PIPING HOT

THE OPPORTUNITY FOR HEAT NETWORKS IN A NEW INDUSTRIAL STRATEGY

March 2017

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SUMMARY

60-SECOND SUMMARY

The announcement of a new industrial strategy presents the country with an opportunity to radically overhaul its aging infrastructure in ways that support the UK economy in every region.

Concurrently, the UK faces the challenge of meeting climate change goals of 80 per cent reduction in CO_2 by 2050, recommitted to in the green paper for industrial strategy. To do this, the government will need to take a whole-system approach to decarbonisation that focuses on both electricity and heat, and considers how they are supplied to, and used, in every part of the country.

Yet, despite a new industrial strategy, clear policy goals for heat are largely absent from the government's green paper. Coherent low-carbon heat policy is challenging. Any strategy must consider *how much* capacity should come from heat generation and energy efficiency, *what* technologies are included, *where* they are optimally located and at *what time* of year.

The Committee on Climate Change (CCC) identifies three main policy areas required to stimulate the low-carbon heat sector: hydrogen, heat pumps and heat networks. Whilst all the technologies cited by the CCC will be critical to achieving the decarbonisation of the sector, heat networks are the technology that can be scaled up most quickly.

Within the context of meeting the industrial strategy's goals to overhaul energy infrastructure, this report will explore the opportunity for heat networks, the challenges facing their deployment, and policy options for their implementation. In particular, this report finds that investing in heat networks, delivered at a local level, can create up to 81,000 annual jobs and leverage up to £22 billion in private investment across the whole of the British economy.

ABOUT HEAT NETWORKS IN THE UK

At their simplest, heat networks are insulated pipes that run underground from a heat generating plant, often at neighbourhood level, to any combination of residential, commercial or public buildings (for example, hospitals). As energy carriers, they can receive heat from any source of generation and this flexibility makes them a key 'no-regrets' option for decarbonising the heat sector. In addition, they are a technology that has application across the country.

Heat networks are a piece of the puzzle in the decarbonisation of the heat sector, which is itself part of a wider debate about how to prioritise energy efficiency in electricity and heat within the UK's National Infrastructure Commission (NIC 2016). Estimates suggest heat networks could serve around 10 per cent of total heat demand by 2030 (CCC 2016). These estimates assume the integration of other renewable heat technologies like heat pumps and hydrogen pumped through existing gas infrastructure. However, when combined with heat pumps in some areas, the total technical potential (that is, independent of economic factors) for heat networks in district heating schemes could serve up to 57 per cent of total heat demand (Ricardo 2016).

At the same time, the announcement of a new industrial strategy presents the energy system with the opportunity of upgrading the aging infrastructures in ways that rebalance the economy.

Such requirements for large-scale investment into infrastructure are well-suited to the profile of heat networks. Indeed, they not only represent a new approach to energy infrastructure, they are also inherently local, with the potential to create new supply chains within regional economies. In this report, we find that deploying heat networks could create up to 81,000 annual jobs and generate up to £22 billion in private investment across the UK economy.

REPORT STRUCTURE

In chapter 1, we start by outlining the underlying weaknesses in the UK economy, why it needs rebalancing and how heat networks fit within this. Indeed, while this report focuses on heat networks, throughout 2017 we will publish a number of other reports that explore industrial strategy in more depth and develop strategies for a number of other aspects of the energy system, other sectors and regions.

In chapter 2, we provide more detail on what heat networks actually are, why they have historically experienced low levels of deployment in the UK and their benefits in terms of energy security and decarbonisation.

This background context sets the stage for our examination in chapter 3 of the potential scale of investment and job creation that the heat network sector could generate. In order to realise this potential, in this chapter we also discuss the key barriers that must be overcome.

Later in chapter 3 we discuss how central government can address these barriers by creating an enabling environment that helps to profile the size and location of heat demand nationally, provide finance and technical support and protect consumers.

Once these conducive conditions have been created, chapter 4 sets out why local authorities will be so important in delivering heat network projects. Furthermore, we discuss the steps they themselves will need to take in order to be equipped for the task.

POLICY RECOMMENDATIONS

From our analysis of both the national and local action required, we finally produce a set of policy recommendations. In summary, at the national level, this report recommends that the government should do the following.

- Expand the resources of the Heat Networks Delivery Unit (HNDU) so that it can map out suitable sites for heat networks (including areas suitable for waste heat) in greater detail and keep records of their performance

- Extend funding for the Heat Networks Investment Programme (HNIP) to 2030 in order to build a greater pipeline of projects and reassure investors of the government's long-term policy commitment – this is particularly important for assets like heat networks that can take a long-time to pay back initial investment. Concurrently the government should explore sector deals with technology companies and manufacturers to ensure the expanded investment goes towards a home-grown supply chain.
- Explore alternative financing options by:
  - evaluating a range of financing options (including grants, loans, equity, guarantees and bonds), and
  - providing technical support to investors through secondments of HNDU staff.
- Ensure customer protection by:
  - creating a framework for price control, similar to that currently in place and administered by Ofgem for electricity networks, and
  - creating the position of a dedicated energy ombudsman to resolve any complaints that customers cannot settle with their supplier.
- Further promote waste heat by:
  - including it within the RHI to incentivise industrial energy managers, and
  - ring-fencing funding within the HNDU to better record data.

At the local level, our overarching recommendation is for local authorities to become more active in the development of district heating projects. In particular, we make the following recommendations for local authorities.

- Seek to continue the work of Manchester city council and create bespoke city-level procurement bodies that can negotiate with suppliers on behalf of different local authorities and help to standardise contractual arrangements.
- Reform local planning by:
  - undertaking heat zoning in conjunction with HNDU to understand the most suitable locations for heat networks and understand how this ties in with energy efficiency upgrades
  - taking a more active role in the construction and supply of district heating schemes by creating council-owned energy service companies.
- Identify gaps in the supply chain for delivering heat networks and ensure they are filled before going ahead with a project.
- Create broad local strategies that incorporate heat networks as well as other renewable heat and energy efficiency options, and share public data and best practice from these strategies and any previous studies with other councils.

In order to realise the opportunity for heat networks both tiers of government will need to act on these recommendations in tandem. In some cases, recommendations may overlap and coordination between central government and local authorities may be required. For example, as the role of HNDU is expanded nationally, local authorities will increasingly be able to work with these experts to undertake heat zoning in their own local areas.

If this can be achieved, the benefits of heat networks, in terms of energy security, decarbonisation and job creation and investment into the UK economy, suggest this sector could become an important feature within a new low-carbon industrial strategy.

1.
UK ECONOMY

Heat networks serve twin objectives of decarbonising the heat sector and providing the kind of regionally diverse infrastructure upgrades required by an industrial strategy that concerns itself with the development of both sector and location. While the primary focus of this report addresses the benefits, barriers and potential for heat networks, this chapter contextualises their importance within the broader challenges for the UK economy.

UNDERLYING WEAKNESSES IN THE UK ECONOMY

Following the UK's decision to leave the European Union, the economy looks set to undergo a severe and lengthy economic shock. Regardless of the deal that the government ultimately strikes with the EU over the terms of Brexit, the country is starting out on this uncertain path already in pretty poor shape. At the national level the current account deficit is at 5.9 per cent of GDP[1], close to a record high, and means we are reliant on inflows of foreign capital to balance the books. Furthermore, despite six years of austerity, we continue to run a budget deficit of 4 per cent, while debt is up at 88 per cent of GDP[2] (Colebrook 2016).

However, these national economic indicators mask an even starker picture in the regions outside London and the South East. Several regions, including Northern Ireland, Yorkshire and the Humber, and the West Midlands, are yet to recover their pre-crisis levels of GDP per capita (Haldane 2016). There are multiple reasons behind this disparity but a central driver is the rapid rate at which economic activity in these regions has shifted away from manufacturing towards lower-productivity service sector work: jobs in manufacturing now account for just 10 per cent of all employment, compared with 15 per cent in 2000 (Colebrook 2016).[3]

The strength of the UK economy is increasingly reliant on the growth within London. Figure 1.1 illustrates the scale and increase in the disparity in GVA growth between the capital and all other regions.

