Department for
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INTERNATIONAL REVIEW OF HEAT NETWORK MARKET FRAMEWORKS

Rapid Evidence Assessment, Regulatory Document Review, and Qualitative Interviews

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Executive Summary

Introduction

UK and Scottish Governments are both considering regulatory frameworks for heat networks. BEIS has committed to establishing an effective long term market framework, to ensuring sufficient consumer protections, growing investment in the sector and maximising the potential for decarbonisation. In order to inform the development of a regulatory framework, BEIS has commissioned this work on international experiences.

There are two types of Heat Network. The first is communal heating, in which all dwellings within a single building are supplied by a central heating system. The second is District Heating, where heat is produced from a central source and delivered through a network to multiple buildings or sites. Buildings could be residential, public or commercial use or some combination of these. The main focus of this research has been regulatory structures for District Heating.

Methods

This report combines findings from a literature review, regulatory document review and qualitative interviews investigating international heat network market frameworks. It provides evidence to feed into BEIS' policy work on the regulation of UK-based heat networks. The work is structured around five research questions:

1. What are the characteristics of regulatory frameworks for heat networks being used in other countries?
2. What consumer protection lessons can the UK learn from other countries' and markets' regulatory frameworks for heat networks?
3. How do other countries' heat networks determine pricing, and what have the impacts of these been? How applicable are these for heat networks in the UK?
4. How do regulations and market frameworks in other countries support the 'investability' of heat networks?
5. Are there obligations or incentives to promote renewable energy sources? Do they apply to new build or existing buildings? Or do they apply to the heat networks themselves?

Research questions have been addressed through:

A systematic literature review – an initial longlist of 67 documents was screened against a set of quality and relevance criteria to generate a shortlist of 25 references selected on the basis of their ability: to provide sufficient market coverage, to address the research questions and level of regulatory detail.

A targeted regulatory document review – as a supplement to the literature review, this has generated a depth of insight from a range of specialist documents. We have referenced nearly

100 laws, regulations, government inquiries, government reports, codes of practice, industry recommendations and schemes.

Semi-structured stakeholder interviews - We have conducted full interviews with 19 people, guided by a set of semi-structured interview questions set out in three topic guides – one for heat network operators, one for heat network regulators and one for heat networks consumer groups. Consumer groups were particularly difficult to source and access, so findings should be interpreted with this in mind. Interviewees and project team members also recommended additional contacts for their specific knowledge and expertise, which we have followed up informally by email which has helped to fill any knowledge gaps that were still remaining after the interviews. In total, across interviews and email consultation, we have consulted 24 stakeholders in 21 organisations.

The literature review was international in scope and culminated in recommendations on where to focus research effort for the interviews and regulatory document review. We identified British Columbia, Norway, the Netherlands and Germany as all potentially offering valuable and relevant insight for emerging and expanding heat network markets i.e. similar to the UK, where the regulatory challenges are centred on implementing new schemes. We also chose Finland as an under-studied but large heat network market. Additionally, we have probed for specific information on pricing, consumer protection, investment and technical codes in the otherwise well-studied Swedish and Danish markets.

Findings

Regulatory framework

British Columbia, the Netherlands and Norway are regulated markets, having a specific government department or regulator that has some level of dedicated responsibility for heat networks. Germany and Finland are largely unregulated although in both cases the Competition Authorities can step in on competition issues.

Where regulators exist, they provide different functions depending on the market, covering one or more of:

- A clear and independent path of redress for consumers.
- Licensing
- Price regulation
- Economic regulation of heat network companies
- Protecting consumers against bankruptcy of heat supplier (backstop arrangements)

Whilst some stakeholders were content with and, in the case of industry, advocated for, an unregulated regime, we are not convinced it would meet the needs and expectations of UK consumers.

In some markets it is clear that regulation has evolved and adapted with the size and ownership structure of the industry. Public sector ownership of heat network companies remains widespread, the majority of which is at the municipal level.

There are clear benefits associated with regulation that provides consumer redress and, through licensing or otherwise, gives a regulator powers to monitor heat network companies and address poor performance in areas of safety, consumer protection, the ability to resource essential operations and price transparency.

Heat networks, as a young and growing industry, needs loyal customers that cannot or do not change their energy supplier. The balance of international experiences suggests that unbundling in support of competition is unlikely to make sense. UK Government already caps electricity and gas prices where consumers are not seeing the benefits of competition. Hence price regulation or rates approval is arguably desirable to protect against exploitation of captive heat network customers.

However, price regulation and economic regulation is difficult and resource intensive for regulators and needs to be very well designed to avoid 'leakage' (recovery of costs from unregulated parts of the market). It can also burden heat network companies with disproportionate regulatory compliance costs and hamper an industry that has the potential to benefit consumers. Therefore, it needs to be very carefully designed.

Consumer protection

Shared living, including communal heating and general building-level co-operation is much more common in all of the countries reviewed than in the UK. For stakeholders in this study, heat network 'customers' are buildings, and customer representatives are building owners, commercial organisations and housing associations. Practices vary on whether consumers are billed based on metered consumption or floor area, although new European regulations generally require some form of metering now.

In this context, we found that there was very little information on the experiences and needs of end users – what, in the UK we would class as a customer. There are however some interesting models of building-level consumer representation and input, including a "price dialogue" in Sweden and collaborative development of terms and conditions of supply in Finland. Aspects of a regulated market can be seen as representing consumers that do not have the resources, expertise or the voice to effectively engage with industry.

Pricing

Heat network costs can vary substantially with the nature and size of a scheme. Final consumer prices depend on specific market characteristics. Prices can be capped (the Netherlands for small consumers and Norway for consumers subject to mandatory connection), set individually for each company by a regulator (British Columbia for customers of private schemes) or reviewed by the Competition Authority where there is concern (Germany, Finland).

Where prices are capped, this is at the nearest market comparison – in the Netherlands this has been gas heating but this is under review following a ban on new gas connections; in Norway this is electric heating. Levelised rates, explicitly used in British Columbia schemes, are a useful means of spreading the high up front cost of capital over a longer period and avoiding rates shock.

Published prices are in the region of €70-88/MWh. Norway has the lowest prices by virtue of a cap linked to the price of electric heating and subsidised scheme costs.

Investability

Heat zoning at the municipality level accompanied by mandatory connection within a zone is cited as crucial for investment by many stakeholders. However, some markets have never had compulsory connection or use it very sparingly. Unfortunately, in these markets it has been difficult to pin down exactly what is providing investment confidence, but it is likely a mixture of strong municipal policies, favourable building codes and, perhaps, contractual protections given as part of a concession.

Some markets are rolling back compulsory connection whilst the Netherlands is strengthening compulsory connection provisions. Our conclusion is that whilst mandatory connection does not appear to be essential, policies which in some way result in customers being bound to heat networks are essential for investment to take place. Mandatory connection as a last resort seems to be an important protection in those markets that use it sparingly.

Industry confidence to invest amongst stakeholders is generally positive across all the markets. However, none would, without specific support or investment protection, invest strategically ahead of need – this is because of the high initial upfront costs of schemes which dominate economic viability.

Decarbonisation

Decarbonisation of heat networks, like decarbonisation of heat more generally, is very much a work in progress in almost all of the countries that we looked at. Pure fossil fuel contribution to heat networks ranges from 5% in Norway to over 90% in the Netherlands. Finland and Norway have both made use of domestic biofuel resources and Norway has been particularly focused on recovery of heat from waste incineration (which accounts for nearly 50% of supplies).

There is a long way to go, especially for markets like the Netherlands and the UK which need to transition from natural gas. Each market has taken its own approach to decarbonisation, employing a mix of hard and soft targets, greening of building codes and financial support.

The UK Government already provides both grant and revenue support for heat networks – capital via HNIP and revenue for renewables based schemes via the RHI. The UK Government has announced that the Future Homes Standard will prevent the installation of fossil fuel heating sources in new build from 2025.

1 Introduction

This report combines findings from a literature review, regulatory document review and qualitative interviews investigating international heat network market frameworks. It provides evidence to feed into BEIS' policy work on the regulation of UK-based heat networks. The work is structured around five research questions on regulatory frameworks, consumer protection, pricing, investment and decarbonisation.

1.1 Background

BEIS has commissioned CAG Consultants, working with Nordic Heat and Robin Wiltshire, to review contemporary market frameworks for heat networks. The work is split into two phases: Phase 1 is a literature review looking at international experiences in the regulation of heat networks. For a sub-section of markets and key issues identified in Phase 1, Phase 2 comprises a regulatory document review and a series of semi-structured interviews with industry, consumer and policy stakeholders.

Five BEIS research questions have underpinned the work at all stages and findings are reported against each of these in turn. The research questions are:

1. What are the characteristics of regulatory frameworks for heat networks being used in other countries?
2. What consumer protection lessons can the UK learn from other countries' and markets' regulatory frameworks for heat networks?
3. How do other countries' heat networks determine pricing, and what have the impacts of these been? How applicable are these for heat networks in the UK?
4. How do regulations and market frameworks in other countries support the 'investability' of heat networks?
5. Are there obligations or incentives to promote renewable energy sources? Do they apply to new build or existing buildings? Or do they apply to the heat networks themselves?

This report:

- Summarises our methods and outputs (Section 2)
- Details our findings against each research question (Sections 3-7). UK contextual information is given at the end of each of these Sections by way of a commentary on the applicability of experiences to the UK. Full references to all documents, laws and regulations mentioned in these findings are provided in the literature review and the regulatory document review.
- Provides some summary conclusions (Section 8).

An appendix to this report provides a more detailed regulatory document review.

1.2 Definition

There are two types of Heat Network. The first is communal heating, in which all dwellings within a single building are supplied by a central heating system. The second is District Heating, where heat is produced from a central source and delivered through a network to multiple buildings or sites. Buildings could be residential, public or commercial use or some combination of these. The main focus of this research has been regulatory structures for District Heating.

1.3 UK Context

The UK government is committed to delivering a self-sustaining heat networks market, which is attractive to investment, where costs continue to be driven down, consumers are properly protected and benefit from reliable and affordable heating, and one which supports the decarbonisation of heat. BEIS has recently published its current thinking on this[1], drawing on recommendations from an industry taskforce and a Competition and Markets Authority inquiry into Heat Networks.[2] The main priorities for the government are to:

- Attract investment in heat networks
- Maximise the potential decarbonisation benefits of heat networks – heat networks are seen as an integral part of full decarbonisation of heat by 2050
- Ensure consumers receive sufficient protections, including on quality of service and transparency

This research will inform BEIS' work to expand the heat network market in the UK while protecting consumers. Although the UK has established structures in place for the regulation of energy, water and telecoms networks, we have made no pre-judgements about the most appropriate model for heat networks.

