municipalities are responsible for developing energy plans and have a monopoly planning of district heating developments, building owners decide on their sustainable heating source as long as they follow environmental standards[55].

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[51] Partners Group (2021) - Partners Group acquires District Heating Platform in Northern Europe
[52] Ulma (2023) - Contribution to the energy efficiency of single-family houses: This means the government's new proposal
[53] RES Legal (2019) - Renewable energy policy database and support: single
[54] CXC "Lessons from European regulation and practice for Scottish district heating regulation" (2018)
[55] Salite et al (2024) "A comparative analysis of policies and strategies supporting district heating expansion and decarbonisation in Denmark, Sweden, the Netherlands and the United Kingdom – Lessons for slow adopters of district heating"

Market ownership

The heat network sector in Sweden currently has a mixture of privately and publicly owned networks and operators. For example, the heat network assets are owned by the local authorities and municipalities or the state-owned operator Vattenfall, but there are also private sector operators such as Eon and Fortum. Additionally, Sweden also has some joint venture structures for example between the City of Stockholm and Achiale (private investors).

A recent example of private investment was the sale of 50% of the Fortum (a Finnish state-owned energy company) holding in Stockholm Exergi to a group of European institutional investors including pension funds.[56] This demonstrates institutional investors recognising the stable returns provided by established heat networks and the opportunity they present to private investors.

ESTONIA

Overview

Estonia's district heating systems were developed during the Soviet era, with the first systems established in the 1940s and 1950s. After regaining independence, Estonia reformed its district heating sector, improving efficiency and incorporating more renewable energy sources. The country has one of the highest rates of district heating coverage in Europe.

Public financing levers

As Estonia’s heat network sector is well advanced, there are limited grants and subsidies available. However, Estonia is encouraging refinement of their heat network market via investment support, compensation schemes and individual connection grants. Examples include the recent €20m investment by Gren (a private energy company) into Tartu, Parnu and Ida-Virumaa heat networks. Gren also received €4.2m of financial support from the Estonian Environment Investment Centre via the European Cohesion Fund and European Regional Development Fund[57].

Other forms of public funding included the Government compensation scheme for household energy consumed to counter the rising energy prices[58]. For example, the state compensates up to 80 percent of the part of the average monthly price that exceeds 80 euros/MWh for district heating. The subsidies are automatically applied to the district heating bills.

Additionally, the Estonian Business and Innovation Agency will provide up to a €10,000 grant for small residential buildings for facilitating the connection to an existing heat network[59].

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[56] PGGM (2021) - PGGM acquires minority stake in Swedish heating company Stockholm Exergi | PGGM
[57] Gren (2024) - Gren in Estonia invests over EUR 20 million in upgrading heating networks - Gren Finland
[58] IEA.org – “Energy price compensation for households” (2023)
[59] EIS Estonia (2024) - Grant for upgrading heaters for small residences | EIS

Regulatory structures

The Estonian district heat sector is regulated by the District Heating Act 2003 where heat operators must coordinate the price of heat sold to the consumer with the Competition Authority. Additionally, Estonia uses a dynamic pricing structure where changes in the heat price are influenced by changes in the underlying fuel prices and also the required investment that needs to be made in the heat network sector. The District Heating Act also stipulates that within district heating regions connection to the network is mandatory for all located in the region[60]. Furthermore, municipal governments within Finland, for example Tartu, mandated new and renovated buildings in district heating zones must be connected to a heat network.

Market ownership

The Estonian market has a high degree of private finance penetration as many heat networks are owned by private equity infrastructure funds. For example, Utilitas is the largest operator of heat networks in Estonia and is majority owned by an infrastructure fund. Similarly, recent transactions such as Gren acquiring Viljandi district heating company[61] and Partners Group acquiring a stake in the Finnish state-owned operator Fortum operating in Estonia demonstrate the attractiveness of a mature and developed heat network sector to private investors.

[60] Riigi Teataja District Heating Act- District Heating Act–Riigi Teataja
[61] Gren (2024) - Gren acquires Viljandi district heating company ESRO - Gren Energy

The role of state-owned infrastructure banks

In addition to the public financing levers noted in section 5.2, there are also state-owned infrastructure banks that can support the heat network sector. Table 7 provides a summary of the banks and their financing products. Examples relevant to heat networks are discussed below.

Table 7: State-owned infrastructure banks

Country	Name	Financing products
rUK	National Wealth Fund/ UK Infrastructure Bank (NWF/UKIB)	• Public Sector Infrastructure loans £5m+ • Low interest rate finance (lower than Public Works Loan Board) • Long maturities up to 50 years • Private sector products via Debt, Equity and Guarantees
The Netherlands	Bank Nederlandse Gemeenten (BNG)	• Local authority and public sector loans • Bond issuance • Balance sheet financing • Project financing
Germany	KfW Development Bank	• Project financings with maturities to match the investments • Corporate financings for investment measures • Structured financings tailored to individual situations • Guarantees • Derivatives to supplement the product range • Grant support
Finland, Sweden, Estonia	Nordic Investment Bank (NIB)	• Project and structured financing • Debt financing of PPP projects • Long term loans 5-25 years • €20m+ ticket size

Source: EY analysis

Relevant Examples:

- rUK: National Wealth Fund (NWF) was set up in2021 and allocated £27.8bn of capital to deploy from the UK Government. Heat networks are a key strategic pillar for the bank.

  NWF explored a connection charge facility[62] to incentivise and fund connection to heat networks and give demand assurance. However, whilst the public sector like the facility to help develop a heat network with the cost of connection rolled into the capex facility, the private sector need clarity on who the risk and responsibility sits with (e.g. project co), and proof of concept to buy in.

[62] Triple Point Heat Networks “Unlocking Private Finance in heat networks” (2023)

NWF also look to provide project gap funding development expenditure and capital expenditure to make heat networks commercially viable for private sector investors. Similarly, the bank is considering early phase guarantees/loans to help crowd in private finance by bridging up front development risk and the early years of projects.

NWF has heat networks as a strategic investment pillar and has the capital available to deploy. However, from our stakeholder engagement sessions an additional barrier to deployment is that heat networks are not yet commercially viable enough to enable what NWF can offer.

- Germany: KfW is the state-owned development bank with a commitment to sustainable infrastructure. The bank has recently introduced support for landlords, homeowners and municipalities to claim grant funding for connecting to existing heat networks or other renewable heating sources. The scheme supports those installing/gaining access to low carbon heating systems with up to 35% of investment costs.[63]

- Nordics & Estonia: NIB was established as an intergovernmental bank between Denmark, Finland, Iceland, Norway and Sweden in 1975. Estonia, Latvia and Lithuania become members of the bank in 2005. The bank has approximately €8.4bn in authorised capital[64]. Whilst not a country in focus, NIB provided €18m loan to finance upgrades[65] to existing heat networks in Riga, Latvia in October 2024, demonstrating how infrastructure banks can support established heat networks.

- Scotland*:* Scottish National Investment Bank (SNIB) has net zero as one of its key missions. The bank has identified there could be opportunities around decarbonising and expanding existing heat networks as well as financing new networks and connections[66]. The bank does not have any publications regarding bespoke financing solutions for heat networks yet. This presents the opportunity to shape heat network solutions by analysing the market looking at other international innovations.

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[63] Clean Energy Wire "Germany opens heating transition support scheme to all groups of building owners" 2024

[64] Nordic Investment Bank - Member countries, governing bodies and capital - Nordic Investment Bank

[65] Nordic Investment Bank - NIB and Rīgas Siltums continue cooperation for efficient heating - Nordic Investment Bank

[66] The Scottish National Investment Bank "Scotland's transition to net zero heat" (2022)

Appendix C – Major UK regulators: a summary of objectives

Ofgem (The Office of Gas and Electricity Markets)

Ofgem are responsible for regulating the electricity and gas markets, implement measures that protect consumers and promote competition within the sector. Within the UK, there is a well-established group of entities who operate across the generation, transmission and distribution landscape. Generating firms provide the power, transmission networks transport the power and distribution networks move it into residential and commercial premises with electricity and gas retailers being the interface between the energy market and end consumers. The natural gas sector follows a similar delivery structure where gas is extracted, refined and piped into buildings for heating and energy generation (Ofgem, 2024).

Ofwat (The Water Services Regulation Authority)

Ofwat oversees the water and wastewater sector ensuring that water companies provide high quality services at fair prices to consumers whilst ensuring the security of long-term water supplies. Water utilities are responsible for treating and supplying clean water, as well as managing the collection and processing of wastewater. Entities provide these services under strict regulatory supervision to maintain public health and environmental standards. The waste management sector addresses the collection, treatment and disposal of waste, including recycling (Ofwat, 2024).

Ofcom (The Office of Communications)

Ofcom is responsible for regulating the broadcasting, telecommunications and postal industries through maintaining the integrity of communication services. Telecommunications serve a critical role in maintaining connectivity within an ever-increasing digital environment, providing phone services, mobile networks, internet access and the infrastructure that underpins them all (Ofcom, 2024).