1 ONS Balance of Payments data release 2016 Q2: https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments

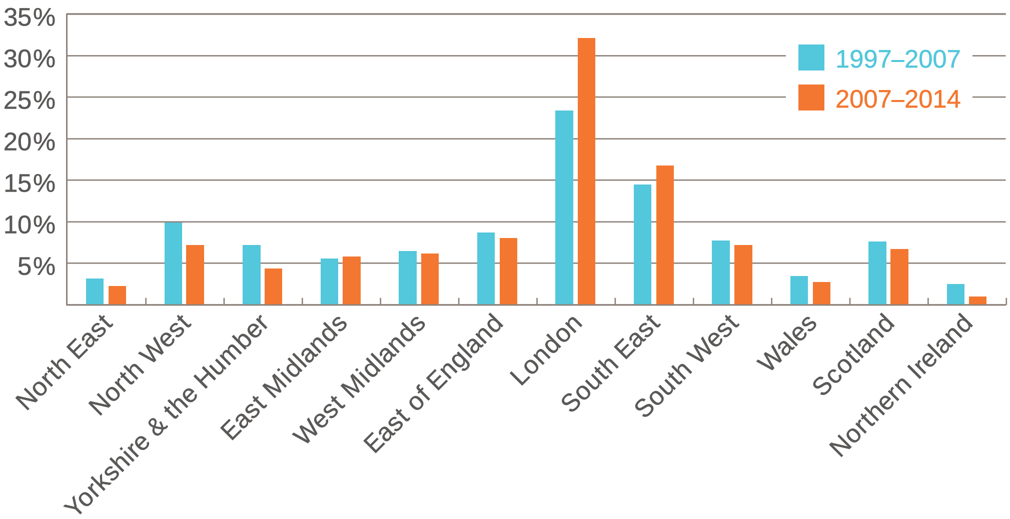
2 Deficit figure is for financial year 2015/16; debt figure for year-end 2015/16. Source: ONS UK government debt and deficit for Eurostat Statistical Bulletin. https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/publicspending/bulletins/ukgovernmentdebtanddeficitforeurostatmaast/aprtojune2016

3 ONS employment by industry data set (derived from the Labour Force Survey): https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyindustryemp13

FIGURE 1.1

The strength of the UK economy is increasingly reliant on the growth within London

Share of nominal GVA growth, by region (per cent)



Reproduced from Bailey et al 2015

INDUSTRIAL STRATEGY AS A MEANS TO REBALANCE THE ECONOMY

These longstanding structural issues have built up over time and are reflected in regional statistics and the UK's twin trade and fiscal deficits. However, following the political shock of Brexit and the related sense of urgency for rebalancing the economy, the new government has now set out its intention to develop and implement a 'place-based' industrial strategy (Clark 2016) to drive growth 'up and down the country' (May 2016). The formation of the new department for Business, Energy and Industrial Strategy (BEIS) suggests a willingness to intervene strategically, and perhaps regionally, in the economy in a way that has not occurred for a long time (Cox et al 2016). The industrial strategy green paper released in January 2017 confirmed this, stating:

> *'The objective of our modern industrial strategy is to improve living standards and economic growth by increasing productivity and driving growth across the whole country.'*
> HM Government 2017

A strategic approach to economic policy is very welcome, and something that IPPR has long argued for, but it is vital that any intervention is based on a clear set of objectives. In late 2016 IPPR published a report that summarised our view on what the government's industrial strategy should seek to achieve (Colebrook 2016). It stated that the **core aims** should be the following.

1. **To spur innovation to boost productivity, pay, and the quality of work**
2. **To 'level up' growth and productivity in the regions and nations of the UK**
3. **To grow the UK's manufacturing capabilities**
4. **To put the UK on track to meet its decarbonisation targets**

Throughout 2017 we will publish a number of reports that explore industrial strategy in more depth and develop strategies for a number of specific sectors and regions. In this report we explore the potential for a strategic approach to developing the UK's heating infrastructure, specifically heat networks.

Discussions on heat policy have tended to focus on the need to ramp up decarbonisation of the sector and the gap between current initiatives and this ambition (CCC 2016). However, in the case of heat networks, there is also an opportunity to create local employment in the industrial sector and attract investment. According to IPPR analysis (detailed in chapter 3), deploying heat networks could create up to 81,000 annual jobs and generate up to £22 billion in private investment into the UK economy.

Heat networks will not address the decarbonisation challenge alone and the CCC has identified other key technologies, such as hydrogen and heat pumps, that will require policy attention. Nevertheless, the timing of the industrial strategy suggests heat networks – large infrastructure projects involving extensive industry participation at a fundamentally local level – could be a good place to start for the UK regional economy.

The list of heat network projects already in the pipeline will be enough to drive significant growth and job creation in parts of the country that have been left behind by years of London-centric, service-based economic output. In addition, there is the potential to substantially increase the number of heat network projects beyond those already planned if the government is prepared to work strategically with the heat sector and local government. The following chapters set out the reasons why this should be pursued and how it can be achieved.

2.
BACKGROUND TO HEAT NETWORKS

This chapter outlines the principal benefits of heat networks: that they could increase the UK's energy security by reducing gas imports and improving the trade deficit, and that they could contribute towards the decarbonisation of the heat supply.

WHAT ARE HEAT NETWORKS?

A heat network is a set of underground pipes that distribute hot water or steam to homes and businesses from a central heating source or sources. The principal structural advantage of a heat network is that it provides economies of scale because the generation of heat in one large plant can often be more efficient than production in multiple smaller ones. According to scenario modelling conducted by Element Energy, by 2020 the levelised cost of gas boilers over a 15-year period ranges from £70 to £90 per megawatt hour (MWh) depending on gas price, compared to as low as £58 per MWh for biomass combined with heat networks (Element Energy 2015).

Networks vary in length from a few hundred metres between homes to several kilometres linking industrial and residential areas. To maximise the efficiency and economics of heat networks, schemes require a high density of heat demand, which means that they are mostly suited to urban areas and new-build developments (DECC 2013). As such, in this report we will use the terms 'heat networks' and 'district heating' interchangeably.

FIGURE 2.1

Heat sources, classified by temperature

Low-temperature heat source	Water (river, lake, sea, aquifer, mine) Sewage networks & water treatment works Ground Air
Low or high temperature heat source	Solar thermal Geothermal Waste heat from industrial processes & power generation
High-temperature heat source	Purpose-built CHP, including energy from waste Boilers (gas, oil, biomass)

Source: Element Energy (2015)

The majority of schemes use heat generated in a combined heat and power (CHP) station that provides high-grade heat that can be used directly in buildings. Most CHP stations burn natural gas to generate heat and electricity but they can also run on biofuels, biomass, biogas, coal or municipal waste. A new generation of heat networks are supplying heat from lower grade sources such as waste heat from industrial processes, which is then upgraded close to the point of supply using heat pumps. Figure 2.1 sets out the various heat sources.

HISTORICAL RATIONALE FOR LOW HEAT NETWORK DEPLOYMENT

In the UK, heat networks typically fall into one of four types.

1. Local authority-led schemes including the connection of schools, leisure centres other public buildings and both private and social housing.
2. Private sector developments on new housing schemes, which may also include blocks of flats or commercial developments.
3. Standalone campus networks serving hospital sites or universities.
4. Schemes in individual social housing blocks built in the 1960s and 1970s.

Currently, district heating networks supply just 2 per cent of heat to buildings in the UK. This amounts to around 2,000 networks serving approximately 210,000 dwellings and 1,700 commercial and public buildings across the UK (DECC 2013).

In Denmark and Sweden around 60 per cent of total heat is supplied through heat networks. This divergence with the UK occurred in the 1970s when the oil price shock led those countries to invest in heat networks to improve the efficiency of heat supply and reduce their dependence on imported fuels. The UK chose to develop the huge gas reserves in the North Sea, convert every appliance in the country to run on this new domestic resource, and install a national gas distribution grid. According to government statistics, in 2015 natural gas accounted for 71.6 per cent of all space heating (including almost 80 per cent for residential buildings) and 74 per cent of all water heating in the UK (BEIS 2016a).[4]

This option worked very well for the UK throughout the 1980s and 1990s as UK gas production soared and imports were low. The system was not designed to maximise efficiency because gas supplies were plentiful and cheap and the UK benefited from their consumption through tax revenues and employment in the gas industry.

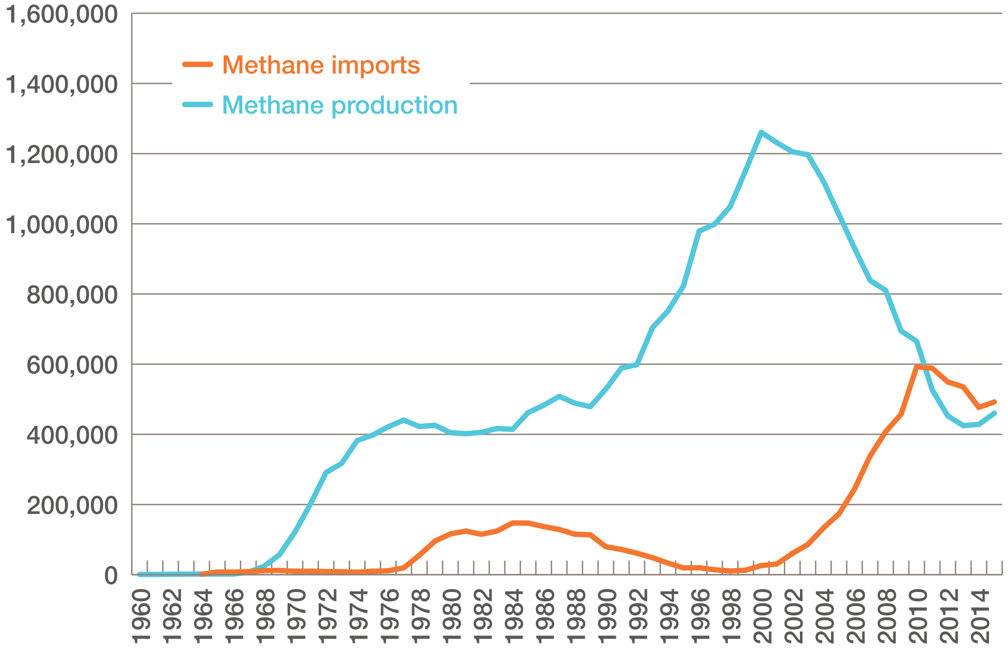
However, despite recent increases in domestic gas production in 2016 compared to 2015, since the late 2000s, the UK has been a net importer of natural gas (see figure 2.2). To an extent, this has undermined the rationale for the existing system of heat supply in the UK. This is explored in more detail below.