BEIS aims to consult on policy options for the framework later in 2019. Any subsequent legislation would be subject to further consultation on the detailed requirements and introduced when Parliamentary time allows.

[1] BEIS, 2018. Heat networks: ensuring sustained investment and protecting consumers. (accessed on 5 February 2018).
[2] CMA. Heat networks market study. (accessed on 3 March 2019).

2 Methods and outputs

Research questions have been addressed through a systematic literature review (Phase 1), a targeted regulatory document review and semi-structured stakeholder interviews (Phase 2). Findings from Phase 1 have been used to inform the country markets and issues on which to focus in Phase 2. We have looked in detail at the markets of British Columbia, Norway, the Netherlands, Germany and Finland. Additionally, we have probed for specific information on pricing, consumer protection, investment and technical codes in Sweden and Denmark.

2.1 Literature review

Our approach to the literature review applied a systematic approach to the identification, screening and reviewing of references. A significant amount of information has been published on heat networks and much of this touches on regulation, but often only in a light touch fashion. There is also considerable duplication in the form of cross referencing. To ensure that the review focused on the material of most relevance to the research questions we applied a structured approach, based on systematic review processes.

The exercise commenced with the development of a set of search terms and search constraints (documents had to be: post 2004, relate to OECD countries and, in general, be available in English). Following agreement of the search criteria we identified an initial longlist of 67 documents. This list was subsequently screened against a set of quality and relevance criteria. This exercise generated a shortlist of 25 references selected on the basis of their ability: to provide sufficient market coverage, to address the research questions and level of regulatory detail. Finally, shortlisted documents were subject to an in-depth review guided by a formal data collection review template.

The review generated insights into all of the research questions across around twenty countries with experience in heat networks. It did not provide a depth of information on regulatory codes and detailed legislation, something which had been anticipated by the inclusion of a focused regulatory document review in Phase 2. Information was sparse on the consumer experience. BEIS has however recently conducted and published research into consumer experiences of heat networks in the UK.

The literature provides a good level of information on the key defining features of most markets. Selection of countries and issues for in-depth review in Phase 2 was a process of gathering intelligence from the literature review, narrowing down from the international perspective to countries and issues emerging as important and relevant to the UK.

Our review included a number of multi-country reviews which drew distinctions between markets by their status and current focus – refurbishing, consolidating, expanding and emerging - as summarised in Table 1. We found this particularly helpful for focusing on which markets are most relevant to the UK context – namely those that are expanding and emerging and where main challenges relate to creating new schemes. In summary, we chose:

British Columbia – the only sub-national market in our selection but operates as a British Columbia-wide and British Columbia-regulated market. An emerging market, strong focus on economic oversight of newbuild schemes and rates stabilisation.

Norway – an emerging, regulated market with licensing regime, UK neighbour and energy trading partner.

The Netherlands – an emerging, regulated market with particular emphasis on price. Like the UK, main competition for heat is natural gas. Currently undergoing a review of the Heat regime with potential learning for UK.

Germany – an unregulated heat network market within an otherwise regulated electricity and gas market, so offering insight into development in UK if heat networks were to continue in the absence of a regulatory regime. An expanding market, and the largest market in Europe.

Finland – unlike the other markets selected this is a mature, consolidating, unregulated market. There are many parallels with Sweden, its neighbour, but it is much less well understood.

Table 1 Market status

Refurbishing	Consolidating	Expanding	Emerging
Bosnia & Herzegovina Croatia Kazakhstan Krgyzstan Kosovo Macedonia FYR Russia Serbia Ukraine Uzbekistan Bulgaria Croatia Czech Republic Estonia Hungary Latvia Lithuania Poland Romania Slovenia Slovakia	Austria Denmark Finland France Sweden	China South Korea Germany Italy	USA Canada Netherlands Norway UK

We quickly established that Denmark and Sweden were both well understood markets, that have been studied many times in the past. Nonetheless we found gaps in specific themes throughout the literature review, where insight from more mature markets would be valuable. Specifically, there were some key unanswered questions from Sweden and Denmark on pricing, industry investment and treatment of profits, technical codes and customer protections. We therefore focused a small number of interviews on looking at these specific issues, rather than on the overall operation of the market.

2.2 Interviews

We have conducted full interviews with 19 people, guided by a set of semi-structured interview questions set out in three topic guides – one for heat network operators, one for heat network regulators and one for heat network consumer groups. Before, during and after each interview we requested information on relevant regulatory documents which were then fed into the regulatory document review. It proved easier to find operators and to a lesser extent regulators and civil servants. Consumer groups were particularly difficult to source and access, so findings should be interpreted with this in mind.

Interviewees and project team members also recommended additional contacts for their specific knowledge and expertise, which we have followed up informally by email. This has helped to fill any knowledge gaps that were still remaining after the interviews. In total, across interviews and email consultation, we have consulted 24 stakeholders in 21 organisations.

We would like to thank everyone involved for being generous with their time and expertise. Undoubtedly stakeholder input has been invaluable in achieving a depth of understanding that is not available in the literature.

2.3 Regulatory document review

A regulatory document review has been undertaken in tandem with stakeholder interviews – this has been included as a published appendix to this report. This supplements the literature review, generating a depth of insight from a range of specialist documents. We have referenced nearly 100 laws, regulations, government inquiries, government reports, codes of practice, industry recommendations and schemes. Our main starting point for the review was a request to stakeholder interviewees to identify key documents, which was supplemented by snowballing from these recommendations, team knowledge and web searches.

Information from the review is incorporated into findings presented in the following sections.

3 Market characteristics and regulatory frameworks

In this and following four Sections we pull together findings from the literature review and interviews to answer each of the five research questions. The five countries and five themes selected for in-depth review form the main evidence base.

This Section looks at the market-defining regulatory frameworks implemented for heat networks. Where there is no framework, it looks at any informal structures and processes that have been implemented. By way of context, it analyses the makeup and structure of the heat network industry, including ownership models.

3.1 Regulators

Table 2 shows that three of the five target countries have a regulatory body overseeing heat networks. Of these one (NVE, in Norway) is a part of central government, and two (ACM in Netherlands and BCUC in British Columbia) are independent regulators set up by, but at arms-length from, national (ACM) and regional (BCUC) government. Both BCUC and ACM regulate the mainstream energy sector. BCUC also regulates car insurance, and ACM telecoms, transport and post.

Table 2 heat network regulators

Country	Regulator	Heat Network Scope
British Columbia	BCUC, an independent regulator	Economic regulation, rates approval and overseeing business planning to meet customer load requirements. BCUC only oversees private schemes, and tiers requirements by capital investment
Netherlands	ACM, an independent regulator	Prices (price regulation only for small customers), licensing, profits (for licensed firms) and customer protections
Norway	NVE, a government body	Licensing, through which NVE enforces planning-type conditions. It oversees complaints on price for licensed schemes. Schemes over 10MW must have a license, smaller need to have a license if they wish to use mandatory connection

In **British Columbia** regulation centres on financing schemes and rates approvals. Because it only regulates private schemes, the regulator oversees just a small proportion of all heat network schemes in British Columbia. There are three tiers of regulation:

- Exempt: Schemes with capital costs of Can$500,000 or less; or self-supply (communal) schemes run by the building's Strata Corporation. Very limited requirements around record-keeping and providing information to BCUC if requested.

- Stream A: On-site schemes over Can$500,000 and under Can$15,000,000 (On-site is defined as the thermal generating equipment and customers situated within the legal boundaries of a property or parcel of land. Generally, no larger than a city Block). These projects must register with BCUC and have certain basic service-provider obligations such as the provision of long-term supply contracts and clear rates. This is by far the largest sector, in number of schemes, that BCUC oversees.
- Stream B: All other schemes are subject to full economic regulation, which means scrutiny of detailed business plans and the financial makeup of the company. Stream B schemes are also permitted and subject to public hearings for rates approvals. BCUC estimate there to have been one Stream B application in the last two years.

The regulatory regime is an important factor when considering ownership models. Interviewees told us that the rates approval process is time-consuming and costly. Rates are approved through public hearings. Third parties who are able to show they are impacted by the scheme can register as an “intervener”, and the heat network operator pays their costs. An intervener could be a potential customer or an alternative energy supplier.

BCUC has also recently ruled against a municipality that brought forward plans to work with a private provider bringing in investment. BCUC would not allow this model in conjunction with the municipality using its powers over compulsory connections. It is this last point, the opportunity for municipalities to designate service areas in which new or retrofit buildings are compelled to connect, that is a key contributing factor for municipalities to develop their own schemes.

In the **Netherlands**, ACM licenses heat network providers supplying more than 10,000 GJ to more than 10 customers (there is an exemption for self-supply, including supply to buildings owned collectively). It also regulates prices for “small” consumers, which are consumers and small and medium-sized businesses with connections up to and including 100 kW (this excludes most apartment dwellings where the building connection is likely to exceed 100kW although updates to the Heat Law in the Netherlands will expand price regulation to these ‘collective’ connections). Price regulation is with reference to the price of gas – specifically prices are capped at the average expenditure of a household using natural gas heating. ACM separately regulates yearly fixed and energy components, as well as one-off connection costs where this is to an existing network (but not to a new network).

ACM also monitors heat network company profits, reporting on this once every two years. It may, if it chooses, ask Parliament for powers to take further action, although it is not clear what this action might comprise. To-date, this has not been necessary, with profits of around 6% considered reasonable.

The government Ministry of Economic Affairs and Climate (EZK) is responsible for heat network policy and is in the process of developing new legislation. This will include a ban on new buildings using natural gas, and, it seems likely, decoupling price regulation from gas.

In **Norway**, permitting is mainly a vehicle for imposing what in the UK would be called planning conditions – specifying commissioning deadlines, and environmental and heritage protections – as well as reporting obligations (investment costs, heat sales, renewable energy mix and plans for phasing out fossil fuels) and emergency preparedness. A licensed party is exempt from needing a building permit from the municipality.

NVE told us that that timescale conditions are more or less self-regulating, in so far as there is some leeway provided for permit holders demonstrating progress, and that companies would generally withdraw from the permit themselves if they hit insurmountable problems.

Permits are tied to a company's ability to benefit from mandatory connections, and as a result projects under 10 MW will apply even though it is not compulsory. NVE's oversight of permitted projects provides some extra protection for consumers, allowing NVE to investigate and rule on pricing complaints. However, NVE's role is largely reactive in this respect, it does not approve investment plans or rates, reporting that it is a relatively small field of heat network players that are generally considered to be robust and competent.