ORR (The Office of Rail and Road)

The ORR is responsible for ensuring the safety, reliability and efficiency of the railways whilst protecting the interests of rail and road users. They supervise network operators, such as Network Rail, through licensing to ensure compliance with health and safety law as well as competition law whilst also enforcing economic regulation (ORR, 2024).

CAA (The Civil Aviation Authority)

The CAA maintains a high level of safety in the aviation industry whilst representing the interests of consumers and wider public. It regulates various aspects of airline operations and aircraft management whilst also enforcing economic regulation through controlling pricing at major UK airports to prevent the abuse of market power and ensuring fair charges for passengers and airlines (CAA, 2024).

Appendix D – Overview of utility comparators methodology

The different characteristics of utility sectors have been examined acknowledging the following key attributes associated with the development of heat networks:

- A sector that is immature and in the early stages of its development and growth cycle within the UK
- A sector that provides services direct to its customers (retail in nature) and therefore exposed to a degree of demand, payment and operational risks akin to more conventional services provided in the private sector
- A sector that will be subject to incremental development of heat network infrastructure that will be dependent on accelerated connection of residential and commercial customers, ideally supported through zoning and policy in regard to the mandating such connections
- A sector that must address the affordability challenge of decarbonisation, particularly the cost of transitioning from conventional fossil-based energy sources like gas boilers; noting also that air source heat pumps are increasingly used as the counterfactual cost benchmark when developing an economic case
- The nature of the investment in heat networks, that involves significant upfront capital expenditure, requires funding that can be invested or repaid over extended time of 25 to 40 years, thus requiring investors and developers to take a long-term view of expected return on capital
- A sector that has historically and for the foreseeable future (3 to 4 years) been supported by investment support from the Scottish and UK Governments

Initial analysis was undertaken which focussed on the maturities and similarities between various utility sectors and heat networks across 39 regulated utilities covering electricity, water, telecommunications, rail and air regulation against the criteria listed below, in Table 8. Based upon the preliminary analysis, 17 utilities were taken forward for further examination, which is discussed in Appendix K.

Table 8: Criteria for longlist analysis of maturity and similarity between utility sectors and heat networks

Long List Methodology	
Area evaluated	**Description**
Maturity of Sector	This reflects the stage of development and stability of the sector within the utility industry as a whole: • A mature sector is well established with known and proven technologies and market structures, such as offshore wind electricity generation. • A developing sector, or one in its infancy, is characterised by emerging technologies, evolving regulatory frameworks and less certain market dynamics and funding solutions.
Similarities to heat network	This area examines the extent to which the utility sector shares similar characteristics to heat networks. It considers factors such as:

Long List Methodology	
	• Whether recent infrastructure capital expenditure has occurred within the sector. • The type of environment the sector is within in terms of a natural monopoly or a competitive landscape. • Typical entities involved within the sector such as private or joint ventures. • Regulatory environment of the sector.

A shortlist was then derived in accordance with an assessment of the following criteria set out in Table 9.

Table 9: Assessment criteria for the shortlist

Short List Methodology	
Area evaluated	**Description**
Investment Time Horizon	This indicates the anticipated timeframe one expects an investor to hold their investment to make an appropriate return on its investment. It can range from the short-term (a few years) to long-term (several decades) depending upon the useful and economic life of an asset, contractual arrangements, market conditions and funding solution.
Retail versus Wholesale Activity	This distinguishes between services that are provided direct to end consumers (retail) such as those in the water and sewerage sector and those activities that operate higher up in the supply chain within a wholesale market, such as electricity generation.
Stakeholders	This details the parties with an interest or influence over the sector including the customer base, user of assets base, owner of asset and who is subsidising the regulatory regime.
Investment Support	This refers to the mechanisms, incentives and financial environment and structure that exist to incentivize investment in the sector. It covers areas such as government grants/subsidies, regulatory frameworks like a RAB model alongside any market mechanisms such as Contracts for Difference (CfDs).
Areas of Regulatory / Financial Difference	This identifies some of the unique regulatory and financial characteristics of the sector in terms of market operations, investment models and compliance requirements.
Risk Profile	This evaluates the types and level of risk present within each sector. Whilst risk can be subjective and dependent on the risk appetite of the related party, it encompasses design, construction, operations, maintenance, revenue, availability and revenue risk (demand and bad debt).

Appendix E – Key characteristics of utility sectors evaluated

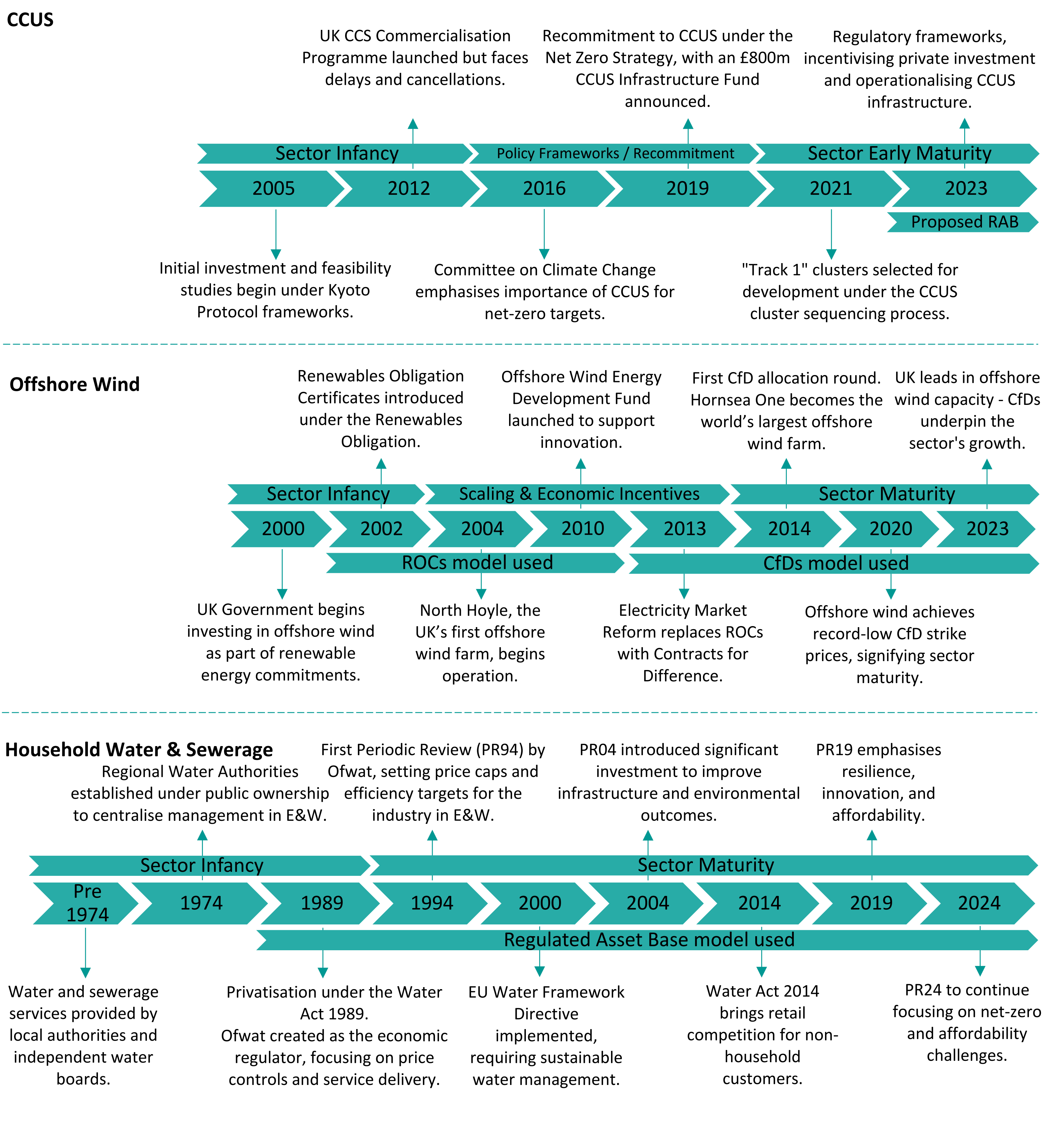
The table below summarises the key characteristics of each utility sector evaluated within Section 6.