4 The rest of which comes from a combination of oil, electricity and bioenergy and waste, all less than 10 per cent each.

FIGURE 2.2

The UK has become a net importer of natural gas

Methane production and imports, 1960–2015



Source: BEIS 2016b

WHAT ARE THE ADVANTAGES OF HEAT NETWORKS?

In urban centres, with higher population density and corresponding heat demand, a well-designed heat network connected to a CHP unit is more efficient, and uses less primary energy (gas), than meeting the equivalent demand with onsite boilers (DECC 2013). A heat network that supplies waste heat from industry, or heat from renewable generation or heat pumps, will use even less primary energy gas. This has two main advantages.

1. Increased energy security

Whilst domestic production of natural gas in 2016 steadily increased compared to 2015[5], IPPR analysis of government data shows that, for 2015 as a whole, the UK still imported more gas than it produced at 51.7 per cent (BEIS 2017).

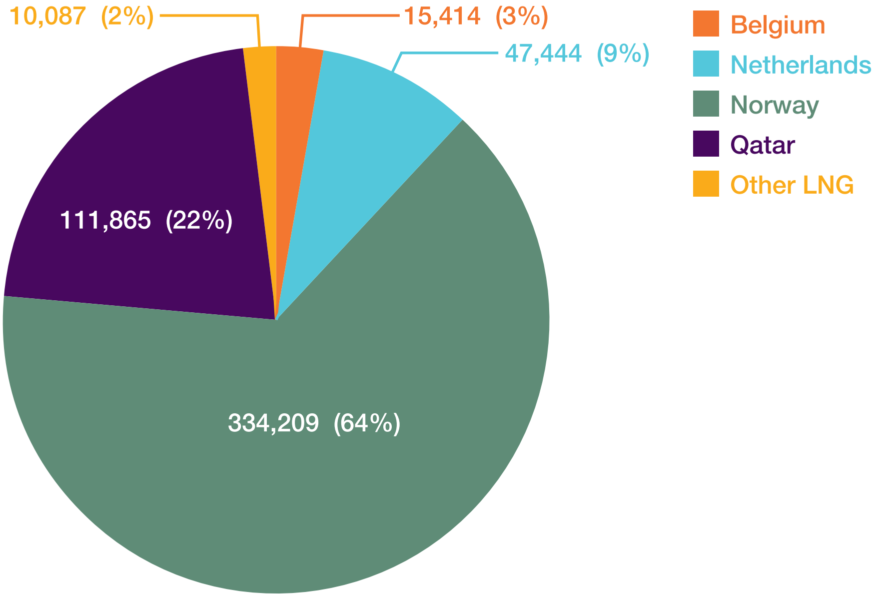
As figure 2.3 illustrates, the UK's imports of gas come from a variety of countries and are therefore relatively resilient to geopolitical shocks. On the other hand, while government data shows that the UK does not import any Russian gas directly, Russia does top up many countries that do supply the UK and, in 2014, supplied 37.5 per cent of the EU-28's gas imports (Eurostat 2016).

5 Figures for Q4 2016 are not yet available.

FIGURE 2.3

The UK's gas imports come from a variety of countries

Gas imports to the UK (GWh [per cent]) by country of origin



Source: BEIS 2016c

Under a scenario of very cold winters and restriction of Russian gas through Ukraine to Europe, the UK would have to respond by importing greater volumes of liquefied natural gas (LNG) or restricting its exports to Continental Europe, both of which would increase gas prices (National Grid 2015). The UK's decision to leave the EU creates further uncertainty around gas supplies because it remains unclear what role the UK will play within the Energy Union initiative, which is seeking to increase European energy security and diversify away from Russian gas imports.

From an economic perspective too, if the UK continues to be reliant on gas imports, this would have a negative effect on the trade deficit. Indeed, in 2016, non-oil fuels including and dominated by gas contributed to 1.8 per cent, and £7.7 billion, of the UK's imports compared to 0.8 per cent and £2.4 billion of non-oil fuel exports (ONS 2017). The principal concern is that this gap increases the country's vulnerability to future economic crises and amplifies the impact of any economic shock. In 2014, the UK was the country twelfth most dependent on foreign energy imports out of the EU-28 (ONS 2016). Given the economic uncertainty created by Brexit and the poor state of the country's finances highlighted in chapter 1, it will be important to avoid further increases in trade deficit and explore alternative heat sources.

Whilst increasing domestic production represents one short-term option pursued by the current government, heat networks not only insulate the UK economy from future global price instability but also, as discussed below, help to meet decarbonisation goals at the same time.

2. Decarbonising heat supply

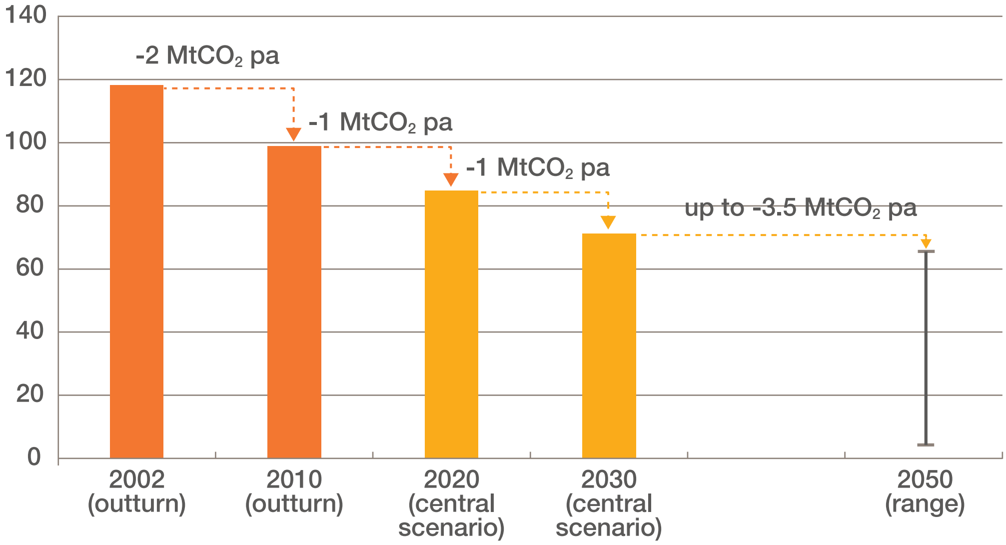
The 2008 Climate Change Act placed into law a reduction in greenhouse gas emissions of at least 80 per cent relative to 1990 levels by 2050. Heating and hot water for UK buildings makes up around 40 per cent of our energy consumption and 20 per cent of our greenhouse gas emissions (CCC 2016). The Committee on Climate Change (CCC) has therefore indicated that meeting our decarbonisation targets,

> *'will be much more expensive and maybe impossible without a near complete decarbonisation of space and hot water heating'*
> CCC 2015

As figure 2.4 shows, the trajectory to 2050 for emissions reductions in buildings is challenging and involves a reduction from 99 $MtCO_2$ in 2010 to between 4 $MtCO_2$ and 66 $MtCO_2$ in 2050.

FIGURE 2.4

The target for emission reductions in buildings by 2050 is challenging
Rate of change in direct building emissions (2002–2050)



Source: CCC 2015
Notes: $MtCO_2$ per annum reductions based on average for the period.
Outturn data is temperature-adjusted.
2002 is the earliest year that emissions have been calculated on a temperature-adjusted basis.

A number of studies have laid out the various pathways available for decarbonising the UK's heat supply (CCC 2016, MacLean et al 2016). All studies conclude that the transition will involve a mix of different technologies and approaches due to the variation in geography, building types and occupancy patterns across the country, as well as the different characteristics of heat provision in domestic, commercial and industrial applications. Local authorities and local enterprise partnerships (LEPs) are, therefore, essential players in a greater deployment of heat networks.

One of the key concerns for low-carbon heat technologies in particular are the inter-seasonal changes in heat demand that can be difficult to meet. For space-heating, for example, winter peak demand for heating is estimated to be four to five times higher than summer peak demand (MacLean et al 2016). To address this, when combined with thermal storage, heat networks can help to balance supply and demand by releasing stored heat to meet these winter peaks (Webb 2016). This has the effect of reducing the need for high carbon 'peaking' gas plants that would otherwise be used to top up homes during periods of high demand.

Currently this demand management, along with other system services provided by heat networks, are not captured in project valuations. Though it falls outside the scope of this report, further research should be undertaken to make the case for monetisation of these services to government.

Options for decarbonisation

In order to decide on the optimal levels of deployment for each kind of technology, the government will need to develop an overarching heat strategy that considers type, location and seasonality of different technology options. The key technologies that will likely need to be included are briefly discussed below.

Energy efficiency

Energy efficiency upgrades are an option for decarbonising the heating sector as, put simply, they keep buildings warmer for longer at the same level of consumption and so improve the efficacy of all the solutions below (CCC 2016).

