in association with

VIEWPOINT

INSIGHTS AND OPINIONS FROM BARINGA PARTNERS

Heat decarbonisation

Decarbonising buildings is a generational challenge

Different regions of the world take different approaches to heating their buildings, generally based on locally available resources, and the price of power. In the UK these factors have led to gas being the predominant mode of heating, and as a result buildings are a major source of greenhouse gas emissions which will need to be addressed to achieve the net zero target.

Vattenfall worked in collaboration with Baringa to analyse the consumer perspective of heat decarbonisation, and consider the characteristics of a policy framework that can deliver it.

In 2018, buildings accounted for 88 $MtCO_2e$ of emissions, representing 18% of the UK total. Under the Government's 2019 commitment to achieving net zero emissions this will need to be reduced to near zero by 2050, but progress so far has been slow. In comparison, power generation has made the most substantial headway in reducing emissions, and now accounts for less than buildings. Surface transport is another sector yet to substantially reduce emissions, but there is a sense of gathering momentum and concerted action by government and industry, primarily directed towards Electric Vehicles (EVs). In heat however, that sense of momentum is absent; the Committee on Climate Change's (CCC) 2019 assessment of progress towards the carbon budgets in the building sector found progress far short of what was needed in installation of insulation and heat pumps. There are a number of reasons why this might be so.

- Decarbonising buildings requires active consumer engagement, often requiring people to make disruptive alterations to their homes. Such engagement is currently limited: improving the efficiency of a home does not enjoy the kudos of buying an EV (at the moment at least), and public awareness of low carbon heating options is low.
- Heating buildings with boilers burning grid-delivered gas is convenient and engrained in the public perception of what is normal; absent incentives, there is limited impetus to change.
- Current (and past) policy has not been particularly effective or consistent in driving change, indeed arguably a number of long standing policy imbalances have impeded it. For example, gas is undertaxed relative to electricity, signalling a substantially lower effective cost of carbon.
- Identifying an efficient route to decarbonisation is inherently complex: determining the right mix of efficiency improvements with the right low carbon heating technology is difficult for one building, let alone for the country's entire building stock.

Major parts of the existing building decarbonisation policy landscape are due to fall away in the early 2020s, including the Renewable Heat Incentive (RHI) in 2021 and Energy Company Obligation (ECO). A comprehensive new policy framework will need to be implemented in this time frame if the challenges identified above are to be overcome and the net zero ambition delivered. To date, Government has reviewed evidence on heat decarbonisation[1], but the necessary policy framework is yet to take shape. In this paper we explore some of the issues relevant to this process, and consider the characteristics that efficient policy will demonstrate. To do so, we draw on analysis undertaken by Baringa for Vattenfall, looking at the cost of delivering heat through various alternative low carbon technologies. The analysis was distinctive in taking a bottom-up approach, considering the final cost of delivered heat to the consumer.

