HEAT INVESTMENT IN THE UK

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CATAPULT Energy Systems

THRIVE RENEWABLES

EXECUTIVE SUMMARY

Heat accounts for over 45% of UK's energy consumption, with gas as the predominant fuel and is responsible for a third of UK's greenhouse gas emissions. It is therefore imperative to decarbonize heat for UK to achieve its Climate Change target of 80% emissions reduction by 2050.

Heat Networks are an energy efficient and cost efficient way to decarbonize heat, especially in areas of concentrated demand i.e. densely populated and mixed use areas (commercial, industrial, public and residential) such as urban centres.

In the UK, only 2% of heat is currently supplied by heat networks however the government, in its 2015 autumn review announced £320m capital allocation to the Heat Networks Investment Programme (HNIP) over the next 5 years. This is expected to support UK's development of heat networks, to provide impetus to necessary innovation and to leverage an additional capital investment of around £2bn into the sector over the next 10 years.

Heat Networks usually require significant upfront investment and the larger networks tend to be developed in phases. Typical upfront capital expenditure (capex) requirements in the UK are £4-40m. Projected customer demand over the lifetime of the network is key to its commercial and financial viability and it is desirable that core demand is secured in the early stages via long term contracts with aggregators or anchor loads. Historically, heat networks supplied by gas fired CHPs have seen nominal returns of 6-9%.

For much of Northern Europe, heat networks are the norm, however it is still in early growth stage in the UK. Projects are available across the full range of commercial complexity in the UK, across various development phases and with bespoke financial structures. Investors need to evaluate projects on size, security of demand and supply, counterparty risks, development phase, technology performance and potential scope of expansion to deploy capital in networks that closely match their risk profile.

Heat Networks are an excellent investment opportunity for investors looking for alternatives outside traditional renewable generation. We have put together this paper to highlight the scope and potential of this opportunity and request for your feedback, your thoughts and questions that you may have on the 'Heat Networks Opportunity' after reading this paper.

HEAT, ENERGY DECARBONISATION AND HEAT NETWORKS

Heating and hot water account for over 80% of domestic and just under 60% of non-domestic energy consumption, making heat decarbonsiation extremely important for UK to meet its legally binding carbon reduction target set in the Climate Change Act, as well as to deliver on the commitments made in the Paris Agreement.

Nearly 70% of current heating comes from natural gas and for UK to achieve its low carbon targets requires a dual focus on overall greater energy efficiency and the use of heat networks.

Heat Networks or District Heating distribute heat generated in a centralized location to nearby homes, public buildings and businesses for heating requirements. The heat for such networks often comes from cogeneration plants (by capturing the heat emitted during electricity generation) but can also be obtained from renewable sources e.g. geothermal heating, central solar heating or biomass; from waste energy e.g. recovered from factory or infrastructure, from waste plants; or from dedicated generation e.g. heat-only boiler and heat pumps.

Well designed and operated heat networks can deliver both lower carbon heat and lower bills for consumers as compared to traditional unit-level heating solutions by reducing wastage and through more efficient generation. A typical CHP is more efficient than generating heat and power separately in boilers and central power stations and has a potential of reducing fuel consumption by 30%. Heat pumps have shown up to 80% decrease in carbon intensity against the counterfactual (gas boilers) in controlled studies.

Reference: Heat Networks Investment Project Consultation, BEIS 2016; RHI: A reformed and focused scheme, DECC 2016; Investing in UK heat infrastructure, DECC 2015; “The Future of Heating: Meeting the challenge”, DECC 2013 , News from DBDH

In a 2013 report, the engineers Buro Happold found that there is enough heat wasted in London alone to meet 70% of the city's heating needs if the wasted heat was instead redirected into district heating. Heat networks facilitate greater carbon reductions over time as the networks expand and thence new renewable and lower carbon generation heat centres can be added as well as replacing aging heat sources along the network.