	Risk Profile	Sector	Investment time horizon
Heat networks	Further to achieving commercial operation of the heat network, there is material demand and revenue risk due to the uncertainty and timing of commercial and residential connections.	Operates essentially as a retail business whereby sales are direct to end customers and therefore subject to revenue risk (demand and bad debt risk).	Long term investment time horizon (between 20 and 40 years) due to large upfront capital expenditure, thin operating margins governed by the competitive pricing relative to the counterfactual of gas boilers and/or air source heat pumps.
Offshore wind	Once at commercial operations, projects are essentially at full operational capacity and connected to the national grid for energy distribution and as such no demand risk. Some availability/revenue risk due to uncontrollable nature of wind.	Conventionally operates in the wholesale market (direct to grid).	Long term investment return of around 15 years commensurate with the term of a CfD due to significant upfront capital costs and competitive bid process for revenue pricing.
Household Water & Sewerage	Demand/revenue risk from users and price reviews by regulator respectively. Large operating expenditure to meet quality assurance requirements.	In England and Wales, operates in the retail sector which inherently creates revenue risk, in particular, bad debt risk. In Scotland, water is devolved with charges occurring alongside the council tax system.	Long term investment returns due to significant upfront capital costs, maintenance costs and price reviews for revenue pricing to ensure appropriate inter-generational cost recovery from customers in line with the useful and economic life of underlying assets (25 to 40 years).
CCUS	Currently a sector proposing to utilise unproven technology at scale, often referred to as a FOAK project (First of a Kind) and therefore subject to material design, construction and commissioning risk. Once commercial operation is achieved, there is material demand and revenue risk due to the uncertainty and timing of connections.	Operates essentially as a retail business whereby sales are direct to end customers and therefore would be subject to revenue risk (demand and bad debt risk) without regulatory funding support mechanism until the sector matures.	Long term investment returns due to significant upfront capital costs, maintenance costs and pricing reviews to ensure an appropriate return on initial investment acknowledging the useful and economic life of underlying assets (20 to 40 years).

Sources: EY, Ofwat (2024)

Appendix F – Timeline of regulatory developments

The figure below represents a timeline of regulatory development across CCUS, offshore wind and household water & sewerage sectors.



Appendix G – Detailed overview of offshore wind sector

The below provides a detailed overview of offshore wind regulation within the UK alongside the regulatory structure and financing mechanisms within the sector.

Overview

Offshore wind electricity generation in the UK is a rapidly expanding sector which plays a pivotal role in the nation's transition to renewable energy and the achievement of its climate change goals. The regulatory framework is overseen by Ofgem who ensure that the sector operates efficiently and contributes to the UK's energy security since the early development of the sector, with regulation becoming more prominent following the significant expansion of the sector in the 2000s. Ofgem is aided by the Crown Estate and Crown Estate Scotland who own the seabed around the UK and are responsible for awarding leases to developers for offshore wind development.

Offshore wind farms are subject to a range of regulations, from environmental impact assessments to marine spatial planning, ensuring that developments are carried out responsibly. Ofgem's regulatory activities encompass various aspects of offshore wind generation. These include connections to the national grid and ensuring that the market operates effectively to facilitate investment and main secure and sustainable electricity supplied.

Regulatory Structure

Following on from the Energy Act 2004, Ofgem has continued to regulate the sector and is adapting its approach and offering new support mechanisms as deployment continues to grow. Ofgem's regulation of offshore wind is structured around several key elements designed to promote the development of the sector whilst ensuring efficiency, competition and the protection of consumers interests:

- Licensing – generation licences are issued to offshore wind farm operators which set out the conditions operators must meet to legally generate electricity;
- Support mechanisms – provide long term price/revenue stability and encourage investment in offshore wind through guaranteeing a fixed price for the electricity generated;
- Grid connections and access – administrating the connections from offshore wind farms to the national grid through Offshore Transmission Owners (OFTOs) who own and operate the transmission assets;
- Market oversight – monitoring of the market to prevent anti-competitive practices whilst also ensuring offshore electricity generation is integrated safely to aid in the security of electricity supply;
- Financial incentives and penalties – through the RIIO (Revenue = Incentives + Innovation + Outputs) model, Ofgem sets price controls and performance incentives for offshore wind network entities;
- Consumer protection – ensuring costs associated with offshore wind generation are reflected fairly on consumer bills, with the benefits of low carbon electricity generation passed on to consumers;
- Innovation funding – innovation technologies and practices which reduce generation costs can be funded by Ofgem. The aim is to accelerate technological advancements,

improving efficiency and reducing costs to support the transition to net-zero energy systems whilst ensuring best value for consumers. As part of RIIO-ED2, Ofgem extended their Strategic Innovation Fund to cover electricity distribution companies with £450m of funding across RIIO-ED2 alongside £68.4m of additional allowances for smaller scale innovation projects through the Network Innovation Allowances.

These structures collectively create a regulatory environment that supports the growth and investment in offshore wind development while managing costs and ensuring the electricity system remains reliable and sustainable.

Regulatory Financing Mechanisms

Offshore wind offers investors long term equity returns over a period of c.15 years commensurate with the term of a CfD. Offshore wind is characterised by large upfront capital expenditure, availability risk (wind), a competitive and volatile electricity market, all of which impacts the sector's ability to secure much needed investment.

Offshore wind is not exposed to demand risk, given it operates on a wholesale basis. However, to aid in the mitigation of electricity price volatility, availability risk and premium over and above the wholesale price of electricity for the development of Offshore wind, Ofgem awards Contracts for Difference (CfDs) to provide long term stable and predictable revenue for offshore wind developers. The reduced revenue risk attributable to a CfD make Offshore wind attractive to investors resulting in optimised financing structures reducing the overall cost of capital.

CfDs represent an evolution in the Offshore wind sector from Renewable Obligation Certificates (ROCs) which were originally used as a support mechanism to promote investment in the sector. Further to CfDs offering stable and predictable revenue, continual development of offshore wind assets is promoted through government grants and incentives for innovation and infrastructure development.

Renewable Obligation Certificates

The ROCs framework was designed to promote investment across a number of different renewable energy technologies by providing a financial reward for renewable energy generation. It achieved this through the creation of a renewable energy certificate market whereby for each megawatt hour (MWh) of renewable electricity granted, generators would be eligible to claim ROCs.

These could then be traded on the open market to suppliers who did not meet ROC generation obligations imposed by Ofgem. If suppliers failed to present enough ROCs to meet their obligations, a buy-out fee would be imposed for the shortfall of ROCs. The buy-out fee was set by Ofgem and increased annually with inflation. The money collected by Ofgem from buy out fees was then redistributed to suppliers who had met their obligations to effectively incentivise renewable electricity generation.

ROCs were the main support mechanism for renewable energy before being gradually phased out and replaced by CfDs for new projects in 2013 with the aim of improving the regulatory regime. One of the reasons ROCs were phased out was due to the relatively primitive nature of the support mechanism whereby different technologies received varying amounts of ROCs per MWh produced in addition to the wholesale power price. In 2012, offshore wind typically received 2 ROCs per MWh compared to onshore wind which typically received 1 ROC per MWh.

The difference in ROC allocation by technology was arguably quite arbitrary and did not necessarily correlate with the underlying levelised cost of the technology. This potentially stifled the deployment of some technologies or encouraged the development of other sectors, resulting in windfall gains for developers

Contract for Difference

Offshore wind projects are eligible to participate in a competitive auction process to obtain a CfD. The auction determines the "Strike price", which effectively equates to a fixed price per MWh of electricity that the project generates over a specified period (typically 15 years). The Strike Price is the price per MWh a developer considers necessary to make its applicable return on investment over the period of the CfD.

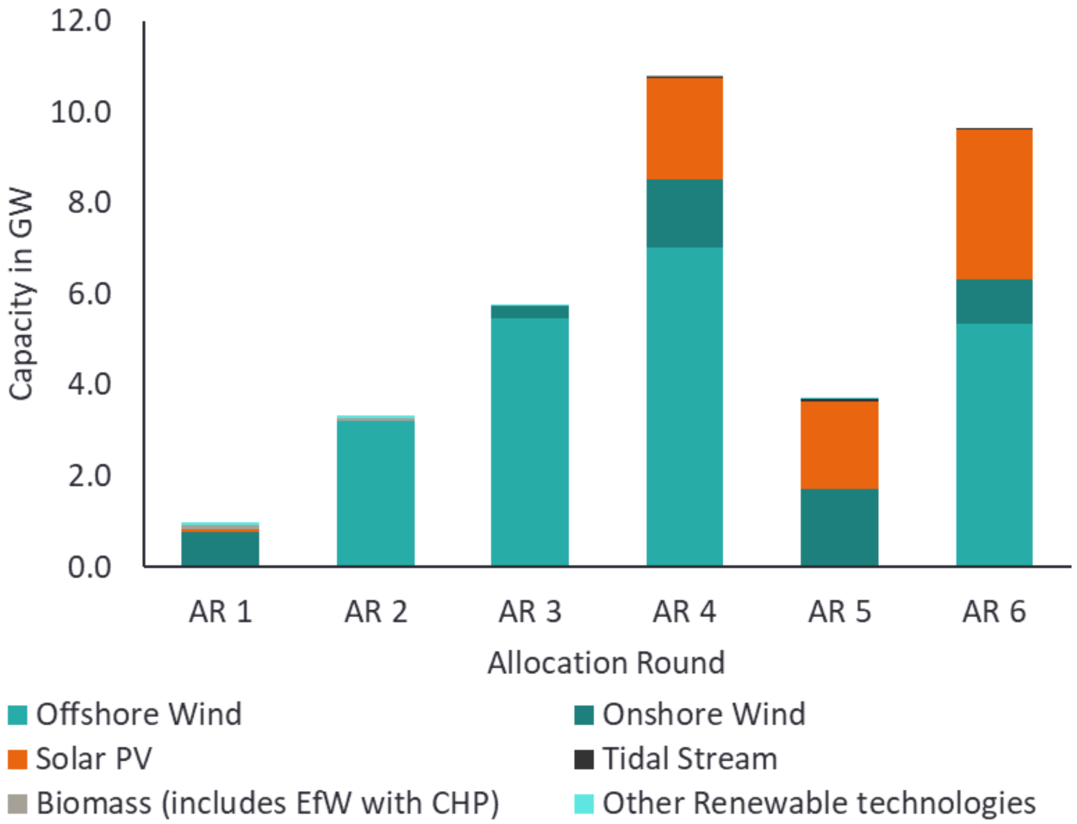
The Strike Price is different to the actual market price, known as the "Reference Price", which is calculated based on the average market price per MWh over a given period. When the Reference Price is lower than the Strike Price, a top up payment of the difference in price is made by the Low Carbon Contracts Company (LCCC) to the offshore generator. Conversely, if the Reference Price is greater than the Strike Price, then the generator must pay the difference to LCCC.