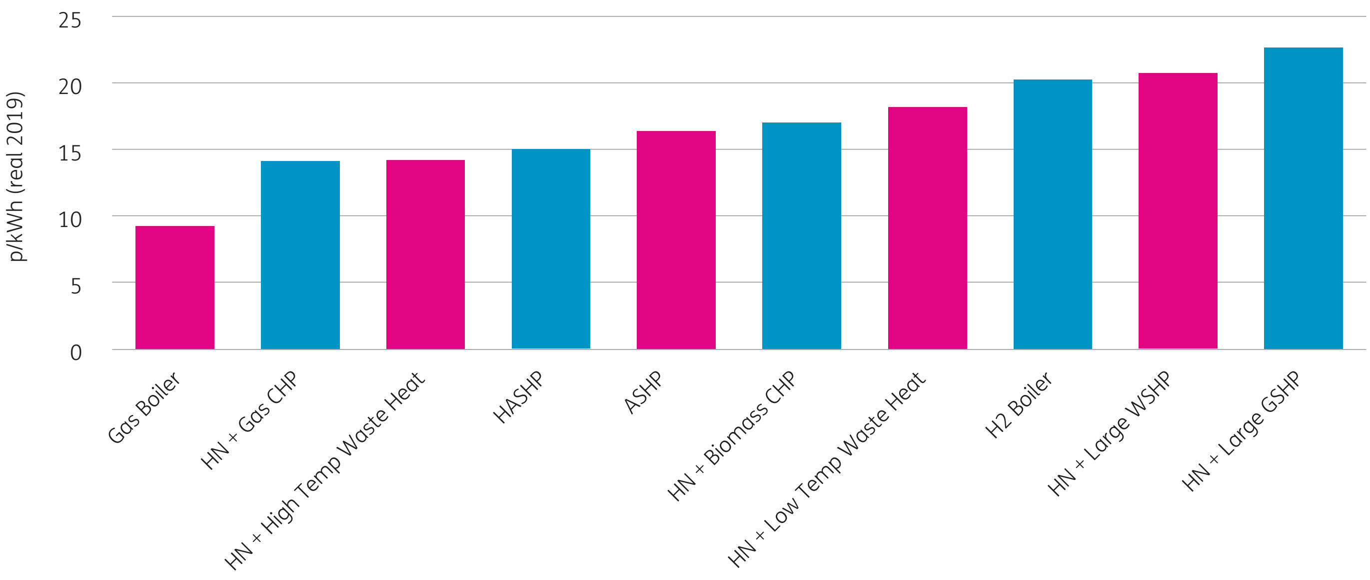
[1] BEIS, Clean growth: transforming heating - overview of current evidence, December 2018

Decarbonising buildings will have a cost

Gas heating is comparatively cheap; ignoring the unpriced externalities of gas such as CO_2 emissions and air pollution, it will cost us more to heat our buildings with low carbon alternatives (such as heat pumps, and heat networks). **Figure 1** illustrates the all in cost of delivering heat to a typical semidetached house using various alternative heating technologies. The analysis builds up the full cost stack to find the final cost paid by consumers and reveals the most material components. It includes fuels costs (including wholesale energy, network, supplier and policy costs), the capital and maintenance costs of in-house equipment (and external equipment for heat networks), and taxes. Energy prices are taken from BEIS' Updated Energy and Emissions Projections and may not capture cross vector effects, for example the cost of electricity network reinforcement that may be necessitated by large scale deployment of heat pumps.

The modelling indicates that the cheapest low carbon heating solution typically costs in the region of 5 p/kWh more than gas heating in 2020[2]. Over time, as the costs of alternative technologies fall and the price of gas rises, the difference may diminish, but is unlikely to disappear.

Figure 1: All in cost of delivered heat, semi-detached suburban home (2025)



See glossary for abbreviations

There will therefore be an incremental cost to decarbonising buildings. A study for the National Infrastructure Commission (NIC) estimated the cumulative additional cost by 2050 versus the status quo will be in the order of £120 - £300 bn in present value terms[3], equivalent to approximately £4,500 to £11,000 per household.