In many cases, energy efficiency upgrades should be the first approach for both new-build homes and retrofitting of existing homes as they ultimately reduce consumer energy bills and reduce emissions at the same time. Indeed, this has been a key feature of the Energy Bill Revolution that campaigned for loans and grants for energy efficiency to be included as a national infrastructure priority for up to 6 million homes by 2025 (Energy Bill Revolution 2016).

Hydrogen

Estimates suggest that hydrogen through existing gas networks could supply up to 85 per cent of buildings connected to the gas grid (MacLean et al 2016). By repurposing this existing infrastructure both costs and disruptions could be reduced.

While the town gas that once supplied many of the cities of the UK contained a significant proportion of hydrogen (around 40 per cent) the use of hydrogen in the existing national natural gas grid is only at the early stages of exploration and safety-testing (unlike some other parts of northern Europe).

While more than one technology exists to produce hydrogen – for example, electrolysis of water, or steam methane reformation (SMR) of natural gas, each has different dependencies (for example, carbon capture and storage (CCS) for SMR in order to qualify as a low-carbon option as the process produces CO_2). It is not yet clear which method will be the most appropriate for the UK. Indeed the variety of situations in which heat is used may mean all hydrogen technologies have some appropriate use when looking at the UK as a whole.

Heat pumps

heat pumps can produce heat very efficiently thereby offsetting increases in cost due to higher electricity consumption. Depending on the location of the premises, heat pump can use air (ASHP), ground (GSHP) or water (WSHP) as their sources of heat. These could be well-suited to less densely populated areas and to houses that are already well-insulated.

Since heat pumps increase electricity demand, additional low-carbon generation capacity will be required to accommodate them. Further, since heat pumps are installed individually at the house level, this will likely place greater strain on lower voltage distributed networks which may therefore require upgrading.

Biomass

To date, biomass has been one of the main sources of renewable heat in the UK. In addition, when combined with CCS, biomass has the potential to become a negative emissions source of heat and power generation.

However, there are questions regarding the long-term sustainability of the supply chains for biomass with its low-carbon credentials highly dependent on the type of feedstock used (Evans 2014). Furthermore, biomass use can also lead to air-quality issues such as emissions of nitrous oxides, which are expensive to address.

Biomethane

Similarly to hydrogen, biomethane can be pumped through existing gas networks, thereby minimising disruption but can also be readily sourced from biodegradable waste. The scale of this option is somewhat limited by the supply of feedstock available from which the methane is generated via anaerobic digestion. In the CCC's scenarios for heat, for example, its potential is estimated at around only 5 per cent of current gas consumption.

Regardless of the heat decarbonisation pathway that the UK ultimately takes, heat networks represent a 'no-regrets' option as they improve the efficiency of supplying heat from any source. Furthermore, estimates suggested that gas boilers provided heat at a cost of between £70 and £90 per MWh (Pöyry 2009; Element Energy 2015). By contrast, by 2020, district heating using renewables sources such as biomass and waste heat could produce a levelised cost of energy of £58–£111 per MWh and £53 per MWh respectively. Finally, though gas prices fluctuate and are not the only component costs for gas boilers, between November 2009 and November 2016, wholesale gas prices have increased 78 per cent (Ofgem 2016a). Thus, while further studies beyond Element Energy's will need to be conducted to demonstrate the cost-effectiveness of district heating compared to a business-as-usual scenario (that is, gas boilers) in more detail, depending on the generation source, heat networks do appear to be cost competitive with conventional heating, especially with increasing gas prices.

Many existing heat networks are supplied by gas CHP units that provide substantial carbon savings relative to the UK average. Ultimately, we will need to decarbonise further than CHP units can achieve and the units will need to be switched for lower carbon fuel options noted above. However, the principal challenge in developing district heat projects is the installation of the distribution pipes, not the supply of heat. Once the pipes are in place, it is relatively straightforward to switch away from more carbon intensive sources (which they will likely outlive) (DECC 2015a).

The development of heat networks can therefore make a significant contribution to the UK's process of decarbonisation as long as projects are developed to supply low-carbon heat in the medium to long-term (CCC 2016).

As with all other heat technology options, there are a number of barriers to the development of heat networks that are preventing the UK from realising their potential. We consider these in the following chapter.

3. UNLOCKING THE POTENTIAL OF HEAT NETWORKS IN THE UK

This chapter sets out an additional benefit of heat networks, and one of the central messages of this report: the industrial and economic opportunity presented by heat networks. They provide a platform for local economic growth within parts of the country that have been 'left behind' by London-centric growth and they can provide jobs and profits that would otherwise be located in countries that supply gas to the UK.

The UK is currently a long way from realising the full potential of heat networks. With just 2 per cent of heat supplied through existing schemes there remain a huge number of potential schemes across the country. It is difficult to state the optimum level of heat network coverage in the future because it depends on the heat decarbonisation pathway that the UK pursues. Estimates of the available resource vary from 14 per cent to 70 per cent of space and hot water demand (Webb 2014, Stratego 2015). The CCC has stated that cost effective heat networks could supply 10 per cent of demand by 2030 and have as their central and max scenarios 33 terawatt hours (TWh) and 54TWh respectively by that date. Therefore, while the appropriate deployment of heat networks in the UK is not clear, it is likely to be several times the current level and could be far higher.

Heat networks thus represent a substantial investment opportunity.

THE EXISTING AND POTENTIAL PIPELINE FOR HEAT NETWORKS

UK Trade and Investment (UKTI) recently published a paper in which it outlined the scale of the investment opportunity within the existing pipeline of heat network projects in the UK (DECC 2015a). They estimated that there was a potential £2 billion of capital investment available if all those projects were to go ahead, along with additional opportunities worth £3.2 to £6.4 billion from the operation and running of those networks.

This measure of the investment opportunity from existing projects is substantial, but we estimate that beyond the existing pipeline the opportunity could be many times greater than this. In the CCC's 'central scenario' the amount of heat supplied through heat networks in 2030 is 33TWh. Our analysis shows that if the average supply in MWh of the existing pipeline were taken as typical, it would require around 1,500 projects to reach that total. A 'max' scenario of 54TWh would require around 2,455 projects. These figures are only illustrative as future schemes may well become larger than the existing average but they give a sense of the potential pipeline.

Using the figures above and the average capital investment required to build the projects in the existing pipeline, we calculate that the amount of investment required to meet the CCC central scenario is around £16.5 billion. The max scenario would require £27 billion of capital investment. In reality these figures would be lower as a growing industry should be able to achieve substantial cost efficiency. If the costs were to fall by 20 per cent (equivalent to the costs in Scandinavian countries where the technology is more advanced) then those investment figures would be £13 billion and £22 billion respectively (see table 3.1 below).

TABLE 3.1

Investment required to meet CCC scenarios for heat supply through heat networks

Annual heat generated by 2030 (TWh)	Potential capital investment (£)	If costs decrease by 20% (£)	Jobs supported during construction (5 years)
33TWh	£16.49 billion	£13.19 billion	49,278
54TWh	£26.98 billion	£21.59 billion	80,637

Source: IPPR calculations

Using a multiplier produced by the Office for National Statistics for jobs created in construction, we estimate that the annual jobs supported during construction of the heat networks to meet the CCC scenarios would be between 49,000 and 81,000.[6] While these numbers are by nature indicative, they reveal the scale of the opportunity available if the barriers can be tackled effectively.

BARRIERS TO DEVELOPING HEAT NETWORKS

While each heat network is a unique place-based project with a specific set of challenges and requirements there are a number of barriers that are common to every project. Frontier Economics has looked in detail at these and identified seven groups of issues (Frontier Economics 2015).

1. **Externalities:** Heat networks reduce carbon emissions relative to most incumbent heating options but the value of that carbon-saving is not reflected in the price of heating. Placing a sufficient price on carbon has proved to be very challenging (in the UK and internationally[7]) but

6 This estimate is based on IPPR analysis of ONS multipliers derived from 2010 ‘supply and use’ tables, and the average capital investment of existing projects, extrapolated to the future GWh potential estimated by the CCC. The calculation assumes a total cumulative capital investment equivalent of between £16.5 and £27.0 billion in today’s prices between now and 2030. We divide this range by five to reflect local authority estimates of capital spend per year in the first five years of a given project. The ONS job multiplier for construction is then applied to upper and lower ends of this range to provide an annualised employment estimate for a given year of investment. Figures for employment are based on full-time equivalent jobs. Estimates of employment effects down the supply chain are based on the assumption that output will rise in construction as a result of the investment. As with all multipliers, these estimates will be subject to a margin of error and pertain to the average effect at the level of a sector. Furthermore, these estimates do not take account of the fact that some people and suppliers would have found jobs anyway were this investment not to have taken place, and that some suppliers and jobs may be located outside of the UK. They therefore represent an estimate of gross employment creation in the UK, not net. However, the figure also pertains to job creation in just a single year and is therefore likely to underestimate the total gross number of jobs created as a result this investment.

7 For a discussion on the price of carbon in the European market, see Garman J (2014) *Europe’s power: Re-energising a progressive climate and energy agenda*, IPPR. http://www.ippr.org/publications/europes-power-re-energising-a-progressive-climate-and-energy-agenda

until this is achieved the cost of heat networks relative to higher carbon options will remain a barrier.