By providing a guaranteed price for electricity, CfDs mitigate price volatility risk within the wholesale electricity market. This helps make offshore wind more attractive to investors and lenders as it reduces financial risk of the project whilst also incentivising generators to produce electricity efficiently and at lowest costs to maximise margins.

CfDs were originally introduced in 2013 whilst the sector was focussing on scaling but have enabled the sector to develop into a mature one. Recently, the CfD allocation round 6 has been completed. It included three new CfDs for offshore wind alongside seven offshore permitted reductions which allows projects previously awarded a CfD contract to withdraw up to 25% of their original capacity and apply to a future CfD round.

The balance in setting the correct Strike Price can prove difficult as demonstrated in allocation round 5 in 2023. Figure 11 highlights that there were no successful CfDs awarded for offshore wind in allocation round 5. This was a result of no bids being submitted by developers for offshore wind, which could have been due to the administrative Strike Price set by UK Government of £44/MWh. This Strike Price remained unchanged from allocation round 4 which made offshore wind developments economically unfeasible due to impacts of inflation on development costs.

Figure 11: Total renewable energy awarded during CfD allocation rounds



Government Grants & Incentives

Government grants and incentives are critical tools used to promote the development, operation and maintenance of offshore wind assets. Government grants can help to reduce the upfront capital required for the development of offshore wind farms including research, design and construction helping to mitigate some of the financial risks that developers face. The UK Government, often through Ofgem or other bodies such as Innovate UK, provide this funding and includes grants for innovation in turbine design, foundation structure, grid integration and operations alongside maintenance practices.

In addition to 21 GW of wind farms benefiting from CfDs through to allocation round 6, another example of government funding is the Strategic Innovation Fund (SIF). This aims to help transform gas and electricity networks for a low-carbon future. It provides funds to projects that could speed up the transition to net zero at the lowest cost to the consumer. After launching in 2021, Ofgem expects to invest £450m by 2028 through partnering with Innovate UK to deliver the programme. Innovate UK offers multiple innovation funding such as the Net Zero Living Pathfinder Places. Oldham Council has secured funding from this to develop an Oldham Green New Deal Delivery Partnership, focussing on delivering the £5.6bn of low carbon infrastructure Oldham needs to achieve Net Zero.

Appendix H – Detailed overview of household water & sewerage sector

The below provides a detailed overview of household water & sewerage undertakers within the UK alongside the regulatory structure and financing mechanisms within the sector.

Overview

Household water & sewerage undertakers within the UK are a well-established utility sector which provides residential and commercial customers essential water supply and wastewater services. The sector encompasses the entire process of sourcing, treating and delivering water to households and businesses alongside the collection, treatment and disposal of wastewater and sewage. The household water and sewerage sector within England and Wales is typically characterised by a natural monopoly due to the inefficiencies of having multiple sets of water and sewerage infrastructure competing in the same geographic area.

As a result, the sector is subject to economic regulation which, within England and Wales, is regulated by Ofwat to ensure the provision of high-quality water alongside reliable water and wastewater services at fair prices for consumers. The two main issues Ofwat regulation aims to address are service quality and tariff prices. Service quality is less important than in other sectors like electricity. Ofwat oversees the performance of water companies, enforces compliance with environmental standards and ensures that the sector remains financially viable.

Regulatory Structure

The regulatory structure for household water and sewerage companies within England and Wales has evolved over time to adapt to changing priorities in the sector, such as the need for increased investment in infrastructure, improving customer service and addressing environmental concerns. Some of the key changes in the regulatory structure include:

- Introduction of competition – whilst the water industry in England and Wales has been privatised since 1989, there has been a gradual move to introducing competition within the household water sector to drive efficiency and innovation.
- Periodic price reviews – Ofwat has moved towards conducting periodic price reviews (such as 'PR19' or 'PR24') typically every 5 years to set price limits and service targets for water companies. These reviews establish the framework within which water companies must operate and balance the need for investment in infrastructure with the protection of consumer interests.
- Performance commitments – Ofwat has introduced performance commitments and outcome delivery incentives (ODIs) to ensure water companies focus on delivering outcomes relevant to their customers.
- Resilience and sustainability – regulatory changes increasingly emphasise the importance of long-term resilience and environmental sustainability through encouraging water companies to invest in approaches that mitigate the risk of drought, flooding and other long term climate related challenges.
- Customer engagement – a greater emphasis is now placed on customer engagement within the regulatory process with water companies required to consult with customers and consider their preferences in the development of their business plan.

- Innovation funding – Ofwat has introduced mechanisms to fund innovation within the sector to encourage water companies to develop and adopt new technologies and practices.

These changes reflect a broader shift towards a more outcome based regulatory regime which encourages water companies to be customer orientated, efficient and forward thinking with their operations and investments. The regulatory framework is designed to incentivise water companies to invest in their networks, improve resilience, reduce leakage and maintain high standards of water quality and environmental stewardship.

Regulatory Financing Mechanisms

Within England and Wales, the water & sewerage sector is predicated on a long-term investment time horizon whereby balance sheets are supported by the capital markets in the form of debt (including bond finance) and shareholder equity. Typically, water utilities seek an investment grade credit rating in order to secure the most competitive form of lending within a highly optimised financial structure, most notably gearing. Regulation by Ofwat in England and Wales provides a stable financial environment for investors, whereby the monopolistic nature of the customer base for each utility provides a reliable level of demand assurance, albeit in a retail market that does result in an element of revenue risk from bad debt.

Ofwat uses various financial levers to encourage initial investment in water infrastructure whilst also encouraging water companies to invest in their infrastructure and services. These financial levers are primarily through a Regulated Asset Base (RAB) model, as well as through the existence of price reviews to adapt to market conditions and innovation funding. Key risks that are borne by utilities in the water sector is that of managing capital programmes, maintenance and operational costs. These risks will be similar in nature to those of the heat network sector.

Regulated Asset Base (RAB)

A RAB model provides a structured approach to regulating the prices that water companies can charge alongside ensuring they maintain and improve the infrastructure, whilst delivering high quality services to customers. The RAB represents the value of a water company's capital assets, such as pipes and treatment plants and is calculated based on historical investment costs, depreciation and new qualifying capital expenditure. The general value of the RAB can be expressed as:

$$gross\ current\ cost\ of\ assets + provision\ for\ depreciation = net\ book\ value$$

However, for previously privatised UK network infrastructure sectors such as water, the RAB is generally lower than the current replacement cost of the net book value as when privatised, the assets were sold at a substantial discount to the replacement cost. Within the water industry, the current replacement costs of the assets in 2010 prices are greater than £200bn but the privatisation proceeds were just £10.3bn in 2010 prices. This difference is a combination of the privatisation discount and the capital investment net of depreciation undertaken since privatisation. As such, for UK infrastructure industries privatised after 1980, such as water, the RAB value is further defined as:

$$net\ book\ value - privatisation\ discount = RAB\ value$$

Ofwat then uses the RAB value to derive the allowed revenue requirement, which is used to ultimately set prices for consumers, to cover the costs of operations, maintenance as well as providing a fair return on the capital investment on the RAB. This is done through the regulator setting a Weighted Average Cost of Capital (WACC)% which is then applied to the RAB value to calculate the total amount of allowed revenues each company can charge to its consumers. This process, albeit simplified and not considering inflation, is expressed as:

$$maximum\ allowed\ revenue = RAB\ X\ WACC\%$$

The RAB model inherently encourages water companies to invest efficiently in their assets as a company retains some of the savings as profit if it can deliver the required services at a lower cost than the allowed revenue. Furthermore, since depreciation is active in the RAB, unless ongoing capital expenditure is made, the allowed revenue dwindles. This incentivises water companies to continually invest in their infrastructure, with these investments eventually being included in the Regulated Asset Value (RAV) and therefore in future revenue streams (Frontier Economics, 2010). The RAB model works particularly well within the water sector due to the limited number of operators within the sector (11 regional water and wastewater companies in England and Wales) meaning the time and cost requirements of administrating this regime is manageable.