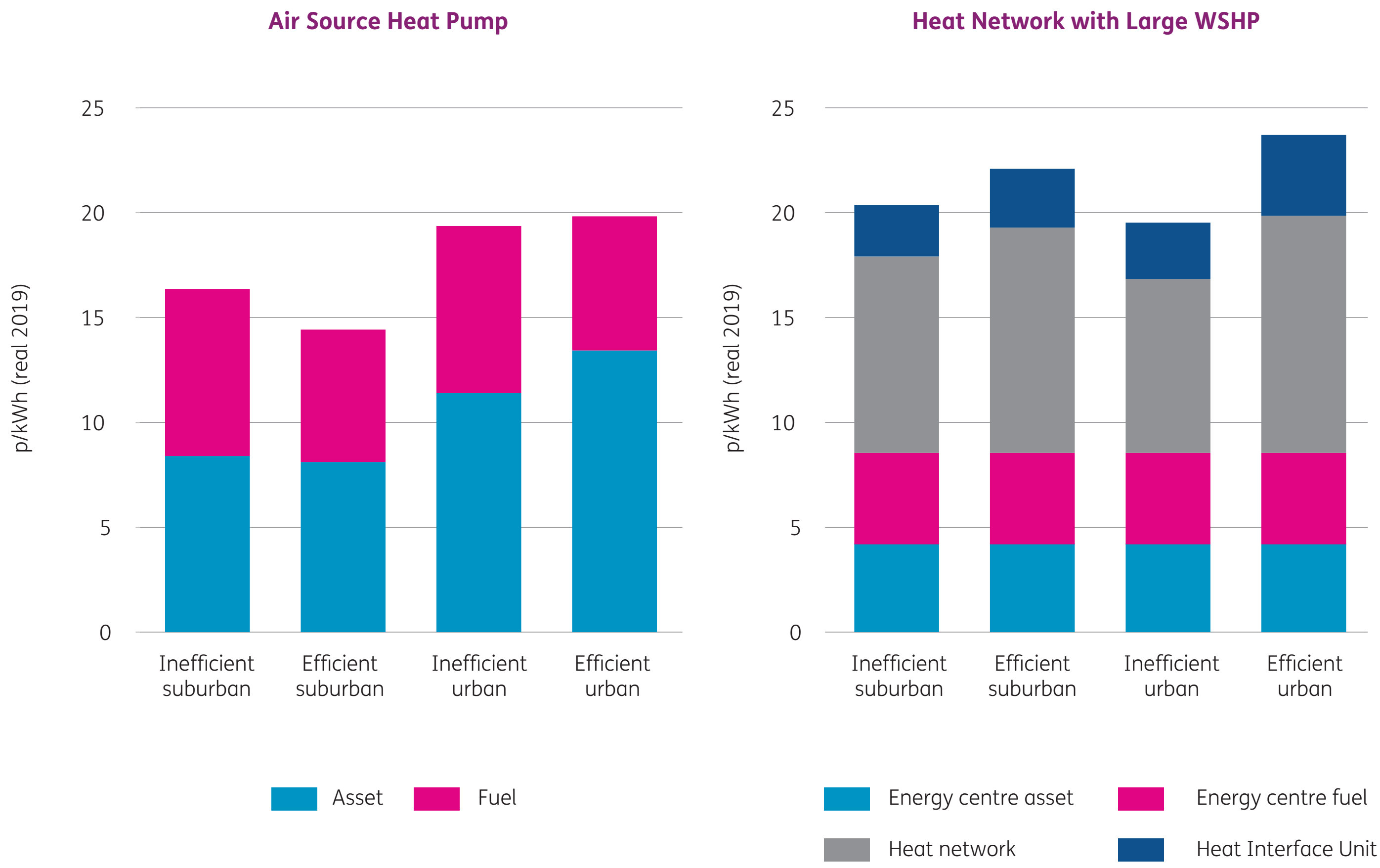
[2] This is generalised across the whole building stock; there are locations where other solutions such as heat networks or potentially heat pumps are already cheaper.

[3] Discounted at 3.5%, and based on the 2050 emissions targets existing before the adoption of the net zero target.

Context is as important as technology in determining the cost of decarbonising heat

How much it costs to heat a building clearly depends on what technology is installed to produce that heat. However it also depends on the physical properties of the building and its ambient environment[4]. Furthermore, the cost of a shared heating solution (such as communal or district heating) versus an individual solution (such as an individual heat pump) will depend on the level of heat demand and the urban fabric of the area surrounding the building. Heat networks make sense where many customers can be served by the same length of piping, and where that piping is cheap to lay. *The implication is that different buildings in different places will have different costs of decarbonisation.* **Figure 2** illustrates how the cost of heating varies between illustrative building types and locations for two example technologies: air source heat pumps and a heat network supplied by a large water source heat pump. It is notable that the difference in cost between contexts for the same technology is comparable to the difference between technologies for the same context, indicating that the two factors are of comparable importance.