Heat Networks are used extensively in continental Europe, especially northern Europe, where 60% of the Danish population is connected to district heating networks. In the UK, there are a few district heating systems some of them having survived since the 1980s with over 2,000 heat networks across cities such as Sheffield, Nottingham, Coventry, Southampton and Birmingham and in many London boroughs; some them operating for over 50 years.

However, this accounts for only about 2% heat supplied in the country. In order for the UK to meet its carbon objectives cost effectively, DECC (now part of BEIS) has estimated that between 14% and 43% of heat demand could be supplied by efficient heat networks by 2050, whilst analysis for the Committee on Climate Change's (CCC) Fifth Carbon Budget Report modelled heat networks serving 18% (81 TWh) of building's heat demand in 2050.

INVESTING IN HEAT NETWORKS

Investment Environment in the UK

The UK has a long way to go to fully exploit the potential of heat networks. The networks that have been built to date have been funded largely by public sector sponsors e.g. local authorities and private sector owner-operators trying to meet energy efficiency targets on new-builds. To achieve the desired scale and the build rates needed to realise heat network's carbon reduction contribution, a greater diversity and breadth of investors is key.

In November 2011, the Renewable Heat Incentive (RHI) was introduced to support businesses, public bodies and charities transitioning from conventional forms of heating to renewable heat generation. This scheme was extended to households

in April 2014. The scheme was launched to help deliver UK's 2020 renewable energy targets and in November 2015, the Government confirmed a continued budget for the RHI with expected spend rising from £430m in 2015/16 to £1.15bn in 2020/21.

DECC has further taken steps to facilitate the development of heat networks in UK. It established the Heat Network Delivery Unit in September 2013 to provide grant funding and guidance to England and Wales local authorities looking to develop heat network schemes. Since its inception, HNDU has already assisted over 200 projects across 131 local authorities including £14m of grant funding to end of 2016.

In addition, the Government in 2015 Autumn statement announced £320m of capital funding to support investment in heat networks over the next 5 years under the HNIP. This capital will be deployed towards the construction costs of heat networks to increase build rate momentum, influence the types of heat networks built and also seek to encourage the necessary innovation in the sector. HNIP expects to leverage this funding for up to £2bn of additional capital investment over the next 10 years and stimulate a self-sustaining heat networks market. A £39m pilot for HNIP was further launched in November 2016, targeted at local authorities and other public sector bodies.

Investment Considerations

District Heating projects are in essence infrastructure projects in that they require significant upfront investment. The characteristics of individual projects vary however overall project viability depends on availability of heat customers and securing long term revenue streams underpinned by long term demand and the potential for growth and expansion. Historic unlevered IRR for CHP supplied heat networks have been in the range of 6-9%.

A strategic way to approach district heating projects is to build them out in phases, securing demand for built networks before further investments. Typical upfront capex for heat networks in the UK range from £4-40m, falling closer to the lower end of the range for early investments.

Heat networks are likely to have greater feasibility in denser urban areas where the complimentary consumption patterns of domestic, commercial, public service

and leisure buildings are balanced across the day and across the week. Such a setup is ideal for ensuring reliable / guaranteed demand i.e. anchor load.

Alternatively anchor loads can also come from industrial estates, hospitals, large care homes or demand aggregators such as local authorities, social landlords, property managers of multi-tenanted properties. The contribution of the anchor load depends on the respective size of the network and such an arrangement minimises the counterparty risk exposure usually associated with individual domestic customers, which are less common in the UK.