Price reviews

The price reviews performed by Ofwat determine the revenue that water companies can earn from customers, usually lasting for a 5-year period. Price reviews adopt a total expenditure approach, considering both capital expenditure and operational expenditure when setting price controls. Price reviews promote the development of new assets by providing a framework for recovering the costs of the investment over a period of time. This in turn encourages companies to undertake necessary large scale capex projects.

Furthermore, the price review process also includes performance incentives, through ODIs which reward companies for meeting or exceeding targets set by Ofwat. Conversely if targets are not met, water companies are penalised for underperformance. This system helps align the company’s financial interests with the delivery of high-quality utility services.

Every 5 years each utility must submit an Asset Management Plans (AMP) to the regulator Ofwat. Ofwat will then use the AMP to set price increases and review the quality of services provided which take the form of Key Performance Indicators (KPIs).

The latest AMP is AMP8 for the period 2025 to 2030. AMP 8 will have a greater focus on climate change & emissions reduction challenges, improving water quality, reducing leakage and ensuring reliable water supply and wastewater services. Ofwat has highlighted a strong desire to find new and innovative funding solutions to meet the significant investment in infrastructure required to achieve these goals. An example of this is the Direct Procurement for Customers programme (DPC) which involves the utilities competitively tendering services in relation to the delivery of large new water and wastewater assets. It is envisaged the projects will be similar in nature to Design, Build, Finance and Operate (DBFO) whereby the chosen Competitively Appointed Provider (CAP) will be paid essentially a service fee for a period of between 25 and 30 years.

Innovation funding

Innovation funding impacts the financial environment by providing the means and incentive for water companies to invest in the future. It supports an approach to asset management and service delivery which is proactive in nature. Although there are many external innovation funds available to water companies, Ofwat has established their own Ofwat Innovation Fund. The aim of this £200m fund is to encourage collaborative initiatives and partnerships within the water sector to tackle the larger challenges the sector faces such as climate change, leakage and affordability. Most recently, 17 projects have been awarded funding in the fourth round of the Water Breakthrough Challenge ('Breakthrough 4'), sharing in approximately £40m towards solutions that will bring benefits to water customers, society and the environment. One example of this is the award of £1.6m to Pipebot Patrol. This aims to develop an autonomous sewer robot which constantly inspects sewers, raising alerts to the precise location of blockages as they begin to form. This proactive approach allows maintenance teams enough time to respond before sewer flooding occurs, potentially contaminating the environment.

Although Ofwat regulates the water sector in England and Wales, due to the privatisation of the sector combined with regulatory models used, profits made by companies can be either distributed to shareholders or reinvested in infrastructure. If too great an emphasis is placed on the former, issues can arise in under-investment in infrastructure, impacting the long-term viability of the sector. Thames Water, England's largest water company, over the years has significantly borrowed debt totalling over £15 billion under the RAB model, creating about 80% leverage in the company. This has allowed owners of Thames Water to take billions of pounds out the company as loans or dividends within the last 5 years, including over £200m in dividends to other group entities. However, the debt servicing requirements, alongside the need for infrastructure investment to meet efficiency targets, has led to Thames Water requesting Ofwat to allow water bills to rise by 40% by 2030. Ofwat has however rejected these proposals and has currently suggested a rise of 23% as part of its 2024 price review and suggests further capital injection from shareholders to develop infrastructure and service debt payments. As such, without careful regulation throughout the years, potential mismanagement of utilities can arise leading to price increases for consumers.

Scotland has mitigated these specific risks through the water services being publicly owned and operated by Scottish Water who remains accountable to the Scottish Government and its customers. This helps to ensure profits are reinvested in the infrastructure rather than distributed to shareholders.

Water Regulation Within Scotland

Scottish Water remains economically regulated by the Water Industry Commission for Scotland (WICS) which ensures Scottish Water delivers value for money whilst achieving efficiency targets. Regulation ensures that public funds are used efficiently with no profit motive influencing decisions. The social focus of WICS places an emphasis on affordability and maintaining public ownership which is aligned with Scottish Government policies. Furthermore, since Scottish Water is the sole provider of water within Scotland, regulation can be simplified as it benefits from economies of scale.

WICS is governed by the Water Industry (Scotland) Act 2002, as amended by the Water Services etc (Scotland) Act 2005 and the Water Resources (Scotland) Act 2013. WICS is an Executive Non-Departmental Public Body whose principle statutory functions are to:

- Determine charge caps and, in so doing, promote the interests of customers of Scottish Water both in terms of quality of services and the charges that have to be paid;
- Monitor Scottish Water's performance, encouraging efficiency and sustainability;
- Facilitate (in a manner not detrimental to Scottish Water's core functions) the entry of retail water and sewerage providers that want to supply non-household customers in Scotland;
- Support the Scottish Government's vision of ensuring that Scotland is a Hydro Nation and meet their obligations under the Water Resources Act 2013.

Water charges are set by WICS and remain relatively stable as profits are reinvested. The domestic charges are linked to council tax bands, with prices increasing as bands increase, and historically were calculated based off a version of the RAB model. However, since the price review in 2010, WICS have moved away from the RAB based model and instead moved towards looking at business requirements as the basis in setting prices during price reviews.

Price Reviews

Similar to Ofwat in England and Wales, WICS performs Strategic Reviews of Charges to set price limits for the next regulatory period (usually every 6 years). The Strategic Reviews of Charges is initially based upon Scottish Water's long term business plan which encompasses short- and long-term infrastructure investment requirements, debt repayments and operating costs. As part of this business plan, Scottish Water also works with the Customer Forum to ensure that customer views influence the business plan and pricing requests. WICS subsequently evaluate the business plan, with a focus on Debt Service Cover Ratio (DSCR), alongside multiple other factors including inflation, investment needs and operational efficiency to determine annual price caps for customers. These may be adjusted annually within the limits set by WICS to account for inflation or other changes.

Alongside setting price caps, WICS will also set efficiency targets for each period based upon what it deems Scottish Water should be able to achieve. Although a proxy RAB continues to exist to act as an internal comparator to England and Wales water sector, this customer focussed business plan helps to align Scottish Water with Scotland Government objectives.

Although WICS exercises these functions independently of the Scottish Ministers, whose power to direct WICS, is confined to matters relating to the WICS financial management and administration, ministers can potentially influence agreed charges to customers. If agreed charges are lower than Scottish Water's requirement, the cash surplus may be insufficient to meet required investment and maintenance programmes. This in turn could impact the long-term lifecycle maintenance and development of new assets meaning the extension of useful economic lives of existing assets is required. There is a risk that, despite it being a public body, if agreed charges are continually lower than what Scottish Water deems as necessary, the integrity of the network in the future is compromised.

If a cash shortfall is present for infrastructure expansion or maintenance of assets, public borrowing could provide the required capital for required expansion or maintenance of assets.

Government Grants and Incentives

Scottish Water receives loans or grants from the Scottish Government to finance large capital expenditure projects such as upgrading treatment plants, replacing aging pipes and building flood defences. This aids in reducing the reliance upon customer charges to fund these large capital expenditure projects helping to ensure affordability for households and businesses. This could provide an advantage over private companies as government-backed loans typically offer more favourable terms than private market financing resulting in further cost savings being passed onto consumers. However, this funding route depends upon the impact this borrowing would have upon Scottish Government balance sheet. This impact could mean funding is not granted for infrastructure development and maintenance projects and instead a short-term increase in customer prices would have to be required. As such, any borrowing is carefully managed to ensure long term financial sustainability for both Scottish Water and Scottish Government.

Appendix I – Detailed overview of CCUS sector

The below provides a detailed overview of CCUS within the UK alongside the regulatory structure and financing mechanisms within the sector.

Overview

CCUS is an emerging sector within the UK and is expected to play a crucial role in the UK achieving its net zero emissions target by 2050. The UK Government has recognised the importance of CCUS in reducing carbon emissions from industrial processes and power generation and as such is actively developing a regulatory framework to support the deployment of CCUS related projects.

This framework aims to ensure that CCUS projects are financially viable, environmentally effective and financially resilient to market uptake. The regulatory environment is shaped by multiple pieces of legislation including the Energy Act and the Infrastructure Act which establish the legal basis for CCUS operations and the regulatory role of bodies like Ofgem, the Oil and Gas Authority and Department for Energy Security and Net Zero.