Figure 2: Cost variation across contexts for alternative low carbon heating technologies (2025)



[4]The way the building is used by its occupants and the comfort level they seek is also relevant, but is subject to change as tenancy and lifestyle changes.

What should we surmise from this? There are key localised attributes to heat delivery and use that are not present to the same extent in electricity. From a policy perspective, however, there is a tendency to look to electricity to provide the template for heat decarbonisation, given it has already shown significant progress. We are therefore familiar with the concept of technology differentiation in policy (established in the Renewables Obligation bandings and Contract for Difference technology pots). The idea of differentiation by place is less familiar in energy policy, but a heat policy framework tailored to the combination of building, technology and location has the capacity to significantly reduce the cost of transition.

To illustrate the point, consider a scenario where consumers are compensated for the increased cost of heating when they switch from gas to a low carbon alternative, and 25% of domestic building heat is decarbonised by 2035 (broadly consistent with the Clean Growth Strategy [5]). The present value of support payments [6] paid out to reach that level of deployment when a single rate of support is offered to all, set at the cost premium of ASHPs in the most expensive location, is £29 bn. If contextual differentiation is introduced, such that the rate of support offered reflects the cost variation of ASHPs across different contexts, the present value of support reduces to £23 bn. If technological differentiation is then introduced, such that the rate of support offered is set at the cost premium to gas heating of the cheapest low carbon technology in each context, the present value is further reduced to £19 bn. This is summarised in **Figure 3.**

Figure 3: The impact on decarbonisation costs of contextual differentiation

Reduction in support needed

Baseline *No contextual or technological differentiation*	A single rate of support is given to heat from Air Source Heat Pumps, set at a level to match the cost of gas heating in contexts where the cost premium is highest	**£29 bn** present value (2019)	**£150** /household/year (peak)
Contextual differentiation	A differentiated rate of support is given to heat from Air Source Heat Pumps, set at a level to match the cost of gas heating in each context	**£23 bn** present value (2019)	**£115** /household/year (peak)
Optimised *Locational and contextual differentiation*	The cheapest form of low carbon heat source (including heat networks) available in each context is supported at a rate set to match the cost of gas heating	**£19 bn** present value (2019)	**£100** /household/year (peak)

[5] HM Government: the Clean Growth Strategy, October 2017
[6] Discounted at 3.5%

What will an effective heat policy framework do?

So decarbonising buildings will have a cost, suggesting it will not happen at large scale without policy intervention of some sort. What worked for electricity though will not necessarily work for heat, as the latter has different properties and poses particular challenges. So in wider terms, what should an effective building decarbonisation framework aim to achieve?

- **1.** It will need to engage and inform consumers.
- **2.** It should help find efficient trade-offs between improving building efficiency and installing low carbon heat sources.
- **3.** It should enable the right technology using the right resource to be installed in the right location, implying removing existing distortions that prevent this from happening.
- **4.** It will need to enable a degree of central coordination, to allow co-ordinated solutions to be developed where this lowers total costs versus individual home solutions.

Having established that heat decarbonisation will come at a cost, a key question for policy makers is whether, and how, these costs should be shared. Assuming some socialisation of the costs is considered appropriate, the mechanism by which this is done could be designed to sharpen the incentive for consumers to invest, or to ensure the burden falls equitably on different parts of society. Possible alternatives are outlined in **Table 1.**

