Gateshead District Energy Scheme

The Gateshead District Energy Scheme is an award winning project owned by Gateshead Council which supplies heat and electricity to consumers from gas-fired Combined Heat and Power (CHP) engines. It connects to public buildings via a heat network and also a network of private wires, and provides heat only to council and social housing. The project also includes a 250,000-litre hot water thermal storage facility and a 3MW battery. It is innovative in the sense that it stacks revenues and trials new products, such as plastic heat network pipes.

We selected this project because of its district heating and private wires elements. It is ambitious both in terms of scale and in ambition to add battery storage and thermal storage at scale. It is also an early example of accessing multiple revenue streams ("revenue stacking"), in this case through the CM and frequency response. The project also has a strong element of urban redevelopment associated with it.

1. Summary

The Gateshead District Energy Scheme utilises two 2MW gas CHP engines to supply heat and electricity to public buildings in Gateshead. Heat and power are supplied to consumers via heat and private wire networks, offering the services at 10% and 5% discounts on grid prices. It also incorporates a 250,000-litre hot water thermal storage facility and a 3MW battery, which were installed and are managed by Centrica.

The scheme is financially viable due to the use of private wires installed by Gateshead Council – the scheme owner and funder – and the establishment of a wholly owned Energy Services Company (ESCo) to supply utilities to customers. The scheme stacks revenue by also providing grid services to National Grid and through cost avoidance (e.g. Triad avoidance).

The scheme has the potential to act a blueprint for similar projects across GB although some local conditions are necessary to do so. These include the establishment of an ESCo, purchase of private wires and a large enough captive consumer base.

2. Description

Features of the scheme

The Gateshead District Energy Scheme was initiated in 2011 by Gateshead Council with plans and scoping completed in partnership with WSP I Parson Brinckerhoff Ltd, a district energy consultancy.

The scheme is based on two 2MW gas fired Combined Heat and Power engines located on Quarryfield Road in the Baltic business quarter, known as the Gateshead Energy Centre. The gas-fired CHP generates electricity and waste heat in a process around twice as efficient as a conventional power station. There is also 7.5MW of gas boilers, to provide backup to the main engines.

Connected to the engines are 3km of district heating pipes and high-voltage private wire networks which provide low cost heat and electricity to a range of public buildings, including the Gateshead Civic Centre, the Sage Gateshead, BALTIC and Gateshead College as well as homes managed by the Gateshead Housing Company (350 social housing customers).

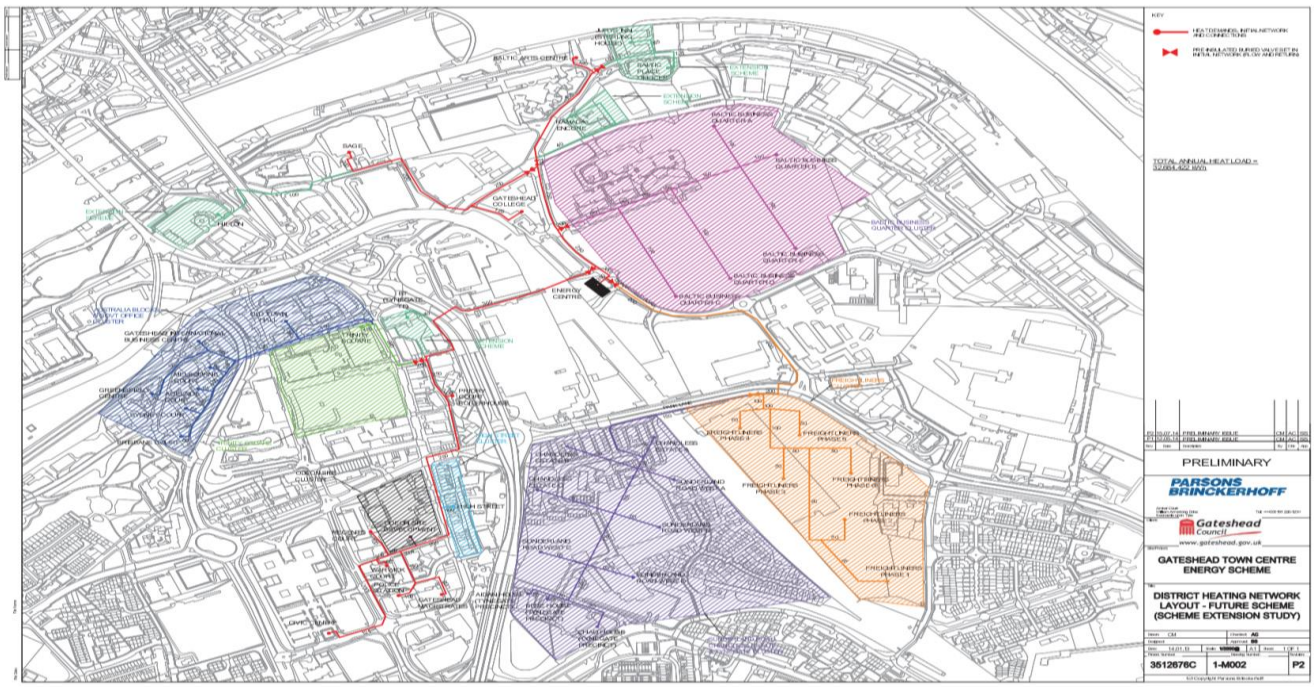
The project is owned and funded by Gateshead Council, with initial investment of £18mn. The Gateshead Energy Centre opened in March 2017. The CHPs are operated as "heat-led" for the majority of the time, but the thermal storage unit allows it to run as "power"-led during winter peak periods. This means that the CHPs usually run to produce heat as-need to meet heating demand (heat-led), but sometimes run to produce power when it is especially valuable, with excess heat being stored (power-led).