Norway's system of regulation is "light touch", with powers to intervene if something goes wrong, but which assumes these powers will rarely if ever be used. NVE believes that the linking of permits with mandatory connection has been essential for growing the sector. Enhanced oversight has been discussed, weighed up against the higher supervisory and enforcement costs this would incur.

UK context

By comparison to the UK, NVE is comparable to BEIS and its energy project licensing function. ACM is comparable to Ofgem, Ofwat or Ofcom. There is no devolved government regulator in the UK that is comparable to BCUC in terms of scope, but (notwithstanding that energy regulation is currently reserved) there is, for example, a Scottish Housing Regulator and a water regulator for Scotland.

BCUC's style and scope of heat network regulation, and in particular Stream B, is directly comparable to Ofgem's regulation of the monopoly electricity and gas networks. BCUC's economic regulation under Stream B is a "cost plus" model, with an allowed rate of return specific to each company. Ofgem latterly has a more performance-based style of economic regulation – BCUC is trialling a similar approach, but not with heat networks.

BCUC's Stream B regulation for schemes costing $15M+ faces issues of investor confidence in comparison to unregulated municipal schemes – evidenced by the lack of applicants as well as stakeholder's comments. There is certainly a view, expressed by those with private sector experience, that BCUC's regulatory model for large energy utilities with extensive and integrated networks is being applied disproportionately to heat network undertakings. One stakeholder reported a regulatory burden that had grown over time and that had deterred new private investment.

In the same way as BCUC does for Stream A and B, it is very common in the UK, including by Ofgem, to taper regulatory burden by the size of an operation (for example the license lite[3] option for smaller suppliers). There is however no UK equivalent that we know of that applies regulation on the basis of ownership.

ACM's price regulation is at first glance directly comparable to the recent price caps imposed in the UK for Standard Variable Tariffs and those on restricted meters. In derivation, they also both share a political pressure to keep consumer costs down (although Ofgem administers the price cap, it is a government-imposed measure).

However, the UK cap is designed to be a short-term measure, imposed on unbundled Suppliers, and in lieu of effective competition across the whole market. ACM's price cap is

[3] https://www.ofgem.gov.uk/licences-industry-codes-and-standards/licences/licence-lite

applied to, in the main, vertically integrated utilities and can be seen as a substitute for deeper economic regulation.

3.2 Self-regulating

Municipally-owned and small schemes in British Columbia, all schemes in Finland (96% of which are municipally owned), all schemes in Germany (mixed ownership), and some small schemes in Norway – are self-regulated.

In **British Columbia**, Federal legislation exempts municipal schemes from any heat nework-specific regulation. This includes there being no independent consumer protection nor economic oversight. It is assumed that political supervision and – indirectly voter pressure and reputational risk – will drive good practice.

All municipalities have their own governance procedures, and heat network schemes generally fit in with these. Plans for heat network schemes, including rates, need to be approved through the relevant committees and sign-off processes that a municipality adopts for any large expenditure. Vancouver has an independent advisory board for rates. We did not find any evidence of specific procedures or rules for consumer protection, but BC municipalities operate water and sewerage already and will generally route complaints through established channels.

In **Finland**, heat networks are widespread and a mature market. There are established consumer organisations who appear to have some influence, through purchasing power, over terms and conditions of supply contracts. Billing requirements for heat networks are set out in an Energy Efficiency Law.

However, it is the industry, through the trade association Finnish Energy, that organises its own regulation. Member companies comprise 98% of heat network sales. It publishes industry information (prices, costs, supply interruptions), develops and governs standards and codes and registers third party heat purchases. It also lobbies, for instance arguing against moves to allow open Third Party Access (TPA)[4]. The Competition Authority provides some oversight on abuse of power and may intervene where there are substantial consumer complaints.

Germany is much the same as Finland, an unregulated market with oversight (the ability to investigate and if necessary intervene) from the Competition Authority on competition issues. It differs from Finland in so far as standard terms and conditions for supply of heat networks are defined by Federal law. Like Finnish Energy, the German AGFW (Energy Efficiency Association for District Heating, Cooling and CHP) has developed codes and standards from metering, to pipes to commissioning tests. AGFW has approximately 400 members representing 92 % of heat network load.

UK context

In many ways industry self-determination is not unlike the existing mainstream electricity and gas market across Great Britain. Under this model, industry experts constituted into working groups develop codes and standards which define the technical and economic rules for using the shared electricity and gas networks. This is described in further detail in Section 3.5. Through this process, industry has a large amount of influence over development of the

[4] Finnish Energy, 2018. Opportunities and challenges of opening the district heating networks – How to heat the future home?

regulatory framework and invests substantially in this. However, the governance structure and major decision-making sits with Ofgem, the regulator.

Finland cites consumer participation in development of guidelines for supply terms and conditions. RAKLI, one of our interviewees, a Finnish consumer group, seemed content with this arrangement, and even keen to promote new terms. Similarly, in the UK consumer groups can and sometimes do participate in the process of developing the regulatory framework. However, it can be difficult for consumer groups, and for small independent industry players, to engage, constrained both by resource and expertise, and so the UK regulator acts an important check on abuse of power. Citizens Advice and Citizens Advice Scotland do participate in regulatory reviews, and are able to commission expert advice and support. This role could be expanded to include heat networks.

3.3 Industry structure

Netherlands	Two thirds of networks produce their own heat and the remainder purchase from third parties
Norway	Mainly vertical integration with some negotiated Third Party Access (TPA) for heat (e.g. from data centres)
Finland	About one third, just under 10 TWh, of generation, is traded under negotiated TPA. Transactions are registered and posted by the trade association Finnish Energy
Germany	Vertically integrated, very limited TPA
British Columbia	Vertically integrated, no TPA

More or less every heat network exhibits integration of supply and distribution, and the vast majority are also integrated with generation either wholly or partly. There is some limited Third Party Access (TPA) for generation and / or heat recovery i.e. heat supply to the heat network from an entity that is not owned by the heat network provider. TPA to one network from another, and heat sales between separately-owned networks, is very rare and limited to large interconnected heat networks.

There seems to be agreement that vertical integration is acceptable and even necessary for all but the largest, city and regional-wide schemes. In 2012 the Swedish ministry of economic affairs concluded that heat networks were not large enough for unbundling to be economically worthwhile, and that TPA was difficult in a closed-loop system. In the same year the German Federal Cartel Office (Bundeskartellamt) came to similar conclusions. A 2018 consultant's report for the Netherlands Ministry of Economic Affairs and Climate again came to the same conclusion.

Cost-wise, there is significant expenditure in separating out different functions and putting in place the markets architecture (metering, cost allocation mechanisms, trading arrangements etc). There will be also be ongoing transactional costs between the different interconnected parties. Technically, the Netherlands report explains that "*Hydraulic flows are much less flexible and controllable than gas and electricity flows*" meaning, amongst other things, that TPA needs to be carefully "*negotiated*" rather than "*open*."

An additional motivation for looking at unbundling in the Netherlands appears to be the consequential opportunity to transfer ownership of parts of the network to state ownership.[5] The rationale is not entirely clear, but there seems to be a suggestion that the more monopolistic elements of the heat network business (the pipes – distribution and in the case of large interconnected networks, transmission) would sit more naturally in state ownership and more readily facilitate investment in line with policy priorities.

UK context

Heat networks in the UK are a small and emerging industry. Unbundling is unlikely to make sense at this early stage because the costs of breaking up the industry will only prove worthwhile if there is significant savings from doing so – such as lower prices driven by enhanced competition between generators and between suppliers. The industry is likely to be too small and the network not interconnected enough to make this worthwhile. Furthermore, in the UK the business case for heat networks (at the moment) is usually premised on guaranteed heat sales and hence control of heat supply.

Some form of negotiated TPA would provide opportunities for industrial heat sources for example to join networks. Industry will likely resist any proposal for forced TPA, on the grounds that it will make it difficult if not impossible to accommodate this in an unplanned manner.

Vertical integration does need to be seen in the context of consumer expectation in the UK. Energy consumers have a free choice of their energy supplier at the moment, even if investment in a gas boiler is a major long-term commitment. This choice is only one of Supply – namely who buys and sells energy on your behalf and issues bills, and only about 40% of consumers actually exercise this choice.[6] However, UK energy suppliers are only able to differentiate on their energy offering because the industry is unbundled and large enough to support wholesale markets. These issues are discussed further in Section 5 on consumer protection.

3.4 Industry ownership

Netherlands	There are 10,000 heat “networks” in the Netherlands, approximately 9,000 of which are unregulated communal schemes operated by housing associations. The remainder are small-scale networks and 13 large-scale (more than 5,000 connections) networks. Ownership of the larger networks is a mixture of private companies (Vattenfall, Eneco) and municipally owned companies (e.g. HVC – is owned by 46 municipalities and 6 water boards and operating in its own municipalities).[7]
Norway	There are 107 heat network companies in 2017. The market is made up of both municipal and privately owned projects. Many are owned by municipalities or districts. A good proportion of smaller schemes are privately owned. Large schemes are mainly based on municipal ownership, but through separate municipal energy companies. Some municipal schemes have been sold. In Oslo, Fortum is 50% private, 50% municipality.
Finland	96% of heat networks in Finland are run by municipalities. They account for 85% of district heating production in Finland. District heating is the

[5] SEO Economisch Onderzoek, 2018. Belang bij splitsing in de warmtemarkt (Interest in splitting the heat market).
[6] Ofgem, State of the energy market 2018
[7] SiRM, 2019. Tariefregulering warmtebedrijven voor kleinverbruikers. Onderzoek in opdracht van het Ministerie van Economische Zaken en Klimaat. (Tariff regulation of heat networks for small consumer. Research commissioned by the Ministry of Economic Affairs and Climate).

	dominant form of heating in the heating market in Finland, with a market share of just under 50% of the heating market. In larger cities, district heating has a market share of almost 90%. Almost 95% of all apartment buildings are heated by district heating. Large companies, active in large cities, dominate in terms of volume. Municipalities are allowed to divest their assets but most have chosen not to and are run for profit. They are not legally separate from the municipality and cannot go into bankruptcy.
Germany	District heating operators can be private firms or Stadtwerke (municipally owned companies). To be a Stadtwerke there must be a share owned by the municipality but the amount of ownership required is not clear. Stadtwerke are free to operate outside of their municipal boundaries and several do so. Big companies operate in the cities. Almost every city has a Stadtwerke, they are not always active in district heating but district heating is a popular Stadtwerke undertaking.
British Columbia	There are an estimated 48 district heating systems in British Columbia, the majority are heating-only.[8] Some are historical but under the current regulatory system there appears to be a mixture of smaller developer-led schemes or larger, more strategic municipal-led and owned schemes. A 2019 survey found around 20% of investment Canada-wide is private, the remainder local or Federal government or state institutions (academic, health). Municipal owners operate either from within the council structure or as a separate wholly-owned company.