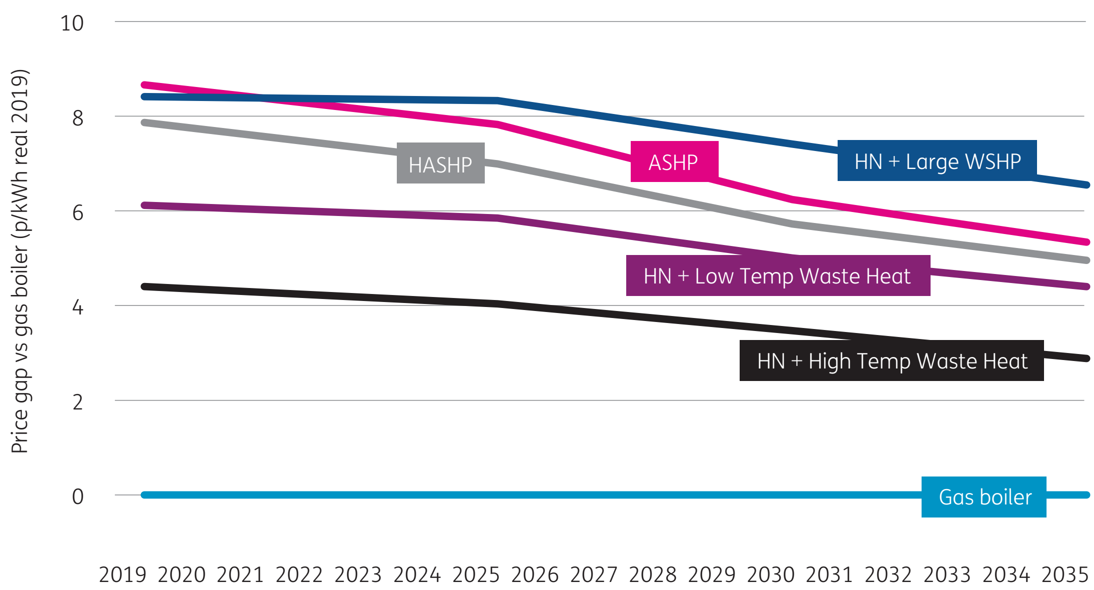
Table 1: Alternative means of recovering building decarbonisation costs

Policy cost recovery	Commentary
Gas bills	Sharpens incentive to invest in efficiency and low carbon heat, but burdens fuel poor households, and the taxable base will diminish as gas use decreases. Additionally, not all homes are gas connected
General tax	Cost distribution more closely linked to income, but no signal to reduce gas use
Council tax	Some linkage to building size and allows for locational flexibility, but no signal to reduce gas use (unless EPC linkage introduced)

Test case: heat networks

To be successful, a framework must enable deployment of the most complex-to-deliver heat infrastructure required for decarbonisation. A relevant test case therefore is heat networks, for which the Government has substantial ambitions. The Clean Growth Strategy calls for 17% of domestic heat to be delivered this way in the UK in 2050, up from approximately 2% currently. Heat networks are likely to be the cheapest solution in areas with high heat density, especially if anchor loads and waste heat is available, and the costs of installing the network can be minimised. This is illustrated in **Figure 4** which plots the *premium* to the cost of gas heating for various low carbon alternatives in an urban location, for a building with relatively high heat demand.

Figure 4: Comparison of cost of delivered heat for a low efficiency urban flat



A framework that delivers the ambition for heat networks will need to address the following areas.

- *Location:* there are defined geographic areas where heat networks offer the least cost low carbon solution. If heat networks are to be successfully deployed, these areas must be delineated and project sponsors given protected rights within them.

- *Coordination:* for heat networks to take advantage of the opportunity to minimise infrastructure and spread costs widely in these areas, there must be capacity for coordination to maximise the proportion of local heat load connecting to the network.