Regulatory Structure

The CCUS sector is in its infancy within the UK and as such projects are unlikely to be at full operating capacity at the point the facilities are commissioned, in terms of emitter uptake. As such, any proposed regulatory structures will need to take into account:

- Financial incentives: Providing financial incentives to encourage investment in CCUS technology and making it cost effective;
- Economic regulation: To provide stable and predictable revenue streams for CCUS infrastructure investments;
- Licensing: Licensing and permits for CCUS operations including the capture, transport and storage of carbon;
- Safety Standards: Safety and environmental standards to protect public health and the environment;
- Liability Frameworks: Liability and risk management frameworks given the first of a kind nature of CCUS;
- Market Development: Facilitating the development of markets for carbon utilisation and promoting innovation in CCUS technologies; and
- Infrastructure Planning: Planning and developing the necessary infrastructure for carbon transport and storage, including considering shared access and usage to maximise efficiency and reduce costs.

The proposed regulatory structure will need to enable the growth of the CCUS sector whilst ensuring it contributes effectively to net zero goals. It is anticipated that the regulatory framework is likely to evolve as technology and risks develop. Current regulatory proposals to encourage initial investment, development and maintenance of assets include having a RAB based model with revenue support.

Regulatory Financing Mechanisms

Regulated Asset Base

Similar to the RAB model used within the water and sewerage sector, it is proposed that the entities that will develop, own and operate the transport and storage infrastructure (T&SCo) will have a regulatory RAB model as the basis to provide long term reliable revenues to service the initial upfront expenditure and ongoing operating costs.

The process for establishing the amount of allowed revenue is derived in the same way as that used in other RAB models, such as that used in water and sewerage. The difference between the RAB model in water and sewerage sector when compared to CCUS is that the allowed revenue and qualifying operating and capital expenditure, will initially be administered by DESNZ prior to Ofgem fulfilling this regulatory role a short period after commercial operations date. RAB based models require significant resources requirements and time to administer. However, on the basis there is not anticipated to be a large number of T&SCo projects, a RAB based model is deemed an appropriate and effective mechanism to provide an attractive financial proposition (environment) to attract investment from the private sector in a cost-efficient manner.

Revenue Support Agreement

As uptake of CCUS technology is uncertain due to the maturity of the market there is a significant risk associated with T&SCos being able to generate sufficient allowed revenue under the RAB model based upon number of emitters committed to CCUS on day one. As such, the regulatory structure, at least until the market is more mature and developed, includes a revenue support agreement which acts in a similar manner as CfDs in other sectors such as offshore wind. LCCC is the proposed counterparty to the revenue support agreement responsible for paying T&SCo any shortfall in actual revenue generated when compared to the allowed revenue forecast as per the RAB model. This support mechanism helps to address demand risk as the sector develops.

The CCUS regulatory framework helps to address risks associated with a First of a Kind ("FOAK") project through the amalgamation of previous regulatory support mechanisms. Although the current mechanism is likely to evolve as the sector matures, it currently encourages investment within the CCUS sector through providing long term and predictable revenue for equity investors which is supported through a contract with LCCC. Furthermore, it is predicted continual maintenance of assets will occur due to the RAB model and increasing allowed revenue to enable a return on maintenance expenditure. This helps to encourage the adequacy of the level of net revenue alongside the visibility of sufficient value of future similar projects. However, this amalgamation of support mechanisms is not yet practically tested and remains in development until construction beings on large CCUS projects.

Appendix J – Possible implications of regulatory regimes

Regulatory Support Mechanism	Possible impact within heat networks
CfDs	• Competitive allocation of subsidy support could help to reduce the overall levels of subsidy required. • Helps to develop the market through smaller scale investors' input, before large scale investors are involved as the sector develops and uncertainties reduce. • Demand risk heat networks are exposed to would still be present as unlike sectors for which CfDs are actively present, heat networks are not at full capacity from commercial operations. • CfDs more suited to competitive environments as opposed to natural monopolies. • Provides long term stable and predictable revenue for a specified period of time. • Counterparty for heat networks would need to be agreed. • Adequacy of the level of net revenue could be achieved through the competitive CfD process helping to promote investment in the sector. • Visibility of sufficient value of future similar projects could be achieved through governments ambition of renewable energy and the availability of implementation into networks.
RAB & Periodic Price Reviews	• Could encourage investment within heat networks sector through competition for licencing rights with a set pricing mechanism. • Could help mitigate demand and revenue risk for projects of large enough size. • Provide long term stable and predictable returns whilst potentially mitigating revenue risk and demand risk if underpinned through a revenue support mechanism. • A minimum MWh requirement could be introduced to reduce administrative burden through limiting qualifying project numbers. • Potential district heat networks could be added to existing RAB network business subject to legal power and regulatory alignment. • Adequacy of the level of net revenue could be achieved through the RAB regime which allows for recovery of the notional cost of debt and equity alongside performance incentives helping to promote investment in the sector. • Visibility of sufficient value of future similar projects could be achieved through price controls for each RAB network.
Grants	• Could encourage investment within heat networks through subsidising the upfront capital expenditure to aid in commercial operations. • Long term stable and predictable revenue alongside the adequacy of the level of net revenue would likely be dependent upon the company

Regulatory Support Mechanism	Possible impact within heat networks
	managing demand and revenue risk unless further regulatory support mechanisms are put in place. • Visibility of sufficient value of future similar projects could help to be addressed through the continuation of government grants and aims for renewable energy generation. • Grants could be used to prioritise the development of specific projects which could have the greatest impact in meeting net zero aims.
RHI type Incentive	• Could provide long term stable revenue alongside the adequacy of level of net revenue through the aid of tariff payments. • Grants and incentives could be used concurrently with tariff payments to provide subsidy for upfront capital costs. • Visibility of sufficient value of future similar projects could be achieved through the incentive programme especially when coupled with grants and government net zero aims.

Appendix K – Regulatory regime overview

The table below includes analysis performed over regulatory regimes and serves as a basis in selecting comparators for heat networks. The analysis includes typical characteristics of the regulatory sector, timeframe of returns, stakeholders typically involved, key differences in the sector alongside the risk profile of each sector.

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Distribution - heat network	Ofgem (2025 onwards)	Infancy / Developing	Characteristics: • Risk of bad debt due to retail nature • Pricing governed by counterfactual - cost of installation (customer pays), cost of network maintenance and variable electricity cost. • Counterfactual historically were gas boilers but air sourced heat pumps now increasingly popular. • Gradual build up of capacity as users are connected to system over time.	-	Long term	Retail	Customer base: Households / Businesses User base: Energy suppliers Owner of asset: Private / JVs Who is subsidising regime: Government at a minimum	• Grants (GHNF) announced by UK Government	-	*Maturity:* Infancy / Developing *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Medium *Availability:* Medium / High *Bad debt:* Medium	-
Energy	Distribution network operators (interconnectors)	Ofgem	Mature	• Recent capex investment • Natural monopoly characteristics • JVs common due to large capital and cross border nature	Yes	Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private / JVs *Who is subsidising regime:* Costs spread across customer base	• Cap and floor regime	•Interconnectors use cap and floor regime while DNOs typically regulated under RIIO framework • Cross-border interconnectors may involve different national regulatory regime.	*Maturity:* Mature *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - other utilities have a more comparable risk profile / characteristics to heat networks although cap and floor model is an interesting variation to CfDs.
Energy	Electricity transmission (OFTOs)	Ofgem	Mature	• Recent capex investment • OFTO have parallels to PPP in respect of no revenue at risk due to regulatory re-setting of prices with revenue being long term, stable and RPI linked. • OFTO investment from equity investors, investment banks (EIB) and commercial banks • Natural monopoly characteristics • JVs common due to risk and investment requirements	Yes	Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / generators *Owner of asset:* Private (institutional investors) / JVs *Who is subsidising regime:* Costs spread across customer base	• RAB model providing stable returns with price reviews • Tender regime to encourage competitive pricing	-	*Maturity:* Mature *Design:* Low *Construction:* Low (built by developers before OFTO sale) *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - more comparable utilities to heat networks exist for a RAB based model in terms of risk profile (especially demand & bad debt risk) and market it services.