Gateshead District Energy Centre

Source: CK21

A map showing the scale of the scheme, which connects the town centre with Gateshead Quays can be seen below, which also shows the masterplan for potential expansion of the scheme to further neighbourhoods.

A map of the Gateshead District Energy Scheme and potential areas for expansion



Source: Gateshead District Energy Scheme

NB – Areas marked in red lines and blue-green hatching are already connected, other coloured areas are under consideration for expansion of the network

100% renewable electricity is imported into the private wires from the scheme's own grid connection when the CHP engines are not running or when demand is greater than supply. This safety net makes the scheme resilient, potentially more so than a conventional building with a gas boiler and electricity grid connection. It also saves on some network costs as less of the public networks are being used to deliver power (though this must be set against the cost of the private wires themselves).

From the initial development, the network has been extended twice – the second 1.5km extension coming after a £0.9mn grant from the European Regional Development Fund (ERDF) – to include a 3MW battery storage facility, and there is a 250,000-litre hot water thermal storage facility at the main energy centre. This last feature allows the 10MWe thermal load to be supplied by the 4MWe CHP engines, reducing the cost of investment and demonstrating the scheme's flexibility.

The 3MW/ 3MWh battery storage facility was installed by Centrica. It can respond to demand fluctuations in under a second, using this capacity to deliver a frequency response contract with National Grid. Centrica will manage the battery under a 10-year contract to provide these flexibility services. The site was also awarded a 15-year Capacity Market contract, at a clearing price of £18/kW in the 2015 T-4 auction. This was brokered through aggregator Flexitricity, and pays the Council £60,000 per year.

The Gateshead District Energy Scheme has developed into a major infrastructure project that will underpin the future redevelopment of the town centre while stimulating investment and job creation and offering the Council a trading opportunity to improve its financial position.

Why is the Gateshead District Energy Scheme unique?

Gateshead Council won the Visionary Project Award from the Association of Decentralised Energy (ADE). This award is given to projects that seek to change the energy industry for the future. One unique feature that contributed to the award was the fact that it provides peak power generation to help balance the grid though a combination battery storage and CHP with heat storage.

It also offers significant technical impacts including carbon emission reductions of between 2,900-6,100 tonnes per year (dependent on how the scheme develops and expands in the future). Customers are also guaranteed cost discounts, starting from 10% on heat costs and 5% on electricity costs.

- Innovation has been critical to the scheme. Specifically, the use of private wires has made the initiative commercially viable. This was achieved through the purchase of high-voltage assets from the DNO to enable the connection of the private wire network to existing buildings. This has in turn opened up opportunities to replicate the blueprint across the UK

With heat rejection plant and controls, the 4MW CHP engines can provide peak power generation, participate in Grid Services (e.g. STOR), and have enabled the scheme to win a 15 year Capacity Market contract, supported by Flexitricity. The addition of a 3MW battery has also allowed the scheme to provide peak power and triad avoidance as well as frequency response to the grid via Centrica.

To reduce disruption and time of heat network installation, the Council has secured £0.9m EU grant, to install the UK's first plastic district heating trial, that can replicate temperatures and pressures of a steel system, aiming to stimulate a new supply chain, which could revolutionise heat network construction.

- Overall, the Gateshead scheme has set a benchmark for what can be achieved through direct generation and distribution of heat and electricity. This shown through the use of private wires, new commercial models with DNOs and the commercial viability of decentralised energy.