2. **Natural monopoly:** Heat networks are natural monopolies resulting in very limited competition. This is in contrast to the current situation for most consumers who are able to choose their gas supplier and may be unwilling to forgo that flexibility. There is a danger that a monopoly can create poor outcomes for consumers which can in turn cause wider reputational damage to the sector and become an additional barrier.
3. **Demand uncertainty:** Heat networks are capitally intensive and so investors are very sensitive to the level of demand, and therefore revenues, that can be secured over the life of the project. However, there can be uncertainty around the level of demand as consumers are often wary of signing long-term contracts for supply, or the future number and characteristics of the buildings on the network may not be known in advance. More broadly this creates friction with energy efficiency policy as, once networks are installed, owners are likely to look unfavourably on any reduction in revenue from servicing heat demand that is brought about by energy efficient technologies.
4. **Long-term commitment:** Heat networks have long asset lives and investments are made on the basis of long-term revenues. Any shift in policy during the life of a scheme can impact the business model, which increases the risks for investors. Heat policy can also disincentivise investment in heat networks, either through incentivising competing technologies or by creating regulatory barriers such as planning restrictions.
5. **Non-financial barriers for consumers:** The public awareness of heat networks is low and there is a widespread lack of trust in the energy industry as a whole. Where there is awareness of heat networks, there is sometimes the negative perception that they can lead to temperature variations over which homeowners have little control. In addition, as with other utility-based infrastructure projects, heat networks are inherently disruptive at street-level meaning very dense urban areas may be difficult to access despite their high heat demand.
6. **Institutional barriers:** Local authorities are key actors in many heat network schemes but they are often poorly resourced. Due to the limited number of existing schemes there is also a more general skills and knowledge gap within the sector.
7. **Barriers to the supply of waste heat:** It can be difficult for developers and investors to gain information on the availability of waste heat (for example from power stations and waste incinerators). The use of waste heat from industry can also involve complex negotiations and contracting between public and private actors and is often not a priority for industrial energy managers (Frontier Economics 2015).

In addition to these seven, our research has identified two other barriers.

- **Lack of comparable projects:** Financing a heat network is challenging because each project is unique and will have a different mix of customers, such as large businesses, local authority buildings, social housing blocks or new developments. As a result, it can be difficult to show investors an equivalent scheme in this country and thus compare the rate of return it provided.

- **Attracting risk-capital:** There is a stage in such projects that is particularly risky and difficult to finance between the feasibility/design stage and the project being built. This includes legal work, seeking permissions, and consultation with stakeholders and affected parties. Projects can fail at this stage so the cost of capital for financing this work is very high. This has hampered the development of potential schemes.

ACTION NEEDED AT NATIONAL LEVEL TO OVERCOME BARRIERS

To unlock the potential investment opportunity and job-creation within heat networks and to enable local authorities to deliver these schemes effectively, national action will be required to address many of the barriers above. In particular, we suggest that the role of central government is to create an enabling environment for local authorities which helps to map the opportunity for heat networks, provide finance and technical support and protect consumers. The specific recommendations are summarised in Table 3.4 at the end of this chapter. In chapter 4, we then discuss the action that will need to be taken at a local level.

EXPANDING THE HEAT NETWORKS DELIVERY UNIT

As with any long-term infrastructure project, once networks are installed, the technology is locked in. As such, it is critical to ensure projects are deployed in only the most suitable locations. In recognition of the capacity and capability challenges that many local authorities face in addressing this challenge, the Heat Network Delivery Unit (HNDU) was established by the previous government in 2013. It exists to provide grant funding and guidance on heat networks to local authorities in England and Wales (BEIS 2016d). It is staffed with experts who are able to provide support on the early stages of a heat network project – commercialisation, heat mapping, energy master planning, feasibility studies, and detailed project management (ibid).

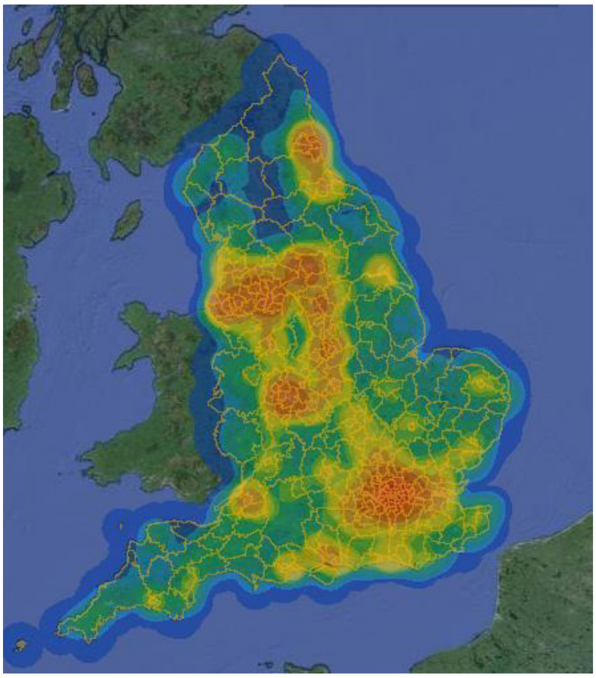
The support provided by the HNDU has created a high degree of interest and activity in heat networks from local authorities. Since 2013 the HNDU has supported 131 heat networks and has provided grant funding of £14 million.

The HNDU has produced an England-wide heat mapping tool (see, for example, figure 3.1) and supported local authorities to produce their own local maps and feasibility studies. This allows authorities to identify areas with an appropriate density of heat demand, ideally including 'anchor loads' – buildings with a high level of demand such as leisure centres, hospitals or large businesses which become the centrepiece of heat network business models – and assess the feasibility of a project in their area.

Across all the interviews undertaken in this research, the HNDU was seen by stakeholders to be a positive development. However, it is a small team with limited resources. As such, expanding this team would give local authorities greater access to information and, crucially, the technical assistance necessary to generate local maps of site suitability. These greater resources will be crucial in developing a more detailed picture of the appropriateness of district heating by identifying 'sweet spot' areas where installation can take place with minimal disruption, rather than simply those areas with the highest heat demand that may be less accessible due to population density.

FIGURE 3.1

England-wide heat map



Source: BEIS 2016e

EXTENDING THE HEAT NETWORKS INVESTMENT PROGRAMME

In the chancellor's 2015 autumn statement it was announced that a fund of £320 million would be made available to stimulate the growth of heat networks (HMT 2015) and build on the HNDU's work in helping local authorities to develop viable schemes. The funding, called the Heat Network Investment Programme (HNIP) will contribute towards the construction costs of heat networks and is available over the next five years (from 2016/17 to 2020/21).

In the pilot phase, eligibility is expected to be restricted to public sector schemes or public sector investment in privately owned networks (BEIS 2016f). It is expected to leverage around £2 billion of additional private capital investment and to lead to the construction of hundreds of heat networks that will generate enough heat to supply the equivalent of over 400,000 homes across England and Wales.

The funding is a welcome development in that it recognises a market failure affecting heat networks whereby the lack of an existing UK industry, compared to Scandinavian countries for example, has meant that the market overestimates the risk of the projects and many do not get beyond the feasibility stage. By driving the market with this capital injection, it is hoped that a sufficient industry can develop such that costs start to come down and additional private finance is committed.

Although the funding is very welcome there is a concern that five years of support may be insufficient time to build a sustainable heat network industry. For the major utilities to commit to developing a business and a supply chain in the UK they need to have faith in the long-term pipeline of the available projects and to know that the government is committed to supporting it. For this reason, we recommend that the HNIP capital fund is increased to cover the period to 2030 and that action is taken on the demand side through public procurement.

Using the leverage ratios contained within the HNIP documentation we calculate that a fund of £1.8 billion would leverage in the £13.19 billion required to meet the CCC central scenario of 33TWh supplied by heat networks in 2030 (see table 3.1 above). To meet the max scenario of 54TWh a fund of £3 billion would be required.[8] These estimates include the £320 million already committed.

Putting this into practice, we therefore recommend that government commits to extend HNIP beyond 2030 with two additional funding rounds of between £458 million and £858 million in 2022 and between £550 million and £1.05 billion in 2027, depending on the heat decarbonisation pathway that the UK takes. In addition, this would require a smaller expansion of existing funding to £400 million from its £320 million starting point.

In order to ensure that this investment leverages private finance that goes back into the UK economy, IPPR would strongly advocate that the government looks into a sector deal with UK-based heat network technology suppliers. Given the size of potential investment for the sector and the numbers of jobs this could create, an agreement with the industry, for example through tax incentives, would be crucial to realising this opportunity. The specific policy recommendations within this sector deal will be explored by IPPR in a future report.

In reality, the additional funding does not represent a large additional cost as the main purpose of this commitment is to provide policy certainty. In five years, the government may well choose to provide further funding anyway once a UK-based supply chain for heat networks starts to grow a clear pipeline of projects. But this supply chain is unlikely to develop without long-term funding commitments. To break free of this chicken and egg scenario, up-front policy certainty of funding, not up-front provision of substantial funding itself, will be the most important action required. In the section below we explain the options open to government for creating this long-term financing plan.