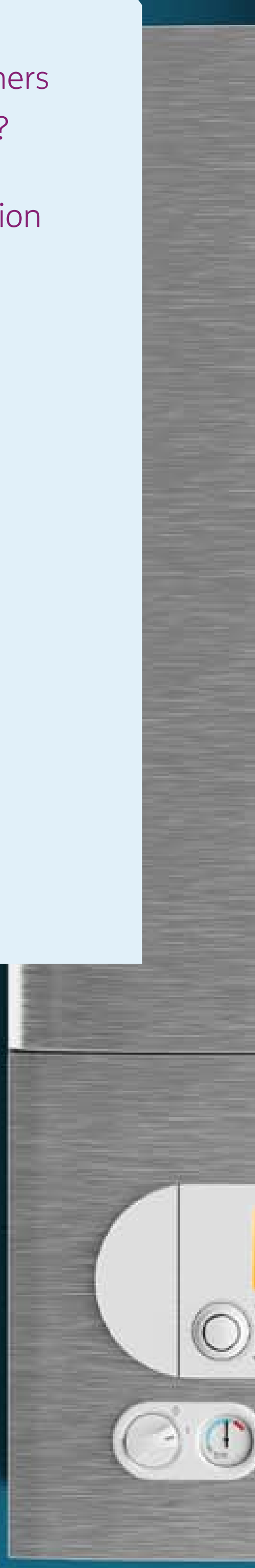
- *Cost of capital:* cost of capital is disproportionately impactful for heat networks, given their very high proportion of capital costs. A 1% reduction in the post-tax real cost of capital can reduce the cost of the delivered heat by 1 p/kWh. It is notable that the regulatory framework for networks carrying electricity and gas in Great Britain effectively isolates them from variation in the volume of energy they are required to deliver, allowing them to attract a regulatory rate of return. Networks carrying heat do not enjoy this benefit, and so investors require a higher rate of return for the additional risk exposure.

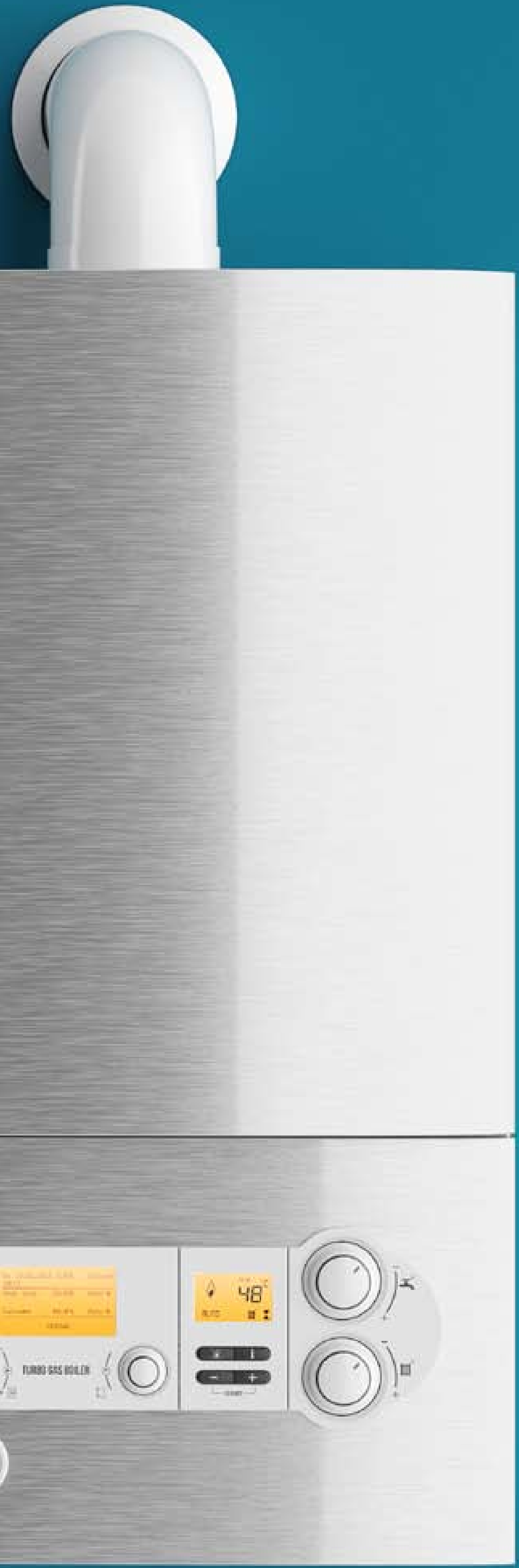
A mechanism that can deliver these objectives is heat zoning. Under this arrangement, a local authority identifies a specific area with high potential for heat network development, and exclusive rights are awarded to an operator to develop a heat network in that area within a certain timeframe. Additionally, there may be some obligation on heat users within the area to connect, subject to certain conditions. This enables the operator to reduce uncertainty in demand and hence cost of capital, and discourages heat users within the zone from investing in individual solutions which would undermine the case for the network.