Project enablers – clear objectives, benefits and local buy-in

The primary driving force behind the initiative is Gateshead Council, which has outlined a number of objectives for the district energy scheme. They are as follows:

- To provide low cost heat and power to existing homes, organisations and businesses in the urban core of Gateshead, reducing their running costs and improving their competitiveness
- To create business growth in Gateshead, by offering low cost, low carbon heat and power to new commercial development
- To reduce Gateshead's carbon footprint, by providing heat and power with lower the carbon emissions of grid energy supplies; the scheme is expected to reduce carbon emissions by nearly 3,000 tonnes/year in phase 1, up to over 6,000 tonnes/year in phase 3
- To reduce the cost of heating for the public estate, commercial buildings, and fuel poor households

The project has been enabled by the set of clear and agreed project needs. These include the realisation that energy efficiency measures could reduce building costs and carbon emissions no further, highlighting the need for a larger scale low-carbon energy generation scheme. Developers were also found to be constrained in providing sustainable, low-carbon development, due to low land values in the area and construction cost premiums.

Gateshead Council has also aimed to make it cheaper for developers to build low carbon developments. Budgetary pressures have pushed the Council to seek new investment opportunities to deliver revenues to support front-line services. Local generation and supply through an Energy Services Company (ESCo) offered an opportunity to retain revenue from heat and energy sales.

A significant number of project benefits were identified and articulated by the Council to developers with regards to connecting to the district energy scheme, these include:

- Cheaper connection construction costs than conventional utilities plus heat plant, as well as allowing developers to meet building regulations, Code for Sustainable Homes, BREEAM and Zero Carbon Homes standards more cost-effectively
    - Buildings also avoid ongoing heat and plant maintenance, servicing and replacement costs. This ties in with the higher resilience of the heat and energy network system
- Reduced plant space requirements in developments allows greater lettable floor area
- Reduced heating and power costs for building occupants, of at least 5% and potentially more, compared to prevailing market rates of heat and power costs
- Flexible energy supply contracts, offering dual fuel, heat only or power only connections
- Through the process of public engagement and clear communication to the project aims and benefits, local consumers have engaged with the scheme as they were able to appreciate the benefits of low-cost, low-carbon heat and energy. The buy-in from the consumers as well as councils, universities and developers have combined to make this a strong location for the scheme.

3. Participants

The table below outlines project participants, their roles and details about their project activities.

Project participants

Gateshead Council	Owner and funder	• Owner and funder having set out initial plans in 2011. Initial investment of £18mn • Objectives are to reduce carbon emissions and energy bills for consumers whilst strengthening its financial position as the project is expected to make an 8% return over a 40 year period
Gateshead Energy Company	Operator and profit making entity	• Gateshead Council established and wholly own the Gateshead Energy Company – an Energy Services Company (ESCo) • Act as the scheme operator and supplies customers with energy and heat
European Regional Development Fund	Funder	• Granted the scheme £0.9mn for a second 1.5km extension as part of the European Structural and Investment Funds Growth Programme 2014-20.
WSP I Parson Brinckerhoff	Consultancy and profit making entity	• District energy consultants - partnered with Gateshead Council in 2011 to perform the early design and procurement work for the energy centre and the wider heat and private wire networks
Balfour Beatty Construction	Construction contractor and profit making entity	• Main contractor for the construction of the scheme
Clancy Dowcra	Construction sub-contractor and profit making entity	• Sub-contractor to construct the underground heat and power network which commenced in January 2016
d3associates	Designer and profit making entity	• Commissioned by Clancy Dowcra to design the underground networks
Edina UK	CHP engine supplier and profit making entity	• Supply, maintain and install MWM CHP engines for 15 year life • Edina will continue to maintain the engines under a long-term service and maintenance contract

Centrica	Supplier and profit making entity	• Installed the 3MW battery storage facility • Centrica will manage the battery under a 10 year contract to provide flexibility services to the grid
Flexitricity	Aggregator and profit making entity	• Brokered a deal for the site for a 15-year Capacity Market contract at a clearing price of £18/kW in the 2015 t-4 auction, yielding £60,000 per year.

Source: Pixie Energy

4. Financials

The main funder is Gateshead Council which invested £18mn in the scheme under phase 1. The project has received £0.9mn in grants from the England European Regional Development Fund (ERDF) as part of the European Structural and Investment Funds Growth Programme 2014-20. No other grants or subsidies have been received.