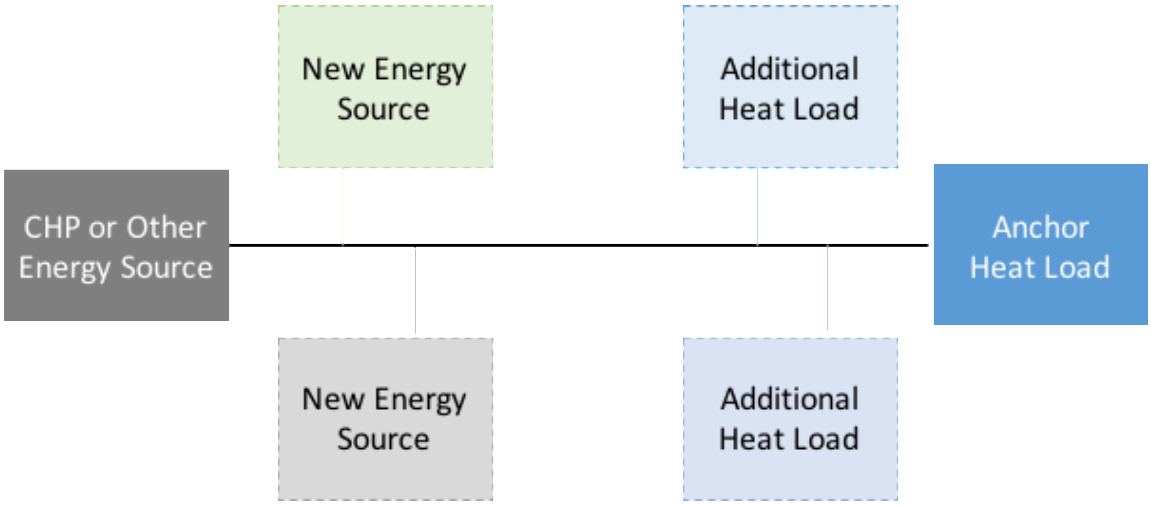

Diagram 1: Typical structure of heat network. The procurement of Anchor Load is key to the initial viability of the project. New Heat Loads and Energy Sources can be subsequently added during expansion.

Heat Networks will tie in their anchor load customers into long term offtake contracts, usually over 20 years, to reflect the long life of the network assets. Customer tariffs are typically structured as fixed + variable. The fixed charge recovers the capex from the consumer over the life of the asset whereas the variable charge is based on the actual heat consumption of the customer and is set based on the energy costs and transportation charges. The variable element is important to moderate consumption and motivate consumers to avoid waste.

Investors more familiar with renewable generation projects should observe the following key differences when evaluating investment into heat networks

	Renewable Generation	Heat Networks
Demand variance	Demand for power is secured by long term offtake contracts with the energy suppliers.	Demand needs to be secured for project viability through local anchor loads, via long term offtake contracts. Standardisation is difficult because of relatively local nature of heat networks and bespoke commercial arrangements.
Generation Technology	Wind, Solar PV, Small Hydro – proven technologies with continued progress in productivity and cost competitiveness	Heat Centres, such as CHP, help reduce overall carbon footprint but still depend on fossil fuels. Newer technologies such as heat pumps and waste heat collection still to catch-up on cost competitiveness However, depending on location and demand structures, there are options to connect to renewable generation
Fuel risk	Abundant natural energy source (wind, sunlight, rainfall) –project design incorporates feasibility assessment, energy yield and variability	Several current projects have fuel based energy centres (usually CHP). Hence fuel supply need to be hedged through long term contracts or/and heat costs indexed to fuel costs.
Counterparty risk	Nationwide market, accessible via distribution and national grid. Offtakers are typically investment grade grids and industries.	Heat Networks can have many local counterparties, of all sizes, not all of whom may be credit rated. Hence important to understand both long term viability and credit risk of counterparties, especially anchor loads, primary fuel suppliers and network providers.
Development risks	Renewable generation projects largely concentrated in low-density areas, minimises disruption during construction however land access can create objections for onshore projects	Projects more suited to high-density locations, hence also having greater disruption impacts. Heat Network projects thus have high exposure to conflicting land use, risk of local objections and NIMBY. Early buy-in from consumers and integration into

		local development plans can help minimize disruption.
Procurement rules	Primarily private sector led development	Considering Local Authorities are key champions, network investment and development contracts subject to public procurement rules
Financing	Projects utilising proven technologies with long term warranted performance, and investment grade counterparties under long term agreement can access non-recourse project finance for up to 15 years. An active secondary market allows exit route for developers	Commercial financing of heat projects still in early stages – availability, size, duration and structure will depend on securing heat demand, credit quality of counterparties and governance and ownership structures. Lack of active secondary markets