Conclusion

Decarbonising Britain's building stock will be a challenge. Unlike decarbonising electricity, policy must convince millions of householders to invest (or at least engage), rather than hundreds of power generation businesses. Unlike decarbonising transport, building efficiency and low carbon heat cannot rely on objects of aspiration, like stylish electric sports cars, to inspire those householders. In all likelihood, decarbonising heat will need to be heavily policy led, and require a level of mobilisation comparable to the switch to North Sea gas in the 1970s, or the ongoing roll out of smart meters. Policy in this area is, however, notoriously hard to get right, as the faltering achievements of innovative measures like the RHI and the Green Deal demonstrate. Careful consultation, analysis and planning will be necessary, but also boldness. In particular, where areas are identified in which a coordinated approach to heat decarbonisation is the optimal solution, there is likely to be a strong economic case for policy to enable a more co-ordinated approach than has been considered to date. The key questions policy developers will need to consider at this stage are as follows:

- How do we engage consumers in building decarbonisation?
- How will heat decarbonisation be funded?
- How is consumer choice reconciled with efficient outcomes?
- How are coordinated solutions delivered?





Glossary

ASHP Air Source Heat Pump

CHP Combined Heat and Power

Coordinated solution an approach to heat decarbonisation that requires coordination of decision making beyond individual householders (e.g. heat networks or re-purposing of gas grids for hydrogen distribution)

GSHP Ground Source Heat Pump

HASHP Hybrid Air Source Heat Pump (an Air Source Heat Pump combined with a boiler for provision of peak heat demand)

HIU Heat Interface Unit (in-home unit to transfer heat from a heat network to a central heating system)

HN Heat Network

Individual solution an approach to heat decarbonisation that can be enacted at the individual household level (e.g. an individual heat pump)

WSHP Water Source Heat Pump

For further information,
please contact:

Ryan Thomson,
Partner
+44 7711 576 595
ryan.thomson@baringa.com

James Greenleaf,
Director
+44 7949 044 020
james.greenleaf@baringa.com

About Baringa

Baringa Partners is an independent business and technology consultancy. We help businesses run more effectively, navigate industry shifts and reach new markets. We use our industry insights, ideas and pragmatism to help each client improve their business. Collaboration is central to our strategy and culture ensuring we attract the brightest and the best. And it's why clients love working with us.

Baringa launched in 2000 and now has over 700 members of staff and more than 65 partners across our five practice areas of Energy and Resources, Financial Services, Products and Services, and Government and Public Sector. These practices are supported by cross-sector teams focused on Customer & Digital; Finance, Risk and Compliance; People Excellence; Supply Chain and Procurement; Data, Analytics and AI; Intelligent Automation and Operations Excellence; and Technology Transformation. We operate globally and have offices in the UK, Germany, Australia, US, and the Middle East.

Baringa Partners have been voted as the leading management consulting firm for the second year in the Financial Times' UK Leading Management Consultants in the category energy, utilities and the environment. We have been in the Top 10 for the last 10 years in the small, medium, as well as large category in the UK Best Workplaces™ list by Great Place to Work®. We are a Top 50 for Women employer, and are recognised by Best Employers for Race.

Baringa
Brighter together

We'd love to hear from you

enquiries@baringa.com

Headquarters: London (UK) | Belgium | Ireland | Germany | Australia | Singapore | UAE | USA |

in association with Vattenfall

Vattenfall is a leading European energy company, which for more than 100 years has electrified industries, supplied energy to people's homes and modernised our way of living through innovation and cooperation. We now want to make fossil-free living possible within one generation. That's why we are driving the transition to a sustainable energy system through initiatives in renewable production and climate smart energy solutions for our customers. We employ approximately 20,000 people and have operations mainly in Sweden, Germany, the Netherlands, Denmark, the UK and Finland. Vattenfall is owned by the Swedish state.

VATTENFALL