Public sector ownership of heat network companies is widespread, the majority of which is at the municipal level. This is the starting model for almost all now-mature markets. In these cases, municipal ownership has historically sat side by side with local government planning, building and decarbonisation agendas. Where public ownership is long-standing this is typically in the context of municipal involvement in a range of energy and water utilities. Where there is private ownership, this is often via divestment of assets as the market grows.

The picture is however very mixed overall, with emerging markets such as the Netherlands, Norway and British Columbia showing no clear trends.

Within the municipal ownership model, there are some different practices such as operating for profit (British Columbia, Germany and Finland); eliminating profit (Denmark); operating from within the municipality or as a wholly-owned but separate company; and operating within (British Columbia) or within and outside (Germany) the municipality boundary.

Where municipalities operate outside of their own administrative boundaries, the distinction between municipal ownership, state ownership and private ownership is simply one of profit and where this is directed. This is as opposed to operating within the municipality boundary and being able to, for example: work alongside other municipality functions such as housing or water; and being able to benefit from resident's existing relationship with their municipality.

In Germany and Finland, high proportions of state ownership may well be a driving factor in the absence of formal regulation (although there is also state ownership in the regulated energy industries).

[8] Canadian Energy and Emissions Data Centre, 2019. District Energy in Canada. Report provided by email, but some data available

British Columbia is the only example we found of exemption from regulation by virtue of ownership. Other factors in favour of the municipal model, listed by a British Columbia stakeholder but which we believe are likely to be more widely applicable:

- Lower cost of capital – the City of Vancouver [9] reports that:

  "A City-owned utility would be exempt from income taxes, and the City could take advantage of senior government grant funding opportunities for future expansion, that may not be available to a private owner. In the case of City ownership, it is assumed that the utility will be 100% debt financed and have access to the City's long-term borrowing rate (currently approximately 6.0%)"

  At the time this compared favourably with part equity-funded private utilities with an estimated Weighted Average Cost of Capital of 10%.

- Control over greenhouse gas targets – municipal-level aspirations for reducing greenhouse gases are a key driver for heat networks in British Columbia.

- Control over project scope, future plans and timescales.

- Potential revenue. As well as a source of income for the area, it allows a potential sale of the scheme without the added rate shock of private profit.

Municipalities are free to adopt a number of business models for taking forward schemes – we spoke to Richmond, which operates heat networks from a special purpose wholly-owned company, Lulu Island Energy; and the city of Vancouver which operates schemes from within the municipality's utilities department. In both cases the private sector is involved in some form, typically contracts will be tendered to provide equipment and services. The municipality can however choose to use its own staff and expertise – for example by using its water department to lay pipes.

Whilst ownership is clearly a subject of debate in British Columbia, it is less so in other markets. In part this is likely to be because municipal or mixed ownership is so common as to not attract attention. However, in the **Netherlands** it is currently a topic for debate. A 2018 report on unbundling includes consideration of completely separate ownership of the heat networks in order that they can transfer to public ownership. It describes the potential benefits as:

> *"Public network operators can give priority to public interests when deciding on investments in networks. The environmental interest can be a reason for expanding investments in infrastructure where the public party is satisfied with a lower return than a private operator. In addition, public organisations generally have good access to the capital market….[and] In the case of public ownership of the heat infrastructure, there is also the option of integrating the options for constructing new infrastructure" (electricity and gas network managers are in public ownership in the Netherlands)*

It concludes that:

> *"ownership unbundling is a radical means of promoting sustainability as an objective. It directly affects the ownership structure and therefore causes high*

[9] Baber et al, 2006. Neighbourhood Energy Utility – Evaluation of Ownership and Operating Options for the City of Vancouver. To the Standing Committee on City Services and Budgets. Administrative report. City of Vancouver.

> *economic costs. There are instruments that serve the same purpose but at lower costs. Subsidies are an example, but also a model in which public parties co-invest in infrastructure, according to the literature, deliver good results by spreading the risks that this creates."*

Most publicly owned district heating companies are, as we understand, run for profit. **Denmark** is the exception, disbarring profit from heat network companies. Profit from within the supply chain is however allowed.

UK context

Heat networks in the UK during the post-war period were led by local authorities and developed to supply social housing. However, problems with efficiency and over-heating, combined with a decline in local authority house building meant that its popularity declined.[10] Schemes today are delivered by both the public and private sector, often in partnership.

The UK does not have the continuity of municipal ownership of not just heat networks but energy and water utilities as well, which is commonplace in all of the reviewed countries. Where municipal ownership of heat networks is taken for granted in other countries, there may well be implications for:-

- Customer expectations. There is no real modern-day equivalent in the UK, but it is helpful to think in terms of the council services we might take for granted, such as bin collection. How often are local authority residents asked about or express their levels of
- satisfaction in bin collection for example? This may help to explain some of the difficulty in understanding the consumer experience in other countries, as discussed in Section 4.
- Municipal expertise in heat networks. Notwithstanding some UK local authorities have delivered heat network schemes, if there were to be widespread municipal ownership in the UK, then capacity and expertise to deliver these complex schemes is something that would need to be addressed.

There is no UK policy on heat network ownership and there are a range of potential investment models. Commercial investors however stress the importance of local authority involvement, the Green Investment Group for instance stating that "*the public sector has an important role to play in all cases, from project advocate, to policy maker, to customer and potential funder*."[11] Given this crucial role, the ability of the public sector to negotiate a fair return for its investment – in the form of capital, underwriting, customer guarantees or otherwise – will be important.

3.5 Industry codes

Building codes

Stakeholders in Germany and British Columbia both cite building codes and regulations as essential drivers for decarbonising and facilitating heat networks. The literature review also found this to be an important factor in Finland. In one way or another they allow heat networks to substitute for energy efficiency or renewable energy measures, offering a compliance option

[10] Owen, G, 1992. Community heating, a UK action plan. Combined Heat and Power Association.
[11] Green Investment Bank, 2016. District heating in smarter greener cities. A guide to commercial structuring and financing.

for building developers. In Germany, where there is reticence in using compulsory connection, this can be an important driver for heat network investment. In Canada, ambitious decarbonising building codes are a key driving force for municipality-led heat network schemes.

Industry codes

By industry codes, we mean technical specifications, codes of practice and guidelines which ensure safe, quality-assured schemes to a commonly agreed standard. Interestingly, these were readily available for the unregulated markets of Finland and Germany, and in both cases had been developed by the respective trade associations. For the regulated markets, stakeholders assured us that schemes were built to specified standards but did not point us to specific industry-wide or regulator-approved standards.

In Germany, there is some historical context to the trade association leading on industry codes. Electricity and gas legislation (explicitly not heat networks) states that industry compliance is presumed when appropriate rules defined by the two associations VDE (electricity) and DVGW (gas) are applied. So although the heat network industry codes are voluntary, they have been developed in the same way as those for the electricity and gas sectors. The rules are published in the non-legislative part of the Federal Official Journal and when a problem applying these rules emerges, the far more rigid TÜV (Technischer Überwachungsverein – a group of businesses that provide inspection, standards and certification services) rules apply.

UK context

It is interesting that in some cases, building codes are cited as being on a level to mandatory connection in facilitating investment. These codes can be prescriptive or technology neutral. The UK Government has announced that the Future Homes Standard will prevent the installation of fossil fuel heating sources in new build from 2025,[12] which presents an opportunity to update building standards and consider the position of heat networks as part of this.

For electricity and gas there is a well-established regulated governance process for the development of technical codes (for example the grid code) and terms for connecting to and using the network, including cost allocation methodologies. The process is broadly the same for the technical and semi-commercial codes, involving a) the opportunity for code signatories and interested stakeholders to put forward changes b) appointment of expert working groups to work up proposals which c) are then submitted to the regulator for approval. Some detailed industry recommendations are developed by specialist standards organisations. As part of the Single Electricity Market, a number of change proposals come direct from European harmonisation work. These processes have all evolved over time from a largely industry-led initiative with no independent oversight to an almost wholly regulated approach with detailed governance procedures.

A defining feature of the gas and electricity networks is that they are large, interconnected and shared by ever-increasing numbers of connected demand and generation users. This drives both the content of the codes, and the industry / stakeholder dynamic in developing code change proposals. For example, a change in electricity transmission network tariffs can result in significant winners and losers. Whilst notionally technical documents, there can be commercial agendas and conflicting interests. This in turn means that companies invest in

[12] https://www.theccc.org.uk/2019/03/13/ccc-welcomes-government-commitments-to-new-low-carbon-homes-and-green-gas/

expertise to participate in codes governance, investment that consumer groups cannot and do not match. This is one reason why independent regulatory oversight is important.

This dynamic may not be quite the same for developing heat network codes and standards, but it is still important to bear in mind that consumers and industry will inevitably have some areas of conflicting interests.

Technical codes are beneficial in so far as they provide an established compliance route and have a protective effect for industry in so far as there is clarity on what is required of them. We have had some informal feedback from a UK practitioner that this would be helpful for the heat network sector, especially from an H&S and liability perspective.

A good starting point for the UK might be to collate existing standards, agreements and codes of practice across heat networks and develop them further through expert working groups. The Chartered Institution of Building Services Engineers (CIBSE) have developed a code of practice that could form a useful starting point.[13] This could start as an industry-led piece of work, with consumer input and some independent peer review. There is a question on whether this should begin as an unregulated process with increasing regulation over time, mirroring arrangements in electricity and gas. Or whether there should be regulation from the outset. The answer to this will likely become clearer as the scale and impact of the exercise emerges. It would be sensible to task any regulator with a 'watching brief' with powers of intervention, and to allow (adequately resourced) consumer organisations to participate meaningfully.

[13] CIBSE, 2015. Heat networks code of practice for the UK.

4 Consumer protection

4.1 Who are the consumers?

Netherlands	Mainly building owners
Norway	Mainly building owners.
Finland	Customers are mainly large energy users, tenants associations and consumer representatives. 78% of customers have remotely read meters[14]
Germany	Communal buildings have communal boilers. Rare to find a boiler for every floor, but normally one boiler per building. Buildings usually have commercial owners and most customers rent not own their apartment.
British Columbia	Commercial buildings or Strata. The latter are communally owned residential buildings, with a management committee often staffed by volunteers. Apartment blocks already have communal heating in the form of a shared boiler.