- The project has a 40 year lifespan, with total investment to reach £25mn by phase 3. Investments were £18mn for phase 1, which included the Energy Centre and initial connections; £3.5mn for phase 2 and £1mn for phase 3, which are extensions of the network. The battery storage unit cost £2.5mn.
- Project payback is expected 16-17 years after commissioning. Energy is sold at a discount of 5% and heat at 10%; around 5% heat losses in the network are expected. The projected rate of return is 8% over 40 years. However, the network is estimated to have a 50-100 year lifespan, giving rise to future possibility of replacing carbon-emitting CHP engines with low-carbon technologies.

There are a number of revenue streams in this project. The ESCo established by Gateshead Council earns money through the sale of heat and power to consumers. The 4MW CHP engines are also used to participate in grid services (e.g. STOR) and enable the scheme to participate in the 2015 T-4 Capacity Market auction where Flexitricity successfully secured a 15 year contract at a clearing price of £18/kW yielding £60,000/ year.

The engines also avoid costs by enabling Triad avoidance. Centrica manages the 3MW battery which has a 10 year contract to provide flexibility services to National Grid. Overall, the Gateshead scheme can arguably be said to have a revenue stack.

Key metrics under the Gateshead District Energy Network

Energy type	Phase 1 (2017-18) (GWh/year)	Phase 2 (20118-19) (GWh/year)	Phase 3 (2019-20) (GWh/year)
Heat	11.1	15.5	21.6
Electricity	13.7	14.0	19.6
CHP heat output	11.0	15.3	20.9
CHP electricity output	10.9	14.4	19.6
Gas boiler heat output	0.7	1.0	1.8

5. Replicability

The project has been scaled up from its initial development to including an extension to the networks as well a 3MW battery.

The scheme was been designed from outset to expand to meet the energy needs of future developments planned for Gateshead town centre, including commercial developments at Gateshead Quays and Baltic Business Quarter and major housing developments at the former Freightliner site and the new Exemplar Neighbourhood – an area where up to 1,000 new homes are planned.

Other key future milestones are to demonstrate how existing commercial customers can be integrated technically and commercially into heat/power networks. The model will then be tested and proven for new developers, providing a working example of how district energy can actually reduce the development and operating cost on new, low-carbon development. Generation sources will continue to develop and will offer connections to energy generators, as well as consumers, for combined grid connection/ power purchase agreements to electrical generators. There are also discussions to include local biogas producers indicating that this type of project can be flexed to include additional technologies.

Overall, there are a number of requirements needed to make the project work and therefore replicate it:

- Establishment of an Energy Services Company to supply power and the purchase of network assets from the DNO
- Diverse incomes and avoided costs contribute to the stacked revenue of such a scheme and therefore make it commercially viable
- Consumer buy-in through the identification and communication of objectives, needs and benefits
- A safety net to ensure the system is resilient so that consumers have a secure supply of heat and electricity

There is potential for this scheme to act as a blueprint for future energy and heat provision in the UK. Opportunities are likely to be found in most LA areas for heat networks of various sizes, from village upward. Projects with as many elements as this exemplar scheme many be reserved to large municipalities, but as has been demonstrated on the continent, heat networks can be viable in many physical locations and conditions.

6. Future Outlook

Decarbonisation of heat provision will be one of the big carbon-emissions reductions targets over the next decade, and government has not yet clearly set the policy direction. However, one key aspect is likely to be heat networks. While this example is gas-fired and therefore not carbon neutral, a biomass-fired or heat pump based energy centre could provide zero-carbon heat.

Gateshead's large thermal storage tanks and battery make it eminently suitable to conversion to heat pump operation in the future. With a major river nearby, it would also be possible to establish water-source heat pumps to provide additional capacity as the scheme expands. Heat pump technology continues to develop and installation costs are forecast to fall around 5% from 2018 levels by 2020, or 20% by 2030. The learning rate (cost reduction from doubling roll-out) was projected at 35% so costs may fall more sharply if the technology is more widely deployed.

Using renewable fuels and technologies would also give access to RHI subsidies, though it should be noted that these may be available only for the short term, especially if deployment starts to rise sharply. Cutting of renewable energy incentives has already been seen in the FiT scheme.

With network and other third-party charges rising, providing power off the main electricity grids will become increasingly economically viable. This especially applies to “smart” grids which can help their customers to avoid using power at peak charging times. With drivers for businesses to reduce their carbon intensity also increasing, this reinforces the case for combined heat and power networks.

Discussions around the future of heat network regulation also continue, though again government has not yet set a clear policy direction. However, a heat regulator to protect consumers may be introduced in the next few years; it has been suggested that either Ofgem or a new utilities super-regulator would take on this responsibility. Increased regulatory burden is likely to add operations costs to running a heat network but may also engender additional consumer trust and willingness to connect to a heat network. A clear set of standards and guidelines might also make it easier to develop heat networks and promote deployment.