District heating is largely unregulated in the UK hence DECC established the Heat Trust in November 2015 to provide common standards and some protection for domestic end-user customers. As the industry grows and gains momentum, it could eventually also benefit from the introduction of new regulation to improve customer protection, supply competition, facilitate project development and reduce both capital costs and the cost of capital.

Investment Optionality and Structures

Heat Networks vary greatly in commercial complexity from the simplest single entity generator, supplier, customer and land owner (e.g. hospitals, universities) to complex citywide networks with multiple heat sources owned by third parties and multiple public and private customers, some of whom may also double as suppliers. The ownership across these projects can vary across local authorities, private developers or be held under a joint public/ private ownership model.

There are a range of finance options available to investors. Projects can be funded by equity, debt or mezzanine finance. Separately, financing could be on balance sheet corporate finance, or non-recourse project finance backed by underlying project only. The specific mix of financial product, and how it gets structured

depends on the size and complexity of the project, future expansion options as well as parties involved.

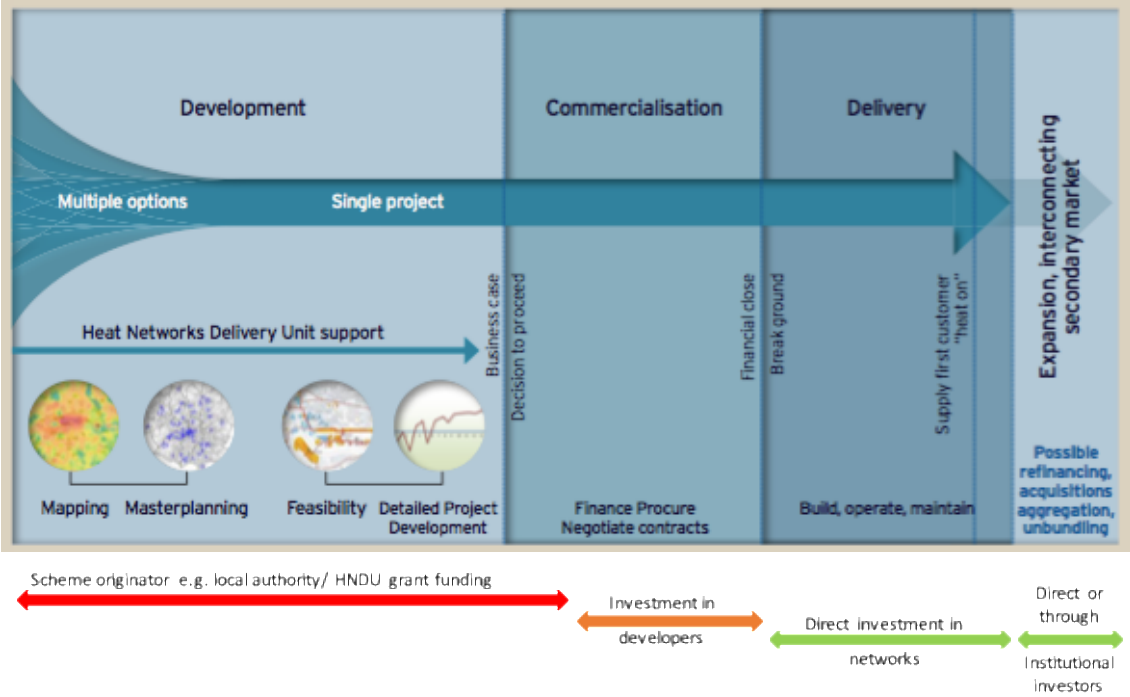

Diagram 2: Heat Networks: Development to Delivery; Source: HNIP Consultation, BEIS

Investors will also have to consider the stage of development at which they would like to participate in projects. Investors with higher risk appetite and looking for higher margins can participate as developers or in the commercialization phase, partnering with local authorities and project sponsors where necessary. A relatively low risk option would be direct equity or debt participations at the delivery stage. Investors with lower risk appetite, looking for long term predictable cashflows would be further suited to secondary market purchases either investing through or alongside institutional investors once demand profile and contractual structures underlying them have been delivered.