Within the residential sector, heat networks are best suited to, and most common within, high density apartment living. It is worth then considering the context around this. The 'consumers' are almost always building owners – co-operatives, housing associations or commercial landlords. Consumers are rarely individual apartment owners. So, all of the negotiation on supply terms, billing or rules on mandatory connection apply to the owners of a building.

Communal heating (as opposed to district heating spanning more than one building) is also the norm in many continental and North American residential buildings. This means that in these countries, households are already accustomed to shared heating systems and, often, have agreed to a system of apportioning costs between individual apartments.

Either the law (e.g. in Germany) or standard practice, determines how costs are allocated to individual households. For heat volume charges, this will be done by floor area, by a meter or by heat cost allocators (devices fitted to radiators that measure heat output). One stakeholder told us that the new 2018 European Energy Efficiency Directive requires there to be rule for allocating heat costs. It also specifies information to be contained in bills, including climate-corrected historical consumption and fuel mix.[15]

4.2 Supply terms and conditions

Both Finland and Germany, the two unregulated markets, highlighted standardised supply terms and conditions. In Finland these are drawn up by Finnish Energy in consultation with customer groups. In Germany, they are in the form of a Federal government Ordinance i.e. they are legally binding. The trade associations for heat networks thought that these were valuable and largely effective in protecting consumers interests. In Germany the trade association acknowledged that customers can terminate a contract – after 10 years was the norm although it says 2 years is now more common in response to consumer complaints.

[14] Finnish Energy, 2018. Lämpöenergiamittarien etäluenta_20180907 (Remote reading of heat meters).
[15] Directive (EU) 2018/2002 of the European Parliament and the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency.

For **Finland**, we interviewed RAKLI, the Finnish association of building owners and construction clients. RAKLI agree that the voluntary terms are the main vehicle for ensuring consumer protection. They cover responsibilities of the customer and the heat network provider on equipment maintenance, access and payments, as well as providing for customer compensation when initial heat network connection is delayed and when heat supply is interrupted.

For the most part RAKLI appeared to accept the voluntary arrangement, although they reported key concerns as costs, compensation for supply interruptions, and penalties for moving away from heat networks. They were also excited by the possibilities offered by digitisation, citing smart building control as a positive development for saving energy.[16]

In **Germany**, heat networks comprise about 14% of overall heating market, and provide heating to 22% of new flats. We spoke to the Federation of German Consumer Organisations (Verbraucherzentrale Bundesverband e.V or VZBV). They characterise heat network customers as "captive" to an unregulated market where there is no transparency of price or even fuel mix. Using the Ordinance on conditions of supply VZBV has taken legal action to improve transparency and consumer protection. There are also examples of local pressure groups – one for example dedicated to more transparent pricing for heat networks.[17]

VZVB believes that the Ordinance on supply terms needs modernisation. They cite heat network providers lawfully meeting their obligation to publicise terms by taking space in local newspapers (as opposed posting on the internet).[18] Despite the Ordinance also covering price escalation, individual price escalation clauses are described by VZVB as "*incomprehensible*." Another market monitoring organisation states that "*Price and contract changes are neither understandable nor comprehensible for customers*."[19]

One example provided:

Grundpreis	Verbrauchspreis
$GP = GP_0(0{,}2 + 0{,}2\frac{L}{L_0} + 0{,}6\frac{I}{I_0})$	$VP = VP_0(0{,}55\frac{K}{K_0} + 0{,}15\frac{L}{L_0} + 0{,}1\frac{I}{I_0} + 0{,}2\frac{M}{M_0})$
$GP = GP_0(0{,}2 + 0{,}2\frac{127{,}1}{120{,}1} + 0{,}6\frac{106{,}2}{104{,}7})$	$VP = VP_0(0{,}55\frac{71{,}21}{110{,}44} + 0{,}15\frac{127{,}1}{120{,}1} + 0{,}1\frac{106{,}2}{104{,}7} + 0{,}2\frac{148{,}6}{144{,}8})$
$GP = GP_0 * (1{,}020)$	$VP = VP_0 * (0{,}820)$

The whole clause with further explanations extends to three pages.

However, BDEW, the Association of Energy and Water Industries in Germany, conducted a consumer satisfaction survey across all energy providers.[20] Heat network customers had the highest percentage of extremely satisfied customers (33% - next highest was natural gas at 23%) and 69% were satisfied or extremely satisfied (68% for natural gas). The drivers of these

[16] Example given
[17] http://interessengemeinschaft-evo-ev.de/index.php
[18] VZBV, 2017. District heating sector did not arrive in the 21st century.
[19] Marktwätcher, 2019. Fernwärme: Preisanpassungen in bestehenden Kundenverhältnissen. Preis- und Vertragsänderungen sind für Kunden weder verständlich noch nachvollziehbar (District heating: price adjustments in existing customer relationships. Price and contract changes are neither understandable nor comprehensible for customers).
[20] BDEW, 2015. Wie heizt Deutschland? BDEW-Studie zum Heizungsmarkt. (consumer satisfaction survey reported on page 32).

high ratings are safety, modernity of heating systems and price (heat network users had the highest price satisfaction ratings). Oil central heating had the lowest overall satisfaction ratings.

In the **Netherlands**, from 2020 consumers will receive compensation for supply interruption. Heat network consumers already enjoy the same protections as other energy companies with respect to disconnection and access to future bill estimations to help with debt management. One stakeholder thought that small consumer groups were not well placed to engage in detailed technical and price discussions with a well-organised industry. So consumer protection is an important part of regulation, and is being strengthened by updates to the Heat Law.

One stakeholder told us that consumers find it difficult to disconnect in the Netherlands, due to the high costs involved. It is possible ACM will regulate these disconnection costs.

4.3 General complaints processes

Netherlands	ACM has a dedicated website for consumers and will hear complaints.
Norway	NVE takes price complaints where there is mandatory connection. Consumers can complain on contractual matters to the Electricity Board, but very few do.[21] Otherwise consumers need to take civil action.
Finland	Arbitration option before taking legal action.
Germany	Ad hoc mixture of voluntary arbitration and civil law
British Columbia	BCUC will oversee price complaints only for price regulated Stream B schemes. Municipal schemes use general municipal complaint procedures.

ACM in the **Netherlands** has a dedicated consumer-facing website, 'consuwijzer'.[22] Complaints are mainly on bills (the amount delivered) and supply interruptions. The Heat Act also requires individual household metering but there are exceptions, and where there are, there can be complaints about the amount delivered. An update to the Heat Act includes measures to make it easier to complain.

In **Germany**, consumers might have the opportunity to avail of the arbitration board. The system works under the regime of ADR (Alternative Dispute Resolution). It is though, a different system from electricity and gas, where suppliers are required to participate. For heat networks there is no mandatory participation for suppliers in ADR.

More detail on pricing complaints is contained in Section 6.

4.4 Backstop arrangements

Netherlands	The Heat Act confers powers on government to appoint an alternative supplier in the case of insolvency
Norway	Planning and Building Act allows Ministry to order heat network providers to make alternative arrangements for customers in the event of a late connection, arrangements for insolvency unknown

[21] https://www.elklagenemnda.no/om-elklagenemnda2/kontakt-oss/
[22] https://www.consuwijzer.nl/over-consuwijzer

Finland	No specific provisions.
Germany	No specific provisions.
British Columbia	BCUC has the power to appoint a supplier of last resort.

Potential bankruptcy of suppliers was not a concern for stakeholders where there is strong municipal ownership of heat networks. In **Finland**, one stakeholder could not think of a case where this had happened but suggested that for companies it would be dealt with by insolvency regulations. Similarly, for **Germany,** it was not something that was ever known to have happened. Although BCUC has powers to appoint a supplier of last resort in **British Columbia**, this is only for private companies.

In **Sweden**, there were several bankruptcies in 2004/2005. A 2005 government investigation looked into protection of supplies, proposing that a mutual fund be set up with operator contributions. However this recommendation was not acted upon. We understand that there have been no further bankruptcies in Sweden, to-date. In **Denmark** it has historically not been a problem because heat network providers must price according to cost. However, one stakeholder told us that more recently, a small supplier has gone into administration because the price set to recover costs was so high that customers left. Whilst municipalities do have an obligation to supply customers, they also may not subsidise heat networks. At the moment this remains unsolved.

4.5 UK context

The UK has neither a co-operative living culture such as the Stratas in British Columbia nor the shared heating infrastructure that seems to be prevalent in flatted living elsewhere. Ceding the customer-supplier relationship, and even heat billing, to the building level would be a cultural shift for many UK residents. Tenants associations, factors (in Scotland), and ad hoc arrangements between apartment owners would need to become more organised and familiar with the responsibilities that come with heat networks. It is probably not an accident that many UK heat network schemes are either commercial or undertaken with housing associations.

Whilst some markets have previously rejected household metering across-the-board on the grounds of cost, (such as Sweden) there is a trend towards more accurate billing, driven by European regulations. In the UK the Heat Network (Metering and Billing) Regulations 2014 require household-level heat metering and billing for new and existing heat networks. In certain cases this requirement is dependent on technical feasibility and cost-effectiveness at building level. There is evidence of UK schemes where a flat rate is charged and customers of unmetered schemes reportedly prefer a flat rate, but with some complaining about unfair cost allocation and many expressing concern about the disincentive to use energy wisely.[23]

Experience suggests that the rules around the terms of supply are important – with the potential to both bring together consumers and industry; or, to be the focal point of discord if not strong enough or not effectively enforced. Not many consumers would be prepared to take court action, as one consumer organisation has done in Germany. And whilst the Finnish terms of supply are developed collaboratively, we do not have enough evidence to say whether they work well for all consumers.

[23] CSE, 2018. Qualitative research with consumers and operators of heat networks.

Electricity and gas supply terms and conditions in the UK, including billing, are covered through licence conditions. Whilst subject to consultation the governance process for license conditions is relatively simple and driven by the regulator. The UK's industry-led Heat Trust already runs a voluntary scheme based on a common set of terms of supply. At the moment the cost of non-compliance for a heat network supplier is purely reputational. UK stakeholders have previously suggested that these could form the starting point for compulsory standards.[24]

Heat Trust signatories also agree to standards of service on complaints, and, should they not be resolved, provide access to an independent Ombudsman. Again, this is a good basis from which to develop mandatory standards.

Transparency is something that is likely to be valuable to UK consumers, and may well be an expectation given the emphasis on consumer's ability to compare prices in the UK energy market. Section 5 touches on the difficulty of price comparison across very different heat networks, but nonetheless there is an opportunity for the UK to lead with best practice and promote meaningful transparency as part of the regulatory framework.