PROVIDING ALTERNATIVE FINANCING OPTIONS

Although we recommend a scale-up in the funding capabilities of the HNIP, there are alternatives for disbursing this money beyond grants alone. Grants are useful for reducing the upfront capital expenditure required, and this in turn improves creditworthiness and reduces the Internal Rate of Return (IRR) required by investors (BEIS 2016f) for future projects. However, grants are not sustainable for developing the market in the long term, as they do not prove that heat networks can be investible projects without subsidies.

8 These figures assume that cost reductions of 20 per cent are achieved relative to current costs, in line with Scandinavia.

TABLE 3.2

Benefits and challenges of the main financing options

Financing option	Benefits	Challenges	Type of suitable project
Grants	Reduce upfront capital required Reduce IRR required by private investors resulting in more favourable lending terms	Not sustainable in the long term Difficult to convince the market that projects are fundable	First-of-a-kind public or private heat networks where financing experience is limited
Loans	As schemes prove that they can service debt, market confidence increases Potentially reduce interest rates in the long term	Interest rates can initially be difficult to set to generate enthusiasm from both investors and councils Opportunity cost of using up borrowing capacity	Public or privately owned heat networks with clear demand profile
Equity investments	Could send message that the industry was self-sustaining Government equity could be sold and the proceeds could then be reinvested to develop new projects	Risk that selling shares and changing ownership could negatively affect consumers Government equity would likely contain strict terms and conditions Required rate of return more volatile and could exceed project cash flow	Private heat networks where the customer-facing operator was separate from the owner
Guarantees	Reduce risk for investors Would prove reliability of heat networks and improve lending terms in the long term	Guarantees for five years (length of current timescale) would not be long enough to cover heat demand for lifetime of the network Risk to government of taking on high level of liability	Public or privately owned heat networks with clear demand profile
Bonds	Do not affect local authority borrowing capacity Capital is provided upfront by investors Length of payback period for heat networks is appropriate to steady return characteristic of bond market	Credit rating of local authorities may vary meaning that the interest required on bonds could be too high for some	Public or private heat networks in areas where local authority has experience of raising bonds for municipal projects and there is a clear demand profile

Sources: BEIS 2016f, DECC 2015b, IPPR analysis

To establish the transition towards a self-sustaining market there are many alternative financing options available. One favoured option by respondents to the HNIP consultation was for the HNIP to offer low (or zero) interest loans under certain conditions (for example, repayment schedules linked to project completion) (BEIS 2016f). As district heating schemes service debt, confidence in the market would gradually increase, resulting in more favourable interest rates from private investors in future. However, loan schemes can also be challenging as it can be difficult to set interest rates at the right level, as programmes like the Green Deal have shown. Set too low, projects, whether funded by the HNIP or through private finance, will be rejected as too risky;

too high and local authorities will not be incentivised to develop the projects in the first place. In addition, a barrier to any loan scheme is the question of opportunity cost, since borrowing capacity is used up that could be channelled elsewhere.

Ultimately, we recommend that the government should provide a range of financing options that can be delivered by the HNIP. By their nature, district heating networks are localised developments and their level of market maturity, their ownership and the demand profile they supply will differ in each local authority. Table 3.2 presents a summary of the benefits and challenges of some of the main financing options that we believe the government should seek to provide for heat networks.

Regardless of the financing options chosen technical assistance with project selection and appraisal will be key to building confidence in the market and demystifying any finance scheme, especially given the longer timescale required to pay back investment for heat networks. In less mature markets, the risk attributed to investment often derives not just from high upfront costs, but also the lack of technical understanding among investors (Retallack et al 2017). As such, we recommend that the government not only expands the remit of the HNDU to support local authorities (mentioned above), but also convenes meetings with private investors and, where possible, arranges secondments for its experts with interested financiers.

ENSURING CONSUMER PROTECTION

However they are financed, district heating networks are likely to result in natural monopolies that risk exploiting the lack of choice available to consumers (Which? 2015). Despite the establishment of the voluntary (industry-led) customer protection scheme, the Heat Trust, and general oversight by the Competition and Markets Authority (Frontier Economics 2015), there is currently no regulation of price or length of contracts. Furthermore, if customers cannot resolve complaints with their supplier, there is no formal alternative dispute resolution scheme available for heat networks (Citizens Advice 2016). As such, IPPR supports Citizens Advice's recommendations for both a clear framework for price regulation and a dedicated ombudsman for district heating.

While intervention will be necessary, regulations on price need not discourage private investment into heat networks. Despite high upfront capital costs, heat networks have long asset lifetimes of around 40 years with reliable paybacks, provided, as mentioned above, they have guaranteed demand and long-term policy commitment. Conceptually, regulation for heat network owners could be similar to the controls in place for distributed network operators in charge of the electricity distribution network and could be similarly administered by Ofgem. Communicating price controls to consumers in this way could improve the acceptance and understanding of future district heating projects. To this end, IPPR strongly supports the Association for Decentralised Energy's newly formed district heating taskforce, which will explore how to address perceptions of investment risk from developers while ensuring that customers remain protected (ADE 2017).

MAKING THE MOST OF WASTE HEAT

UK industries make a considerable contribution to the UK's economy and, despite falls in recent years, manufacturing still represents 10 per cent of UK GVA (Rhodes 2015). It also produces around 14 per cent of the UK's total emissions with 11 per cent of this coming from combustion processes that produce heat.

The estimates of the amount of heat which could potentially be recovered from industrial processes varies. One report by Aalborg University looked at the potential for decarbonising heat across five different EU countries (including the UK) and estimated that there was a potential 80TWh of industrial waste heat that could be used for district heat networks (Stratego 2015). Work carried out for the Department for Energy and Climate Change and for the CCC has put the estimates for available waste heat in the UK at around 30TWh (Element Energy 2015). While using all of this waste heat may not be practicable, this does highlight the scale of the opportunity. To put it into perspective, as mentioned above the CCC central scenario has the total amount of heat delivered through heat networks as 33TWh by 2030.

Furthermore, around 70 per cent of this potential supply is located within 10 kilometres of local authority demand centres. According to Element Energy (2015), some waste heat sources can also be highly cost-effective, with high temperature waste heat estimated at as low as £53 per MWh. As such, greater cooperation between local authorities and industry on the use of waste heat could open up significant opportunities, beneficial both to the industry being paid for a waste product and to the local authority able to purchase cheap heat.

As mentioned above, however, barriers for waste heat remain due to the lack of available data, the complexity of negotiating contracts between industries and district heating schemes and the need for solutions that suit local circumstances. In addition, for industry in particular, installing heat recovery technologies is seen as an energy efficiency requirement that has relatively low importance within corporate priorities due high up-front costs and long payback periods (BEIS 2016f).

Given the emphasis on lowering energy costs for industry in the government's green paper on industrial strategy (HM Government 2017), addressing these barriers should be a government priority. Specifically, we recommend that waste heat recovery should be included within the Renewable Heat Incentive (RHI) in order to guarantee a funding stream that helps industrial energy managers to see past upfront costs. In addition, in order to improve data availability and access, we recommend ring-fencing some HNDU funding specifically to record waste heat generation statistics.

The renewable heat incentive (RHI)

The RHI scheme is a government programme launched in April 2014 that provides financial subsidies to increase the uptake of renewable heat. It is divided into two parts: the domestic RHI applicable to residential homes and the non-domestic RHI for businesses, the public sector and non-profit organisations (Energy Saving Trust 2017).

The domestic and non-domestic RHI schemes give those who purchase eligible technologies quarterly payments for seven years for renewable heat generated by that technology (Ofgem 2017). The total payments are calculated as a tariff paid per kilowatt hour (kWh) of heat generated. The different rates and eligible technologies are shown in table 3.3.

TABLE 3.3

Payment rates and eligible technologies under the Renewable Heat Incentive

Technology type	Tariff (pence/kWh)	Domestic or non-domestic?
Biomass plant	6.44	Domestic
Air source heat pump	10.02	Domestic
Ground source heat pump	19.55	Domestic
Solar thermal	19.74	Domestic
Commercial biomass	0.78–5.24	Non-domestic
Solid biomass CHP	4.22	Non-domestic
Ground or water source heat pumps	2.67–8.95	Non-domestic
Air source heat pump	2.57	Non-domestic
Deep geothermal	5.14	Non-domestic
Biomethane injection	1.76–3.89	Non-domestic
Biogas combustion	0.98–3.32	Non-domestic

Source: Adapted from Energy Saving Trust 2017, Ofgem 2016b

Table 3.4 summarises the policy recommendations for government mentioned above and highlights the barriers that each one could address. Where relevant, the headings of each area requiring action are further subdivided into specific recommendations.

TABLE 3.4

Summary of actions required on heat networks at national level

Action	Barriers								
	Externalities	Natural monopoly	Demand uncertainty	Long-term commitment	Non-financial barriers for consumers	Institutional barriers	Barriers to the supply of waste heat	Lack of comparable projects	Attracting risk-capital
Expanding HNDU staff			✓						
Extending HNIP to 2030									
1. Add funding rounds in 2022 and 2027				✓					
2. Work on sector deal to embed UK supply chain				✓					
Exploring alternative financing options									
1. Provide alternative financing options				✓					✓
Ensuring customer protection									
1. Framework for price control		✓			✓				
2. Dedicated ombudsman		✓			✓				
Making the most of waste heat									
1. Include waste heat in RHI							✓		
2. Ring-fence HNDU funding for waste heat			✓				✓		

Source: IPPR analysis

Not all of the barriers will be addressed by the actions suggested above. Addressing the externality of CO_2 emissions for example, will require national and likely international coordination to establish a carbon price across the global economy. In addition, institutional barriers, such as a lack of resourcing at the local level, will necessarily require the participation of local authorities in heat networks (even if they are initially directed by central government). The next chapter therefore discusses in more detail the importance of local authorities in the delivery of heat networks.