In the context of investment in heat networks, Thrive Renewables' risk and return profile fits best with commercialization and delivery phases. When considering a 'new'[1] asset class Thrive Renewables would aim to work with competent parties with the technical, commercial and operational experience required to successfully deliver the project, through the construction and operational phase. Direct

[1] Thrive Renewables has invested in, constructed and operated renewable electricity generation projects to date.

investment of equity and mezzanine debt would be considered. Thrive Renewables requires a clear case of environmental additionality. This being demonstrated by the greenhouse gas emission reductions achieved through efficiency gains and switching to sustainable heat sources. We can also see the opportunity for social impact, where projects deliver higher quality and competitively priced heat to social housing, schools, care homes and hospitals.

Interest and Feedback

Thrive Renewables mission is to provide individuals with a rewarding stake in a cleaner, smarter energy system. In addition to renewable electricity generation Thrive Renewables is evaluating Heat Networks as an investment opportunity. Through this paper, we have tried to outline the 'Heat Networks Opportunity', its characteristics and considerations and investment options. We see the case for Heat Networks contributing to a more efficient energy system, however we are also conscious of the risks associated with heat network projects, specifically the commercial risks associated with the counterparty risk (mentioned above).

We believe there are ways to mitigate the risks associated with investments into heat networks. We can see the environmental benefit of improving the heat generation and delivery and the potential for a distributed system to be operated in a smarter way. As part of a movement towards a more diversified portfolio, where we are considering solar PV, hydro, storage and demand side management we are also considering heat networks as a means of contributing to a more sustainable energy system. Most attractive to us are heat network projects which incorporate sustainable heat sources, such as geothermal, ground source, biogas or waste to energy. There is a strong case also for CHP where the efficiency gains are enhanced further. In addition to the environmental benefit, the ability to deliver social impact, by alleviating fuel poverty, managing energy costs to social clients such as social housing, health care, or costs to industry, contributing to the viability of local employment is most desirable.

Our strategy is to continue to invest in renewable electricity generation. We are also considering sustainable heat network investments as part of our wider diversification planning. We welcome your feedback on investment into sustainable heat networks.

The Energy Systems Catapult is one of a network of elite technology and innovation centres set up by Innovate UK. The Catapult works with companies that are focused on exploiting the opportunities created by the need to transform global energy systems; not only playing a part in accelerating technology based solutions, but also engaging with Government to address the market mechanisms and business models that will be required to enable such solutions.

The Energy Systems Catapult will create a critical mass for business and research innovation, focusing on electricity, heat and combustible gases. The Catapult's mission is to bring the worlds of industry, academia and Government together, playing an important part in UK's innovation system and making a major long-term contribution to UK economic growth. It is a non-profit, non-partisan company limited by guarantee.

Thrive Renewables plc is a longstanding renewable energy company owned by a community of 5600 shareholders. The Company has built and now operates a portfolio of fifteen onshore wind farms and one hydroelectric project, generating sufficient renewable electricity annually to meet the needs of over 40,000 UK homes.

Thrive Renewables exists to provide an efficient and rewarding financial connection with sustainable energy, uniting shareholders in direct investment into a cleaner, smarter energy system.

Thrive Renewables plc is the new name for Triodos Renewables plc. Thrive Renewables is the trading name of Thrive Renewables plc, Registered in England & Wales, Registered office: Deanery Road, Bristol, BS1 5AS (registered number 2978651).