Backstop arrangements are likely to be relevant for the UK, especially if private investment is a strong feature of the sector. Ofgem already has the power to appoint a supplier of last resort for electricity and gas consumers. Heat network customers would be at a relative disadvantage if they were not similarly protected. However, there is a key difference for heat networks, namely that without supplier separation from generation and network assets, there is a need to consider how ownership of these assets will be treated should a heat network provider fail. In other countries this is an issue that has either not arisen, is still being considered or, in the case of Sweden, has been considered but no specific measures adopted. British Columbia does have a backstop provision for private companies, but as far as we know has not been used.

[24] WWF Scotland, undated. Response to the Scottish Government's consultation on heat and energy efficiency strategies, and regulation of district heating.

5 Pricing

Country	2015 average price, incl VAT Source: Euroheat	Latest price information
Netherlands	€84.40 / MWh	€318.95 fixed supply cost + €25.98 meter cost + €28.47 per GJ for heat and hot water combined 2019 price caps set by ACM[25]
Norway	€70 / MWh	Households 68.90 øre / kWh (approx. €71/MWh) Manufacturing 38.70 øre / kWh Services 73.80 øre / kWh For 2017, taxes excluded Source: Statistics Norway[26]
Finland	€75.80 / MWh	Apartment €78 / MWh Single house €87 / MWh For 2019, inclusive of taxes Source: Finnish Energy
Germany	€88.02 / MWh	Average price €86.47 / MWh For April 2018, inclusive of taxes[27] Source: AGFW
British Columbia		For one scheme, CAN$49 /MWh variable charge, and net effective rate including fixed charges CAN$110 / MWh (approx. €72) For 2018 Source: City of Vancouver[28]

In the **Netherlands**, the vast majority of schemes price up to the price cap. ACM sets a cap separately for the fixed and energy component of supply and the annual metering cost for heat and hot water combined. It also caps one-off connection fees (for up to 25m and greater than 25m length). From a regulator's point of view, an important learning point on price capping is ensuring that heat network businesses can provide price information in a standard format.

In **Norway** prices are capped at the price of electric heating in the same supply area. Norway has the lowest prices of the countries we looked at. Reportedly this limits the viability and profitability of often publicly-owned schemes, which are in any event supported by generous public subsidies. The Energy Act allows for a connection charge, yearly fixed charge and volume charge. In practice there tends to a connection fee (one off), a fixed amount (/year), a capacity charge (/kW) and an energy charge (/kWh). Companies vary considerably in the proportion recovered from each.

[25] https://www.consuwijzer.nl/stadsverwarming-en-blokverwarming/warmtetarieven
[26] https://www.ssb.no/en/fjernvarme
[27] AGFW, 2018. Heating costs compared, based on VDI 2067
[28] City of Vancouver, 2018. False Creek Neighbourhood Energy Utility ("NEU") 2019 Customer Rates. Administrative report.

NVE regulates the overall price rather than the pricing structure. When responding to price complaints, NVE converts both heat network and electricity prices to energy-only. For heat networks it does this by dividing invoiced sales over a year by invoiced volume. For electricity prices, it composes an average residential or commercial price from the spot price, a typical mark-up, network charges and taxes.[29]

In **British Columbia**, pricing is either at the behest of a municipally-owned scheme, or rates are approved by the regulator. In the latter case, the regulator uses Fortis gas as the benchmark utility to establish a baseline rate of return. Rates of return that exceed the baseline are approved in alignment to the individual circumstances of the operator and the scheme. Economic regulation is on a "cost of service" basis for heat network utilities, although BCUC is trialling performance-based regulation (an agreed return for a certain outcome) for some larger non-heat network utilities.

In both regulated and non-regulated schemes, heat network providers operate "rate stabilisation" – basically running up a debt in the early years as revenues are insufficient to cover high up front investment costs. In later years, this debt is paid off through rates that are higher than justified by operational costs alone. One stakeholder told us that levelised rates requires some consumer education: what might seem a higher energy cost will include equipment maintenance and other costs that, for a communal boiler, customers would otherwise pay through a building maintenance fee.

In the **Netherlands**, prices for "small" consumers are regulated with reference to the price of gas – specifically prices are capped at the average expenditure of a household using natural gas heating. ACM regulates yearly fixed and energy components, and connection costs where this is to an existing network (but not to a new network).

This is not sufficient to cover a heat company's costs, and it is common to recover the difference from building owners when establishing a heat network. This contribution is unregulated and is passed through to customers in an apartment purchase price or rent.

The Netherlands government is currently proposing to ban the use of natural gas in new buildings and is increasing taxes on natural gas. This makes gas as a reference price less relevant and as part of market reforms the government is considering alternative regulation options. A consultant's report considers whether competition is sufficient to keep prices down. They conclude there is limited potential for heat providers to compete on the initial cost recovery contribution from building owners. The consultants suggest ACM could supervise this part of the market and require transparency in contractual arrangements. Once a heat network is established, there is no meaningful competition and prices could:

1. Be set by heat companies with full transparency and ACM intervention if prices excessive
2. Set nationally, perhaps by generation technology
3. Set by the regulator for each company or network

No one method has clear benefits over the other, although the report seems to lean more towards (1) on the basis of this being what other European markets have settled on. (2) is the least change option for Netherlands and (3) would be resource intensive for both ACM and

[29] NVE, by email.

operators. In all cases to regulate effectively ACM would need understanding of operator's capital requirements and rates of return and come to a view on these.

In **Sweden**, it is widely reported that prices increased when municipalities sold ongoing concerns to private owners. This came (in 1996) with a change in the law stipulating that heat network companies must be run as a business – including municipally run companies. We could not establish if price rises therefore extended to those heat network operations which remained under municipal ownership.

The industry trade association reports that whilst quality and reliability of supply has always been high in Sweden, regardless of ownership, that issues around price have transformed the operator–customer relationship. The "price dialogue" is an industry initiative which came after the government's decision not to implement price regulation (on the grounds that this was too complex due to specific circumstances of each individual heat network scheme). This dialogue is considered by the industry to have been a success, a view which has been validated by the Markets Inspectorate in its review of the initiative.

In **Finland** there was a Competition Authority investigation into heat network prices[30], closed in 2012 because the threshold for "*clear overpricing*" was not met. It said that "*The average price level of the district heating companies that were the subject of the research turned out to be high considering the profitability of the business and the risk level of the operations, but the intervention threshold required by the competition rules was not exceeded*."

In **Germany** there is no price regulation. A web-based search will return published prices for individual Stadtwerke. This bears out what the consumer organisation told us that pricing models vary significantly, charging per litre of water or floor area or kWh, and for fixed elements a connection fee, a per kW fee or a sliding or stepped kW fee. The balance of costs between these elements seems to also be very variable, making it difficult to conduct comparisons. As far as we could find there is no nationally-compiled data on price.

The approach in **Denmark** has been to provide full transparency, with the government publishing prices for each heat network company on an annual basis. Because of differences between different schemes, especially size, it is difficult to make meaningful comparisons. Industry has started to address this by publishing prices corrected for, amongst other things, scheme size. This is an ongoing effort and stakeholders acknowledge it to be a difficult exercise.

5.1 Relationship between competition and pricing

A common theme across markets is the difficulty in determining how to treat heat networks – as a monopoly with captive customers or as a heat supplier competing in the open market? This has direct implications for regulation of prices, namely regulation normally is in lieu of competitive pressure.

In Germany the 2012 Competition Authority Inquiry spoke about captive customers, something with which the industry does not agree. Rather it says that it is constantly in competition with alternative heating sources.

In a 2011 report, the Finnish Competition Authority said that heat networks in Finland were:

[30] FCA, 2012. The FCA closed its report on the district heating sector at this stage

- subject to limited competition because of the huge investment costs which bind heat networks to buildings,
- but that pricing is not entirely blind to competitive pressure when building heating choices are being made.

The Authority's own reviews of pricing has also, it believes, kept prices down. The language of the report talks mainly of vested municipality interests and notes that municipal finances have increased pressure on heat networks to provide income. It refers to municipalities lobbying to ban ground source heat pumps (because they compete with heat networks) even though the municipalities' ability to oblige connection should make exceptions for more environmentally friendly means of heating. It says that "*consumers have reported being forced to use district heating at the municipality's request and soon after found the district heating company raising prices*."

In Germany, The Competition Authority inquiry into heat networks found evidence that prices were higher in areas where there was mandatory connection than where there was not.

We asked stakeholders where their main competition came from, their answers were:

Netherlands	Natural gas and heat pumps
Norway	Heat pumps
Finland	Heat pumps
Germany	Natural gas and heat pumps
British Columbia	Electric heating

5.2 UK context

UK regulators and government will intervene and cap or otherwise regulate prices where there is little or no competitive pressure. In electricity and gas, retail prices were capped for some time after privatisation and have been re-capped recently. The monopoly networks are also subject to full economic regulation of returns. There is usually a size threshold for intervention e.g. smaller suppliers are currently exempt from the SVT price cap.

So there may be an expectation that prices, profits or both would be supervised in some way for heat network schemes. This expectation would be heightened if heat networks are not under competitive pressure that would otherwise keep prices down. Unfortunately, there are no clear answers from international markets on whether heat networks compete on equal terms with alternatives. Some industry stakeholders strongly believed heat networks to be under competitive pressure. Regulators doubt this, or consider it to be limited. Where there is heat network competition, it is at the building level when a building owner decides on its heating infrastructure, or, at the district level when a local authority decides how to meet its low carbon or heat obligations.

UK consumers are largely unaware of decisions being made at building-level – one exception might be a communal decision to fund fibre broadband. But otherwise, those decisions are taken by developers, historically at least. In the future it may be that individual consumers start to swap gas boilers for heat pumps, but unlike British Columbia and Norway, electricity is not cheap in the UK. More likely developers will continue to make these decisions, at least in the short term.

Whether price-competitive pressure is applied when there are decisions to be made is a function of the regulatory regime, and the characteristics of the market. Clearly mandatory connection eliminates competition, so it would seem reasonable that this would be accompanied either by a competitive award of a concession, and / or some form of profit or price regulation.

Where there is no mandatory connection, competition might be present, but not particularly visible. Similarly, any heating decision that is made for new build properties in the UK and the competition, if it exists, between heat sources, is not very visible. Local authorities and government could still influence the direction of travel of heating choices, via strengthened and properly enforced building codes.