4.
DELIVERING HEAT NETWORKS THROUGH LOCAL AUTHORITIES

EXPANDING THE ROLE OF LOCAL AUTHORITIES

Although action at the national level will create an enabling environment by mapping the potential for heat networks, providing financing options, ensuring consumer protection and making the most of waste heat, it is local authorities that will ultimately be the catalysts that drive the delivery of district heating schemes. As outlined in chapter 2, there have been four routes to delivering heat networks in the UK:

1. Local authority-led schemes including the connection of schools, leisure centres other public buildings and both private and social housing
2. Private sector developments on new housing schemes, which may also include blocks of flats or commercial developments
3. Standalone campus networks serving hospital sites or universities
4. Schemes in individual social housing blocks built in the 1960s and 1970s.

In every scenario above, local authorities play some role. For example, even when the HNIP moves beyond its pilot phase, which has a strong focus on local authorities, developments led by the private sector will likely still need to seek endorsement from councils in order for construction to go ahead (BEIS 2016f). Indeed, since the Localism Act 2011, local authorities have held a 'general power of competence' that grants them broad-ranging powers to develop growth strategies (DCLG 2011) and hence decide on the extent to which heat networks should be developed in their area. Furthermore, local authorities are likely to know more about the condition of the housing stock in their areas, the location of large industrial centres and anchor loads and therefore what the heat demand profile is likely to look like.

However, despite the *potential* power at the disposal of local authorities, policy reform at the local level is still needed to address the institutional barriers discussed in chapter 3, which reveal an *actual* lack of experience and resources. To address these challenges, there are four main steps that we believe local authorities should take. A summary of our recommendations is given in Table 4.2 at the end of this chapter.

CREATING BESPOKE CITY-LEVEL PROCUREMENT BODIES FOR DISTRICT HEAT

Even after appropriate methods of financing have been provided (see chapter 3), public procurement of heat networks is often complicated and time-consuming. This is largely due to a lack of resourcing within local authorities, where procurement officers may not have the technical experience required for understanding the requirements and revenue profile of district heating schemes (King 2015). With the need for local authorities to prove value for money for the goods and services procured, the risk of investing in less mature technologies like heat networks is greater still. Finally, there is a lack of contractual standardisation for district heating as local authorities are left to procure suppliers on a one-to-one basis.

Despite these restrictions, the opportunity for incorporating heat network deployment within public procurement spending is substantial. In 2014/2015, public bodies spent £250 billion on procuring goods and services. In order to make the case for using these funds for heat networks, local authorities interested in heat networks should collectively draw on lessons from Sweden, where one bespoke procurement agency, Värmek, procures heat networks on behalf of all local governments. Having a single body is beneficial both to suppliers, who have a single point of contact, and to authorities, on whose behalf the agency negotiates standardised contracts, exerts downward pressure on price and relieves the administrative burden (King 2015).

There are many different models for creating a procurement agency and deciding what support it should provide. Indeed, one single agency, as in Sweden, may not be appropriate for the UK, where densely populated cities are much more numerous. One suggestion, therefore, could be to create these procurement bodies at the city or council-level, to ensure that the use of district heating schemes is appropriate to each different region. Fledgling work is already being undertaken to this end, with the Department of Energy and Climate Change providing £100,000 of seed funding in 2015 for replicate Manchester city council to create a district energy procurement agency that would act on behalf of local authorities. IPPR supports the creation of such a body with powers to create standardised contracts (DECC 2015b), negotiate these contracts (provided that councils have final sign-off) and, where relevant, provide training on how to appraise projects suitable for procurement.

FOCUS LOCAL PLANNING FOR HEAT

Planning rules are already used in some instances to incentivise the deployment of heat networks. The London Plan, for example, requires developers of major new residential and commercial buildings to show that they have considered the possibility of connecting up to a network when they are being built (Mayor of London 2016). Similarly, in Scotland the government is currently holding consultations on the possibility of mandating 'local heat and energy efficiency strategies' and the provision of regulation to ensure connection to district heating schemes where appropriate (Scottish Government 2017). To extend this thinking further, the central government should grant similar legal powers to all local authorities across the UK. From here, local authorities should then work with HNDU to create heat zones that include large businesses and municipal buildings that have large anchor loads. This would enable local authorities to ensure economies of scale and ensure there is a base network in place that is capable of quickly scaling up.

Though not the main focus of this report, this scale-up should also follow the Efficiency First Principle (ECF 2016) and consider how energy efficiency ties in with heat network delivery before the latter is installed. By considering both options together, local authorities would be able to better estimate the likely demand after project completion, thereby reducing objections from heat network owners who would otherwise see their revenue decrease from post-project efficiency upgrades. The importance of incorporating these planning considerations into broad heat strategies is discussed in more detail below.

In addition, during the actual construction of the networks, local authorities should take a leading role to ensure that the installation of heat networks and energy efficiency is sequenced properly in order to minimise disruption to consumers. As such, in order to ensure consumer buy-in, local authorities could play a greater role in actually providing energy by setting up local supply companies, following on from the examples that have been set by Nottingham and Bristol (Platt et al 2013).

Local supply in Nottingham

Nottingham's district heating scheme is managed by Enviroenergy, an energy service company wholly owned by Nottingham city council. Around 160,000 tonnes of domestic and commercial waste a year are collected in Nottingham and burnt at the Eastcroft Energy from Waste plant, which is operated by WRG and owned by Nottingham city council. Steam is piped 1.5 kilometres to the Enviroenergy London Road Energy Centre, where it is passed through a 14.5 megawatts electric (MWe) condensing turbine to generate 60 gigawatt hours (GWh) of electricity a year and 130GWh heat through a 68-kilometre network of insulated pipes. Across the city there exist a further 10 CHP sites, providing 38.3MWe capacity and generating 191GWh of power and 372GWh of heat.

Heat is supplied to 4,600 domestic homes and 100 businesses across Nottingham including: Victoria and Broadmarsh shopping centres, the National Ice Centre Arena, Nottingham Trent University, BioCity, HM Revenue and Customs, Nottingham Town Hall and various other large local developments. Electricity is supplied to commercial customers through a private wire network with excess power feeding into the National Grid. Approximately 85 per cent of domestic homes connected to the network are on pre-payment heat monitors.

The scheme has been running since 1972, is the largest in the UK and saves on average 27,000 tonnes of CO_2 a year. In 2009, plans were made to increase the Energy from Waste plant's activity and in 2011 the scheme was expanded to include Nottingham railway station and Southside business district. This was funded in part through a £1.5 million grant from the national Homes and Communities Agency and £401,000 from Enviroenergy.

Nottingham's 2020 Sustainable Energy Strategy sets out a target for 20 per cent of the City's own energy generated to come from low or zero carbon sources by 2020. Currently, this is at about

11.45 per cent, and Nottingham city council is looking to develop and extend various district heating networks to ultimately have a linked network supplying heat across the city. Local planning policies require new developments to offset carbon emissions by producing a certain amount of low or zero carbon energy; this obligation can often be met by connecting to a heat network.

Nottingham city council is also exploring opportunities for biomass and anaerobic digestion, as well as energy efficiency improvements. The city council, Nottingham Energy Partnership, local housing associations and NHS Trusts are working with householders and communities to deliver various schemes to achieve at 37.6 per cent reduction in CO_2 emissions from domestic energy efficiency by 2020. These schemes include Nottingham Warm Zone, Greener HousiNG and REMOURBAN and are mostly funded through a variety of income streams from Green Deal Communities, Community Energy Saving Programme, Energy Company Obligation and the European Commission.

IDENTIFYING GAPS IN THE SUPPLY CHAIN

In order to deliver heat networks effectively, local authorities will need to ensure that there is an appropriate supply chain of industry stakeholders in place. Although no two projects are alike, in most cases, local authorities are instrumental in procuring and then managing the relevant stakeholders. Table 4.1 shows those stakeholders that would likely be found in a typical heat network project and the role they play.

TABLE 4.1

Stakeholders in a model heat network project

Stakeholder	Role
Engineering design consultants	Heat mapping and occasional supervision of installation, commissioning and operation
Legal and financial consultants	Draw up contractual arrangements between all parties
Heat network developers and operators	Can provide range of services that could incorporate other stakeholders in this list including: finance, design, build, operation, maintenance, metering, billing and customer service
Civil engineering company	Specialists in construction and installation works including digging trenches, installation and restoring surface
Pipe manufacturer and installer	Supplier of pipework which is assembled and installed by civil engineers (see above)
Generation	Heat generation plant supplying the heat to the networks once pipes are installed
Control systems	Used to understand and, with smart systems, manipulate heat demand once network is connected to homes
Thermal storage	Optional addition to flatten heat demand profile by storing excess heat (and therefore increase utilisation of the generation plant)
Retail or customer interface	Includes the Heat Interface Unit (HIU – often imported) and, occasionally heat meters, both of which can be accessed by the customer

Source: Adapted from DECC 2015a

Some of the stakeholders in table 4.1, such as pipe manufacturers and providers of retail or customer interfaces, are not commonly found in the UK. However, as mentioned in Chapter 3, with a sector deal in place with central government, the process of sourcing suppliers from the UK would be made easier for local authorities. Concurrently, the operation and maintenance supply chain could also be developed with estimates suggesting these contracts could be worth between £3.2 billion and £6 billion over the 40-year lifetime of the networks (DECC 2015a). As such, local authorities will need to ensure that due diligence is conducted before embarking on projects in order to ensure that a supply chain is in place.