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Electricity generation - Off-shore Wind	Ofgem	Mature	• Recent/planned capex investment • Relatively low risk profile underwritten by a stable regulatory framework - generation usually competitive and not regulated under RAB • Mixture of private & plc entities - JVs common due to high capex and technical complexity • Requires significant upfront capital investment • Benefits from government incentives and support	Yes	Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private / JVs *Who is subsidising regime:* Levies on energy bills and gov support	• CfDs (Contract for Difference) used to support large scale deployment • Government grants and incentives for innovation and development	• Subject to environmental and maritime regulations	*Maturity:* Mature *Design:* Medium *Construction:* High *Operation:* Medium *Maintenance:* Medium *Revenue:* Medium / Low *Availability:* Medium *Bad debt:* Low	Yes - long term equity returns whilst having CfDs for stable revenue. The risk profile is similar to heat networks in terms of construction, revenue & availability.
Energy	Electricity generation - Onshore Wind	Ofgem	Mature	• Recent/planned capex investment including contributions from Ofgem • Mixture of private & plc entities - larger projects can involve JVs • Can be part of local energy solutions similar to heat networks • Generation usually competitive and not regulated under RAB	Yes	Medium / Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private / JVs *Who is subsidising regime:* Levies on energy bills and gov support	• CfDs used to support large scale deployment (majority can be self financed etc) • Government grants and incentives for innovation and development	• Planning and environmental regulations varies by region	*Maturity:* Mature *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Medium / Low *Availability:* Medium *Bad debt:* Low	No - can be medium term timeframe of equity returns as opposed to long term in offshore wind which also provides a better risk/return profile to heat networks.
Energy	Electricity generation - Gas	NSTA/Ofgem	Mature	• Recent/planned capex investment • RAB model sometimes used (for infrastructure) • Mixture of private & plc entities - not uncommon for JVs to be present • Transition fuel that could integrate with heat networks for synergy	Yes	Medium / Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private / JVs *Who is subsidising regime:* Levies on energy bills and gov support	• Capacity market to ensure security of supply • Investment incentives for efficient and flexible gas plants	• Can participate in the capacity market to ensure supply security • Subject to emissions regulations and sometimes carbon pricing	*Maturity:* Mature *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Medium (exposure to market prices although capacity market provides some stability) *Availability:* Low *Bad debt:* Low	No - capacity market unlikely to be present in heat networks furthermore gas services the wholesale market
Energy	Electricity generation - Oil	NSTA/Ofgem	Mature although	• Recent/planned capex investment • Mixture of private & plc entities - JVs common although reducing due to decline of oil for electricity	No - phasing out of long established utility with limited new capex. More relevant comparators to heat networks exist.	-	-	-	-	-		-

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Electricity generation - Coal	Ofgem	Mature although	• Mixture of private & plc entities - JVs common historically but declining and unlikely to attract new investment	No - phasing out of long established utility with very limited new capex. More relevant comparators to heat networks exist.	-	-	-	-	-		-
Energy	Electricity generation - Nuclear	Ofgem	Mature/developing	• Recent/planned capex investment • Private/JVs/plc entities	Yes	Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private / JVs with government involvement *Who is subsidising regime:* Levies on energy bills and gov support	• CfDs used to support large scale deployment within the RAB model • Government guarantees or direct investment for new projects	• May involve government guarantees or direct investment • Very highly regulated	*Maturity:* Mature / Developing *Design:* High *Construction:* Very high *Operation:* Medium *Maintenance:* High *Revenue:* Medium / Low *Availability:* Medium *Bad debt:* Low	No - very highly regulated sector with direct government investment. Too great government involvement that what is required with heat networks. Although multiple revenue support mechanisms exist, CCUS provides a more comparable utility to heat networks risk profile.
Energy	Electricity generation - Solar	Ofgem	Mature/developing	• Recent/planned capex investment • Mixture of private & plc entities - JVs common for large scale solar farms • Potential for local generation • Generation usually competitive and not regulated under RAB	Yes	Medium / Long term	Wholesale	*Customer base:* Energy consumers *User base:* Energy suppliers / traders *Owner of asset:* Private, communities or individuals *Who is subsidising regime:* Levies on energy bills and gov support	• CfDs used to support large scale deployment • Feed in tariffs (closed for new applicants) for smaller scale installations	• Previously supported by feed in tariffs but now mainly by CfDs • Regulations around land use and planning	*Maturity:* Mature *Design:* Low *Construction:* Low *Operation:* Low *Maintenance:* Low *Revenue:* Medium *Availability:* Low *Bad debt:* Low	No - mature / developing utility supported by CfDs. There are more comparable utilities with similar risk profile to heat networks under the CfD model.
Energy	Electricity generation - Biomass	Ofgem	Mature/developing	• Recent/planned capex investment • Generation usually competitive and not regulated under RAB • Mixture of private & plc entities - JVs can be present	No - utility regulation/market still developing under wholesale principle. There are more mature similar utilities to act as comparators.	-	-	-	-	-		-

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Electricity generation - Geothermal	Ofgem	Mature/developing	• Recent/planned capex investment • Generation usually competitive and not regulated under RAB • Mostly private/JV entities	No - utility regulation/market still developing under wholesale principle. There are more mature similar utilities to act as comparators.	-	-	-	-	-		-
Energy	Electricity generation - Hydropower	Ofgem	Mature/developing	• Recent/planned capex investment • Generation usually competitive and not regulated under RAB • Mixture of private & plc entities - JVs can be present for larger projects	No - utility regulation/market still developing under wholesale principle. There are more mature similar utilities to act as comparators.	-	-	-	-	-		-
Energy	CCUS	Ofgem	Infancy	• Recent/planned capex investment • RAB model • Mostly private/JV entities • Gradual increase to full capacity of T&SCos similar to heat networks	Yes	Long term	Wholesale	*Customer base:* Emitters *User base:* Emitters *Owner of asset:* Private / JVs *Who is subsidising regime:* Government	• RAB model with cover for revenue and repex through mechanisms similar to CfDs	• Multiple revenue support mechanisms in place to encourage a financially resilient environment.	*Maturity:* Infancy *Design:* Medium *Construction:* High *Operation:* Medium *Maintenance:* Low *Revenue:* Low / Medium *Availability:* Medium *Bad debt:* Low	Yes - propose to briefly discuss CCUS as cross over between multiple revenue support mechanisms exist to support financially resilient environment. T&SCos utilisation is also a gradual increase to full capacity similar to heat networks.
Energy	Gas interconnector	Ofgem	Mature	• Cap and floor model • Recent/planned capex investment • Private/JV entities common due to scale and cross border operations	Yes	Long term	Wholesale	*Customer base:* Gas consumers *User base:* Gas shippers / suppliers *Owner of asset:* Private / JVs *Who is subsidising regime:* Costs socialised across customer base and supported by EU funds	• Cap and floor regime to encourage investment while limiting returns • European subsidies for projects of common interest	• EU funding for projects of common interests available	*Maturity:* Mature *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Medium / Low *Availability:* Low *Bad debt:* Low	No - other utilities have a more comparable risk profile / characteristics to heat networks although cap and floor model is an interesting variation to CfDs.

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Gas shipper	Ofgem	Mature	• Subject to a competitive market environment unlike typical monopoly structure of heat networks • Facilitate a competitive and efficient market for gas trading and shipping that ultimately benefits consumers. • Mostly private entities	No - structure of market too dissimilar to heat networks when compared to others.	-	-	-	-	-		-
Energy	Gas supply (domestic & non-	Ofgem	Mature	• Subject to a competitive market environment unlike typical monopoly structure of heat networks • Mostly private/plc entities - JVs in large scale supply contracts	No - structure of market too dissimilar to heat networks when compared to others which offer more comparable attributes.	-	-	-	-	-		-
Energy	Gas transporters	Ofgem	Mature	• Mostly private/plc entities - JVs can be present for development/expansion projects • Natural monopoly characteristics	Yes	Long term	Wholesale	*Customer base:* Gas consumers *User base:* Gas shippers / traders *Owner of asset:* Private *Who is subsidising regime:* Costs socialised across customer base	• RAB model providing stable returns • Incentives for investment in safety, reliability and decarbonisation	-	*Maturity:* Mature *Design:* Low *Construction:* Low *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - more comparable utilities to heat networks exist for a RAB based model in terms of risk profile (especially demand & bad debt risk) and market it services.
Energy	Gas National Transmission System (NTS) operator	Ofgem	Mature	• Mostly private/plc entities - JVs can be present for specific projects • Natural monopoly characteristics	Yes	Long term	Wholesale	*Customer base:* Gas consumers *User base:* Gas shippers / traders *Owner of asset:* Private *Who is subsidising regime:* Costs socialised across customer base	• RAB model providing stable returns • Incentives for system upgrades and capacity expansion	-	*Maturity:* Mature *Design:* Low *Construction:* Low *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - more comparable utilities to heat networks exist for a RAB based model in terms of risk profile (especially demand & bad debt risk) and market it services.