If price regulation were to be implemented, international experiences point to:

- A price cap – used in the Netherlands. This needs there to be a decent price comparator, and an industry able and willing to provide cost and pricing information. There can be 'leakage' in this model, in so far as heat network providers tend to price at the cap, and recover additional costs through unregulated routes (in the Netherlands, through the connection cost) or there may not be sufficient return on investment.
- Rates stabilisation – in itself this only stabilises rather than regulates the actual price. But it appears to be useful in avoiding tariff shock and overcoming issues of over-recovery in fixed cost elements.
- Full economic regulation with rates approval – this is something with which the UK regulator is accustomed, but is resource intensive for both the heat network company and the regulator. It is should provide the strongest protection against excess profits but may be seen as a disproportionate approach.

6 Investability of networks

6.1 Mandatory connection

Netherlands	Municipalities can but infrequently do, mandate connection.
Norway	Mandatory connection can be specified by the municipality. The power to do so currently under discussion, with a view to removing.
Finland	Law that allows mandatory connection repealed in 2019.
Germany	Municipalities can mandate connection.
British Columbia	Municipalities can mandate connection.

Mandatory connection is cited throughout the literature, and by stakeholders, as being crucial for creating a stable investment environment. At least in the early stages, most markets have adopted this in some form or another. That said the more mature markets of Finland and Denmark have both recently repealed legislation allowing mandatory connection. The still expanding market of Norway is considering doing the same. One stakeholder characterised the rollback of mandatory connection in their market as "*unwise*" and thought it an essential safety net, even if not used – i.e. the prospect of mandatory connection influenced the willingness of developers to engage in voluntary connection. By contrast, there are discussions in the Netherlands, around the new Heat Law, which might extend mandatory connection from new-build to existing buildings.

Compulsory connection is directly linked to regulatory oversight in **Norway**, where compelled consumers can appeal directly to NVE on price. It has been instrumental in growing heat networks and especially, in one stakeholder's opinion, has been essential for re-using heat from waste incineration. Some housing developers however are reportedly against it, preferring electric heating which provides more flexibility in marketing properties one-by-one. As mandatory connection is linked closely to the licensing system, there is discussion around discontinuing both – but as yet no decisions have been made.

80% of heat network customers in Norway are voluntarily connected. Of the remaining 20% that are compulsory, just 5% are residential customers. One stakeholder reported that buildings over 500M2 have an obligation to connect to heat networks which we presume is the municipality policy. This obligation-by-building size aligns with the low level of residential compulsion.

In **British Columbia** the regulator would not approve a private scheme being developed with a municipality because of the use of mandatory connection. Municipally-owned unregulated schemes progress on the strength of mandatory connection.

In the **Netherlands**, municipal policies drive the installation of heat networks. They can develop heat plans for up to 10 years which provide for mandatory connection of new buildings. Proposed changes to the law also envisage mandatory connection for existing buildings – this point is a big theme in discussions around a new Heat Law. Municipalities in the Netherlands can vary significantly in their involvement in heat networks, from simply providing the strategic direction for heat, to facilitating tenders, to running and granting concessions to operating a network themselves.

It is sometimes hard to distinguish between explicitly mandatory connection and de facto connection. One stakeholder noted that an investment in a boiler is equally as tying as paying for a heat network connection. In **Germany** only about 10% of the market is impacted by an obligation to connect, but building regulations still drive heat networks. New developments are often private in partnership with a municipality, on a concession basis. One stakeholder expected competition to be "*fierce*" at this stage.

6.2 Strategic investment

We asked industry stakeholders if they engaged in strategic investment ahead of identified need. For the most part this was a resounding 'No', noting that high upfront costs dominate investment decisions and there was a strong incentive to keep these as low as possible. In **Norway**, this is a commercial decision for the developer who will be strongly influenced by the urban planning process.

6.3 Confidence to invest

We asked industry stakeholders (scheme developers, owners and operators) specifically if they felt confident investing in the market. Overall the outlook was positive, with some reservations specific to each market:

In **British Columbia**, the differences in investment environment between regulated private schemes and unregulated municipal schemes appears to be creating a bias for the latter. Whilst stakeholders told us that private investment is difficult, there was confidence in the future for municipal-owned schemes and the level of control afforded by combining municipal functions of mandatory connection, decarbonisation policies and other municipal utilities. Completely local control over finance was cited as positive. Some however would like more flexibility in drawing in private finance.

Sometimes investment confidence was hard to explain. In **Germany**, mandatory connection is rarely used and heat networks are unregulated. There are, on the surface, no investment guarantees. However building codes and municipal policies appear to be key in maintaining this confidence. Private schemes are awarded competitively as a concession, but we do not know under what terms.

In the **Netherlands**, anticipation of a greatly improved investment environment is high, with planned changes under the new Climate Agreement. One stakeholder cited some 30-40 laws that need to change to give municipalities strong decision making powers over heat networks and the development of mandatory heat maps. As well as a recent ban on new buildings connecting to the gas network, these heat maps will need to include plans which cover sustainable energy supplies to existing buildings – either heat networks or heat pumps. They expected the heat network share of the heat market to increase from 4-5% to 30-40% by 2030.

Where there is a regulator, industry-regulator relationship and levels of trust is also clearly important for investor confidence. A Netherlands stakeholder describes ACM as "balanced" between consumers and industry and praised its approach to the complex price capping dilemma. The light touch system of regulation in Norway relies on good industry-government relationships and an industry track record of delivering.

6.4 UK context

In the UK it is generally considered advantageous for customers to be connected to the gas grid. Ofgem operates a Fuel Poor Network Extension[31] scheme which provides extra funding to gas distribution companies to extend their networks in areas of deprivation. This recognises that heating costs are generally higher in off-gas areas. At the same time, gas boilers in new buildings will be banned from 2025.[32] Between now and then there will need to be work on the alternatives, including heat networks.

BEIS' initial work on a UK regulatory framework references the ADE's task force recommendation of financial "demand assurance." This is essentially guaranteeing a return on investment in assets, even if those assets are not fully utilised, and would be provided against an approved strategic plan. BEIS stated that it was interested in exploring other options, including heat network "zoning". It expressed interest in the Local Heat and Energy Efficiency Strategies (LHEES) that local authorities in Scotland are starting to produce and, as legislation is passed, will be required to produce.

The ADE's proposed demand assurance is quite similar to Ofgem's approval of major new sections of the electricity grid which it calls "Strategic Wider Works." In response to detailed proposals put forward by transmission companies, Ofgem will either accept or reject the proposals and, if accepted, put detailed conditions against delivery in return for allowing the network companies to recover costs of the investment from the general customer base. Strategic Wider Works are at a much larger scale (in terms of value and customer base) than new heat network schemes, so the level of detail and type and scope of conditions placed on schemes would naturally need to be adapted accordingly.

Proposals for "zoning" are akin to practices that are more common internationally for heat networks, which is essentially mandatory connection within an area deemed to be suitable. Many stakeholders talked openly about mandatory connection and, in Norway, Denmark, Finland and British Columbia it is or has been considered absolutely essential for growth of the industry. We have not been able to establish however if there is any form of demand assurance used in, for instance, the award of a concession.

Strategic investment was just not a consideration for the stakeholders to whom we spoke, with developers facing strong financial incentives to size strictly according to contracted demand. For there to be strategic investment in the UK, it is reasonable to assume that the regulatory regime will need to facilitate it. In electricity, Ofgem can approve network over-sizing on the strength of cost benefit analysis produced by the network companies, but this is in the context of price-controlled networks where all investments are approved in some form. For UK heat networks, those procuring schemes might ask for competitive bids which weigh up future investment options, or, it might be something that could be considered by organisations taking a strategic overview – for example local authorities in Scotland as part of their LHEES, or the UK National Infrastructure Commission.

[31] http://www.energynetworks.org/gas/futures/gas-network-extensions.html
[32] https://www.bbc.co.uk/news/science-environment-47559920

7 Decarbonisation

Netherlands	80.89% natural gas, 11.27% coal, 3.47% waste incineration, 2.48% recycled industrial heat, 0.94% combustible renewables, 0.46% solar, 0.43% heat pumps, 0.06% oil.[33]
Norway	Waste incineration 48%, oil boilers 1%, wood waste 21%, biofuel 1%, electric boilers 13%, heat pumps 10%, gas 4%, waste heat 3%. (2017)**Error! Bookmark not defined.**
Finland	46% of heat network energy is derived from green sources including: forestry (17%), wood waste (12%), other forms of biofuel (7%) and recovered heat (10%). A further 16% is derived from peat. The remainder is made up of coal (20%), natural gas (13%), oil (2%) and unspecified other sources (3%).[34]
Germany	47% coal, 39% natural gas, 13.3% renewables and 8.1% heat from waste to energy (2015).[35]
British Columbia	No detailed breakdown found but fuels in existing systems include: natural gas, biomass boilers and gasification plants, geothermal systems.[36] Another reference suggests there has been an emphasis on biomass CHP and sewer heat recovery.[37] Survey data suggests a predominance of natural gas in British Columbia, with biofuel the main renewable source, with a small amount of heat recovery.**Error! Bookmark not defined.**

We found a mixed picture on historical decarbonisation, with very little evidence of there being one or two approaches that work better than others. Different approaches were very much linked to circumstances in each country: existing natural resources; particular challenges such as the oil crisis and latterly a waste crisis; the government's market philosophy; and the regulatory environment.

Although decarbonisation is front and centre for many of the practitioners we interviewed, this is not reflected in the data – renewable energy's share of heat network supply is low in all of the countries we looked at. Also, peat (e.g. Sweden) and waste (e.g. Norway) is classed as renewable in some of the literature. A stakeholder in Sweden referred to peat as a "slow" renewable and noted that this attitude is changing.

Decarbonisation is therefore an ongoing, and perhaps the, challenge for all of the markets we have considered.

In the **Netherlands** new buildings are no longer allowed to connect to the gas grid, unless an exemption is granted.[38] Heat networks are expected to play an important role in plugging the gap, and there is an expectation that decarbonisation standards will be tightened over time as part of the expected shape of Heat Law 2.0. The new Climate Agreement requires heat roadmaps to be produced for municipalities, which will include plans for heat networks

[33] Kaljee, 2015. The Netherlands. Euroheat country report.
[34] Finnish Energy. 2019. Energy Year 2018 District Heating (powerpoint slidepack).
[35] Moczko, 2015. Germany. Euroheat country report.
[36] District Energy sector in British Columbia, BC ministry of Energy, Mines and Petroleum Resources. (Accessed on 24th April 2019)
[37] Trigg, D..2015. Is CHP a viable option for BC. (Accessed 24 April 2019)
[38] Website of Delta EE, 2018. Do gas boilers still have a role to play in Dutch new build homes?

extending to existing buildings. One stakeholder told us that this would have a huge impact on heat networks.