The case study below provides a best practice example from Gateshead Council working with relevant stakeholders throughout the supply chain to deliver their district heating scheme.

Stakeholder involvement in Gateshead

Since 2011, Gateshead Council and WSP Parsons Brinckerhoff have been developing a district energy network to serve the town centre and Gateshead Quays area. Construction of the 2MW gas CHP energy centre in the Baltic Business Quarter was recently completed, and came online in late 2016. The first buildings lined up to receive heat and power include Gateshead Civic Centre, Gateshead College, Sage Gateshead and the Baltic Business Quarter. In central Gateshead 350 social rented properties managed by The Gateshead Housing Company will be supplied with heat only.

The £18.5 million scheme is entirely funded and owned by Gateshead Council and operated through a new energy service company, also wholly owned by Gateshead Council. The scheme was developed and designed by WSP Parsons Brinckerhoff, with Balfour Beatty contracted to build the energy centre and heat connections for each customer, Clancy Docwra to install the heat and power networks and Edina UK to install and maintain the gas CHP plant.

The 4MW gas CHP energy centre provides heat and power directly to customers via a 3-kilometre network of heat pipes and high voltage private-wire electricity cables. The scheme has a full set of back-up facilities and the CHP engines do not run continuously – when customers do not need heat or when the CHP engines are being serviced, heat is provided from conventional gas boilers.

Funding for the project was borrowed through the Public Works Loan Board. The scheme is estimated to deliver an 8 per cent pre-financing internal rate of return over 40 years (the lifetime of the pipe infrastructure) with positive cashflow from year one and so roughly a 15-year payback period. Income is derived from both long-term (10–40 years) public and private contracts, with 70 per cent revenue from public sector connections. Although the Gateshead scheme is heat-led, income from electricity will provide 75 per cent of revenue. Electricity is provided through private wires at a lower cost to customers, and reduces costs and losses of exporting into the national grid.

Gateshead Council is currently in talks with commercial hotels and offices about connecting to the scheme, and has been awarded £200,000 by DECC's Heat Networks Delivery Unit to explore further extension of the town centre network.

As part of the Core Strategy and Urban Core Plan for Gateshead and Newcastle upon Tyne, connection to a decentralised energy scheme will be a planning requirement for most developments. The Gateshead scheme pipes are presently oversized for the current extent of the heat and power network; this was a decision made by Gateshead Council to futureproof the network and allow for further connections. Gateshead Council is also looking into alternative sources of heat and the potential to provide private wire connection to a neighbouring steel foundry and industrial area.

Sources: Gateshead 2016, WSP 2015, Interviews conducted by IPPR

CREATING LOCAL HEAT STRATEGIES AND SHARING DATA

The system of heat supply in the UK will be totally overhauled in the next 35 years. This transition will involve many different technologies, as discussed above. A central challenge in navigating the transition will be integrating these different technologies and avoiding a suboptimal mix of heating solutions. For example, the installation of heat pumps in some buildings in an area that is later supplied by hydrogen through the gas grid or through a heat network would be inefficient. By contrast however, installing heat networks where demand is uncertain or may not last the lifetime of the pipework could lead to technology lock-in. Thus, a high level of coordination will be required to ensure that system solutions such as heat networks and individual building-scale solutions such as heat pumps do not undermine each other.

More broadly, regardless of the technology chosen to supply the heat, both heat and electrical efficiency upgrades to buildings, such as insulation and efficient lighting, will be required across the UK building stock in the coming years if the country is to stay within its carbon budgets and consumers are to be protected from escalating energy costs. As thermal efficiency increases, heat demand goes down and so it is vital that energy efficiency programmes are closely integrated with heat development to ensure that projects are appropriately sized.

The interrelation of different technologies will not be the same in every region, and some areas will be more developed than others in their overall heat strategies. In Scotland, for example, the Heat Network Partnership already has well developed resources available to developers, with technical support on finance, planning, technology and procurement.[9] However, the sharing of non-commercially sensitive data and best practice will likely benefit those local authorities who have not yet scoped the opportunity for district heating. This information-sharing could be channelled through the city-level procurement bodies mentioned above, and so reinforce collaboration between councils.

9 http://www.districtheatingscotland.com/resources/

Therefore, to improve understanding of the opportunities that exist within their areas, we recommend that, with the help of the HNDU, local authorities expand zoning to go beyond the opportunity for heat networks.

Table 4.2 summarises the action required at the local level and highlights the barriers that each action could address. Where relevant, the headings of each area are further subdivided into specific recommendations.

TABLE 4.2

Summary of policy actions required on heat networks at local level

Action	Barriers								
	Externalities	Natural monopoly	Demand uncertainty	Long-term commitment	Non-financial barriers for consumers	Institutional barriers	Barriers to the supply of waste heat	Lack of comparable projects	Attracting risk-capital
Creating bespoke city-level procurement bodies for district heat						✓			
Focus local planning for heat									
1. Undertaking zoning for heat networks			✓		✓	✓			
2. Leading on construction and supply of heat			✓			✓			
Identifying gaps in the supply chain						✓			
Creating local heat strategies and sharing data				✓		✓			

Source: IPPR analysis

CONCLUSION

If the UK is to meet its own climate change targets, as the government currently intends, the heat sector in the UK will need to change and decarbonise radically between now and 2030, let alone 2050.

As this report acknowledges, heat networks will not be able to achieve this alone. In fact, a long-term heat strategy will not only need to include other renewable heat options such as heat pumps and hydrogen gas, it will also need to consider how energy efficiency within homes interacts with heat and affects demand and seasonal peaks.

However, as heat pumps will require consumer uptake and the viability of hydrogen gas in the existing infrastructure is at early stages of examination, heat networks are likely to be the technology option that can currently be scaled up most quickly. Furthermore, heat networks represent an opportunity to generate £22 billion of investment into the UK and create up to 81,000 annual jobs. Since heat demand is a national energy consideration, heat networks also promote the regionally diverse employment that the government's new industrial strategy is keen to promote.

To realise this opportunity, we propose that local authorities should be the driving force behind the deployment of heat networks. To achieve this will require an enabling environment at the national level combined with more active participation from local authorities themselves.

To this end, on the national level, this report recommends that the government do the following.

- Expand the resources of the Heat Networks Delivery Unit (HNDU) so that it can map out suitable sites for heat networks (including areas suitable for waste heat) in greater detail and keep records of their performance
- Extend funding for the Heat Networks Investment Programme (HNIP) to 2030 in order to build a greater pipeline of projects and reassure investors of the government's long-term policy commitment – this is particularly important for assets like heat networks that can take a long-time to pay back initial investment. Concurrently the government should explore sector deals with technology companies and manufacturers to ensure the expanded investment goes towards a home-grown supply chain.
- Explore alternative financing options by:
  - evaluating a range of financing options (including grants, loans, equity, guarantees and bonds), and
  - providing technical support to investors through secondments of HNDU staff.
- Ensure customer protection by:
  - creating a framework for price control, similar to that currently in place and administered by Ofgem for electricity networks, and

- creating the position of a dedicated energy ombudsman to resolve any complaints that customers cannot settle with their supplier.

- Further promote waste heat by:
  - including it within the RHI to incentivise industrial energy managers, and
  - ring-fencing funding within the HNDU to better record data.

At the local level, our overarching recommendation is for local authorities to become more active in the development of district heating projects. In particular, we make the following recommendations for local authorities.

- Seek to continue the work of Manchester city council and create bespoke city-level procurement bodies that can negotiate with suppliers on behalf of different local authorities and help to standardise contractual arrangements.
- Reform local planning by:
  - undertaking heat zoning in conjunction with HNDU to understand the most suitable locations for heat networks and understand how this ties in with energy efficiency upgrades
  - taking a more active role in the construction and supply of district heating schemes by creating council-owned energy service companies.
- Identify gaps in the supply chain for delivering heat networks and ensure they are filled before going ahead with a project.
- Create broad local strategies that incorporate heat networks as well as other renewable heat and energy efficiency options, and share public data and best practice from these strategies and any previous studies with other councils.

In order to realise the opportunity for heat networks both tiers of government will need to act on these recommendations in tandem. In some cases, recommendations may overlap and coordination between central government and local authorities may be required. For example, as the role of HNDU is expanded nationally, local authorities will increasingly be able to work with these experts to undertake heat zoning in their own local areas.

If this can be achieved, the benefits of heat networks, in terms of energy security, decarbonisation and job creation and investment into the UK economy, suggest this sector could become an important feature within a new low-carbon industrial strategy.

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