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Energy	Gas Site specific pipeline operators	Ofgem	Mature	• May be subject to negotiated access arrangements • Mostly private/plc entities - JVs can be present for specific projects • Can be local monopoly characteristics	Yes	Medium / Long term	Wholesale	*Customer base:* Industrial / commercial users *User base:* Specific industrial / commercial users *Owner of asset:* Private / JVs *Who is subsidising regime:* Users or through commercial agreements	• Negotiated agreements for specific projects • May include user commitments or anchor contracts	• Regulatory requirements can vary based on pipelines purpose and users	*Maturity:* Mature *Design:* Low / Medium *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Medium *Availability:* Medium *Bad debt:* Low / Medium	No - negotiated agreement in place as opposed to more consistent investment support mechanisms. Better comparators exist to heat networks characteristics.
Water	Water & sewerage undertakers (household)	Ofwat	Mature	• Mostly private/plc entities - JVs not uncommon • Natural monopoly characteristics • Has demand/price reviews and bad debt risk	Yes	Long term	Retail	*Customer base:* Household water consumers *User base:* Household water consumers *Owner of asset:* Private *Who is subsidising regime:* Costs socialised across customer base	• RAB model with periodic price reviews • Investment incentives for infrastructure resilience/performance targets and environmental performance	• Regulator sets tariffs, utility still bears demand risk alongside bad debt from individual customers	*Maturity:* Mature *Design:* Low *Construction:* Low / Medium *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Medium	Yes - retail sector reflecting characteristics of heat networks Furthermore although it's RAB based regime, demand and bad debt risks still exist mirroring heat network risks.
Water	Water supply & sewerage services (non-household)	Ofwat	Mature	• Competitive market for non-household customers • Regulated under RAB model • Mostly private/plc entities - JVs can be present for specific projects	No - household represents a better comparator as it services the retail market like heat networks unlike non-household	-	-	-	-	-		-
Water	Infrastructure providers	Ofwat	Mature	• Mostly private/plc entities - JVs can be present for significant capex projects • Natural monopoly characteristics	Yes	Long term	Wholesale	*Customer base:* Household water consumers *User base:* Household water consumers *Owner of asset:* Private *Who is subsidising regime:* Costs socialised across customer base or specific users	• RAB model with periodic price reviews • Incentives for meeting performance targets and service quality	• May involve public-private partnerships	*Maturity:* Mature *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - more comparable utilities to heat networks exist for a RAB based model in terms of risk profile (especially demand & bad debt risk) and market it services.

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Telecommunications	Fibre Broadband network	Ofcom	Developing	•Risk of bad debt due to retail nature •Demand risk and uncertainty on which customers connect to network •Gradual build up of users over time •Competitive market environment • Private/plc entities - JVs common	Yes	Long term	Retail	*Customer base*: Household and business Consumers *User base:* Individual households and business Consumers *Owner of asset:* Private *Who is subsidising regime:* Costs socialised across customer base	• Government grants - Local Full Fibre Network (LFFN) Fund	•Providers set tariffs, providers still bear demand risk alongside bad debt from individual customers	*Maturity:* Developing *Design:* Low *Construction:* Medium *Operation:* Low *Maintenance:* Low *Revenue:* Low *Availability:* Low *Bad debt:* Medium	No – more comparable utilities to heat networks. However, retail sector, demand risks and bad debt risks reflecting characteristics of heat networks.
Telecommunications	Internet based services	Ofcom	Mature	• Competitive market environment • Private/plc entities - capex can involve JVs	No - competitive market unlikely to be present in heat networks. Other more suitable comparators present.	-	-	-	-	-		-
Telecommunications	Media use & attitudes	Ofcom	Mature	• Industry influenced by consumer trends	No - little capex involved and more orientated on the digital environment and attitudes	-	-	-	-	-		-
Telecommunications	Online safety	Ofcom	Mature	• Regulatory oversight for consumer protection • Involves both private and public entities	No - little capex involved and more orientated on the digital environment and safety	-	-	-	-	-		-
Telecommunications	Phones & broadband	Ofcom	Mature	• Competitive market environment • Private/plc entities - JVs common	No - competitive market unlikely to be present in heat networks. Other more suitable comparators present.	-	-	-	-	-		-

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Telecommunications	TV, radio & on-demand	Ofcom	Mature	• Content regulation and licensing • Private/plc entities	No - regulation surround content and licencing as opposed to primarily physical assets.	-	-	-	-	-		-
Postal	Post	Ofcom	Mature	• Universal service obligations similar to concept of providing heat to all connected consumers • Private/plc entities	No - little regulation over financial assets but instead regulation over service obligations, access and consumer protection.	-	-	-	-	-		-
Rail	Infrastructure	ORR	Mature	• Natural monopoly characteristics • Mostly private/plc entities - JVs present in significant capex projects	Yes	Long term	Wholesale	*Customer base:* Rail passengers and freight users *User base:* Train operators *Owner of asset:* Private companies & public sector bodies *Who is subsidising regime:* Gov funding and user fees	• RAB model with periodic price reviews • Government funding and support • Regulatory incentives for private investment	• Government funding and support for major projects	*Maturity:* Mature *Design:* Low *Construction:* Medium / High *Operation:* Low *Maintenance:* Medium *Revenue:* Low *Availability:* Low *Bad debt:* Low	No - more comparable utilities to heat networks exist for a RAB based model in terms of risk profile (especially demand & bad debt risk) and market it services.
Rail	Passenger train operations	ORR	Mature	• Competitive market for franchises • Mostly private/plc entities - JVs present in specific services	No - competitive franchised market unlike heat networks with little emphasis on long term infrastructure.	-	-	-	-	-	-	-
Rail	Freight train operations	ORR	Mature	• Competitive market environment • Private/plc entities - JVs can be present	No - competitive market unlike heat networks with little emphasis on long term infrastructure.	-	-	-	-	-	-	-

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Rail	High speed rail	ORR	Developing	• Regulated infrastructure and operations • Mostly private/plc entities - JVs can be present	Yes	Long term	Wholesale	*Customer base:* Rail passengers and freight users *User base:* Train operators *Owner of asset:* Private companies & public sector bodies *Who is subsidising regime:* Gov funding and private investment	• Government funded for major projects • Private investment in stations and related developments	• Government funding and support for major projects	*Maturity:* Developing *Design:* Medium / High *Construction:* Very high *Operation:* Medium *Maintenance:* Medium *Revenue:* Medium / High *Availability:* Medium / High *Bad debt:* Low / Medium	No - government funding provides a lot of the investment in the infrastructure. This, alongside the risk profile means there better utility comparators for heat networks.
Rail	Station and depot access	ORR	Mature	• Access arrangements regulated for fairness • Mostly private/plc entities - JVs can be present	No - regulation not around physical infrastructure assets but around access	-	-	-	-	-		-
Air	Airline licensing	CAA	Mature	• Competitive market • Private/plc entities - JVs can be present (route sharing etc)	No - regulation not around physical infrastructure assets but around licensing alongside it being a competitive market.	-	-	-	-	-		-
Air	Air traffic services	CAA	Mature	• Natural monopoly • Private/plc entities - JVs present in significant capex projects	No - regulation not around physical infrastructure assets but around service and safety	-	-	-	-	-		-
Air	Airports	CAA	Mature	• Can be regulated under RAB model • Private/plc entities - JVs common • Long term infrastructure investment	No - better comparators for a RAV model within the energy & water markets exist (greater similarities to heat network operations than airports)	-	-	-	-	-		-
Air	Pilots & aircrew licencing	CAA	Mature	• Licensing and certification requirements • Private individuals and entities	No - regulation not around physical infrastructure assets but around licensing alongside it being a competitive market.	-	-	-	-	-		-

Utility sector	Subsector	Regulator	Maturity of sector	Similarities to heat network	Initial comparator for analysis?	Timeframe of return	Retail vs wholesale	Stake-holders	Investment support	Areas of regulatory / financial difference	Risk profile	Appropriate comparator for analysis?
Air	Safety & airspace	CAA	Mature	• Regulatory oversight for safety • Involves both private and public entities	No - regulation not around physical infrastructure assets but around service and safety	-	-	-	-	-		-

Definitions:
Retail – Sale of utilities / services directly to the end consumer. Retail providers manage the relationship with individual customers and are responsible for meeting consumer protection regulations /service quality standards. For example, delivery of electricity, gas, water etc to residential or commercial users.
Wholesale – Not directly interacting with the end consumer but rather with other businesses / entities within the utility sector. Typically deal with large volumes of utility services and subjected to regulations around market competition, access to infrastructure and pricing. For example, for electricity, many are classified as wholesale as they generate the electricity and its sale to retail suppliers through a wholesale market.

How to cite this publication:
Thomson, N., Davidson, H., Smallman, J. (2025) 'Funding and financing heat networks in Scotland', ClimateXChange. DOI: http://dx.doi.org/10.7488/era/5740

This work was supported by the Rural and Environment Science and Analytical Services Division of the Scottish Government (CoE – CXC).

ClimateXChange
Edinburgh Climate Change Institute
High School Yards
Edinburgh EH1 1LZ
+44 (0) 131 651 4783

info@climatexchange.org.uk
www.climatexchange.org.uk

If you require the report in an alternative format such as a Word document, please contact info@climatexchange.org.uk or 0131 651 4783.