Otherwise the main incentive for decarbonisation is the Stimulering Duurzame Energieproductie (SDE)+ incentive scheme. 2019 is the end of it operating in its current form. SDE++ will widen out and provide an operating subsidy to cover the difference between renewable energy and the market price. SDE +(+) does not appear to be available to commercial renewable energy producers.

In **British Columbia**, electricity is largely carbon-free hydro and heat networks are generally more expensive than electric heating. However, there are challenges to expanding the electricity network and new hydro comes with environmental impacts, which in turn is driving an expansion of renewables-based heat networks. Municipalities value their ability to influence decarbonisation through choices made on heat networks.

In **Norway**, there are no specific policies on heat network decarbonisation but the government uses the licensing regime to monitor and set licensee-specific targets for low carbon energy sources. One stakeholder described this approach as tightening a “rubber band” each time a new license is granted.

In **Finland**, the government is phasing out coal generation. One stakeholder described decarbonisation as the biggest challenge for the industry, and one which will require substantial investment.

The Renewable Energies Heat Act (EEWärmeG) in **Germany** stipulates a certain percentage of renewable energy use for space and water heating in new buildings and allows municipalities to make additional regulations for existing buildings. “Alternative” measures to meet this requirement include the use of heat networks. Heat network providers can also access funding through the Wärmenetze 4.0 programme, covering feasibility (up to 60% of costs) and construction (up to 50% of costs).

In both of the unregulated countries of Germany and Finland, stakeholders cited heat networks as being within the EUTS, but that competitors such as heat pumps were not – creating an uneven playing field.

7.1 UK context

Figure 1 shows the energy source used in current heat networks and planned energy source for projects in the pipeline, reproduced from the Association of Distributed Energy (ADE) 2018 market report[39]. It is based on survey returns completed in 2017 covering 810 networks serving around 160,000 domestic and commercial customers (which was, then, around a third of all heat network customers in the UK). Natural gas is the fuel source for the vast majority of schemes surveyed. BEIS has also compiled experimental statistics on the estimated 13,995 communal (11908) and district (2,087) heat networks in the UK[40]. This found that 90% used, at least in part, natural gas, electricity 5% and bioenergy and waste 2%.

The UK has had effective policies for renewable electricity, relying mainly on market-based production incentives for large-scale decarbonisation. Heat has not received the same level of attention or support. The Renewables Heat Incentive (RHI) is the only production-based

[39] ADE, 2018. Market report. Heat networks in the UK.
[40] BEIS, 2018. Special feature – Experimental statistics on heat networks.

incentive and it currently runs to March 2021. Heat networks are eligible under the scheme and a number of heat-pump based schemes have benefited from the RHI. The Heat Networks Investment Programme (HNIP) has to-date funded mainly gas-fired schemes, and one waste-to-energy-based plant that was to receive funding is now no longer going ahead.[41]

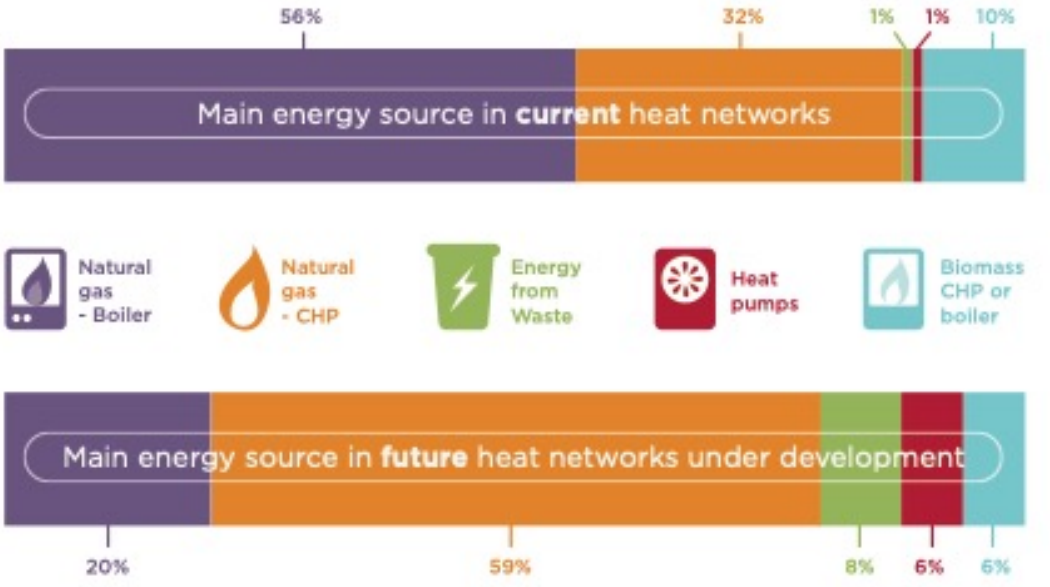

Figure 1 Energy source for heat networks in the UK. From ADE, 2018

[41] https://www.gov.uk/government/collections/heat-networks-investment-project-hnip-overview-and-how-to-apply

8 Conclusions – Measures of success

At the outset of this research we had proposed eight key tests for success of a heat network regime in each country. Our original intention was to give each market a 1-5 performance score for each test. However, there is an insufficient depth of comparable data and experiences to do a meaningful comparison. Instead, we have provided a qualitative comparison, commenting on key areas where information is lacking.

8.1 Consumer confidence

We found very little evidence of systematic consumer surveys of heat network consumers, in the identified countries. One stakeholder provided us with a survey, conducted in Germany by an energy industry trade association. This showed comparatively high levels of satisfaction (better than all other heating types). At the same time, it is only for Germany that we accessed some detailed insight into examples of poor service levels. Where heat network providers expressed confidence that consumers were content, this was largely based on impression and anecdote.

It is impossible to say which market's consumers are best served by which regime. Where there is a prescribed independent process for logging and dealing with complaints – for example as ACM oversees in the Netherlands – then there is at least insight into common problems. NVE in Norway only takes complaints on price for those subject to mandatory connection, and similarly BCUC in Canada can only rule on rates for the very small number of private schemes that are rate-controlled.

Final users, namely individual households, are not at all well represented in any of the markets we looked at – either because they are not considered to be consumers or because they do not have the level of organisation or expertise to represent themselves. Where consumers are engaged in developing supply guidelines in Finland or invited to participate in a price dialogue in Sweden, this is mainly at the building level.

Qualitative research for BEIS with heat network consumers in the UK found "*reliability, control of heating and water, and speed and effectiveness of repair services*" to be most important in determining consumer satisfaction.**Error! Bookmark not defined.** Research in the Netherlands collating consumer attitudes information from the Netherlands, Finland and the UK found transparency to be a key component of consumer satisfaction.[42]

8.2 Industry confidence

Across the board industry, (private, municipal and mixed ownership), expressed a general level of confidence in investing. It was sometimes difficult to pin this down to particular aspects of a market, it being more a case of familiarity with the market in which they were operating. So, for example, German and Finnish stakeholders were strong in their belief that an unregulated market works well, whilst Netherlands stakeholders praised the regulator for its balanced

[42] Kathelijne Bouw, 2016. Increasing the attractiveness of district heating networks to consumers. An exploration. Flexiheat. Hanzehogeschool Groningen. Available at (accessed on 11 February 2019).

approach and thought that anticipated changes to the regulatory framework would be a huge boost to heat networks.

Mandatory connection is cited by many heat networks commentators as essential for investment confidence, and this is strongly backed up by feedback from stakeholders in British Columbia, Norway and Denmark. A recent spate of rolling back mandatory connection is met with trepidation from industry. However, where mandatory connection is not widely employed, in Germany and the Netherlands, industry appears to accept this approach – although it may be that the possibility as a last resort, combined with strong municipal policies including strategic development plans which incorporate heat networks, achieve a similar outcome.

8.3 Government and regulatory confidence

There is no objective measure that we could find of government and regulator confidence in the industry. Where there is no dedicated heat network regulator – notably Germany, Finland and Sweden – the relevant Competition Authority has stepped in and questioned whether industry is acting anti-competitively and whether it is acting in the interests of consumers.

8.4 Scheme quality and safety

We do not have the data to be able to compare scheme quality and safety across different markets. There is no suggestion that schemes are unsafe or not of good quality, and there is substantive evidence that standards are enforced via a mixture of customer standard terms and conditions and technical industry codes. However, there is no information on how well these measures work and how effectively they are enforced.

8.5 Market liquidity (competition & customer choice)

Ofgem described market liquidity in energy markets as "vital" in supporting competition and efficiency. It describes liquidity as "*a measure of the ability to buy or sell a product – such as electricity – without causing a major change in its price and without incurring significant transaction costs.*" It describes an important feature of a liquid market as "*the presence of a large number of buyers and sellers willing to transact at all times*."[43]

Liquidity is not a desirable feature for, say, monopoly network assets which might benefit from long-term stable, responsible ownership. It is a desirable feature for wholesale energy markets, as it allows new smaller players to access the market without needing an extensive generation portfolio i.e. it makes what might be a closed market, much more accessible and open.

As there is virtually no unbundling in heat network markets, we have extended this question out to consumer choice and competition. At the household level, in all heat network markets, there is no meaningful customer choice. What this means is that once a consumer is signed up to a heat network:

[43] https://www.ofgem.gov.uk/electricity/wholesale-market/liquidity

- They almost always cannot physically disconnect and find an alternative heat source. This is because either they are compelled to stay connected, or, having paid connection costs, it makes no economic sense to leave.
- They also almost always cannot leave and find an alternative 'supplier' responsible for billing and sourcing heat supplies. This is because there is no unbundling of supply and only limited levels of third-party heat.

Competitive pressure is experienced when decisions are being made about how to heat buildings, either for new buildings or during refurbishment. It is also experienced when organisations tender for heat network services and equipment. We simply do not know the extent of this competitive pressure at these stages, for any of the markets considered.

This effective lack of consumer choice is not all that different from any of the heating decisions that are made at the building level – for example to install individual gas boilers.

8.6 Tariffs

Inclusive of taxes Germany and the Netherlands appears to have some of the highest heat network prices – between around €85-88 / MWh. Norway, Canada and Finland are around €70-75 / MWh. It is hard to be completely sure that any price comparison is on equal terms, given the differences in how one-off, fixed and variable charges are levied.

8.7 Stranded assets

We could find no evidence of stranded assets. The majority of stakeholders said that they actively avoided this risk, building only for load for which they were confident. There is a significant financial disincentive for over-building in advance of known requirements, because of the high up-front capital costs.

This publication is available from: www.gov.uk/government/publications/international-heat-networks-market-frameworks-review

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