Appendix D – Plant Strategies

With regards to the Energy Centre strategy, there are 2 main variables that are longlisted. These are;

- The option to supply both peak (the instantaneous maximum heat demand for a given year) and baseload (the more consistent level of heat demand) heat from the LZC plant, or just the baseload, with peak heat supplied by gas boilers.
- The option to have a single energy centre or multiple energy centres.

Peak or Base Load LZC

Heat demand varies significantly throughout the day and between seasons (see box 3 for a graph showing a typical weekly fluctuation in heat demand). In operation there are very few hours in the year when the maximum demand is ever reached.

LZC technologies such as CHP and heat pumps, discussed above, are significantly more expensive to install and maintain than traditional gas boilers. Installing sufficient LZC plant to meet the peak demand would therefore mean high capital outlay, with a large proportion of the plant sitting idle for long periods of time.

Furthermore, LZC plant (apart from an ERF connection) takes up to 3 or 4 times more footprint per unit of heat output (m^2 / kW) compared to a traditional gas boiler.

LZC plant can also be combined with thermal storage to efficiently store heat for long periods of time (several hours). This allows;

- LZC to operate at full output (which is typically more efficient) even when demand is low, as the surplus heat produced goes into storage rather than to the instantaneous demand.
- LZC to operate for prolonged periods of time, as it enables LZC plant to be able to operate even when the demand is below the minimum output.
- Additional short-term LZC capacity as the thermal store can be discharged in addition to LZC operation.

Thermal storage is proposed to be installed centrally alongside the other plant items but additional local storage within buildings can be located where space permits to maximise the use of LZC generated heat.

Gas fired boilers can alternatively be used to meet the networks peak demands for heat. The benefits of this design approach are:

- Boilers are significantly cheaper than LZC, both in capital and operational terms, as well as securing all energy needs from the gas grid, ensuring they are relatively resilient. Whilst they impact the carbon savings offered by the heat supply, they provide a cost effective and efficient way of meeting the peak demands for heat.
- Boilers can also be installed in a modular fashion, i.e. in small increments allowing their capacity to meet the demands of the network at the time. This is unlike LZC technology which due to space requirement and expense tends to be installed in larger blocks of capacity.

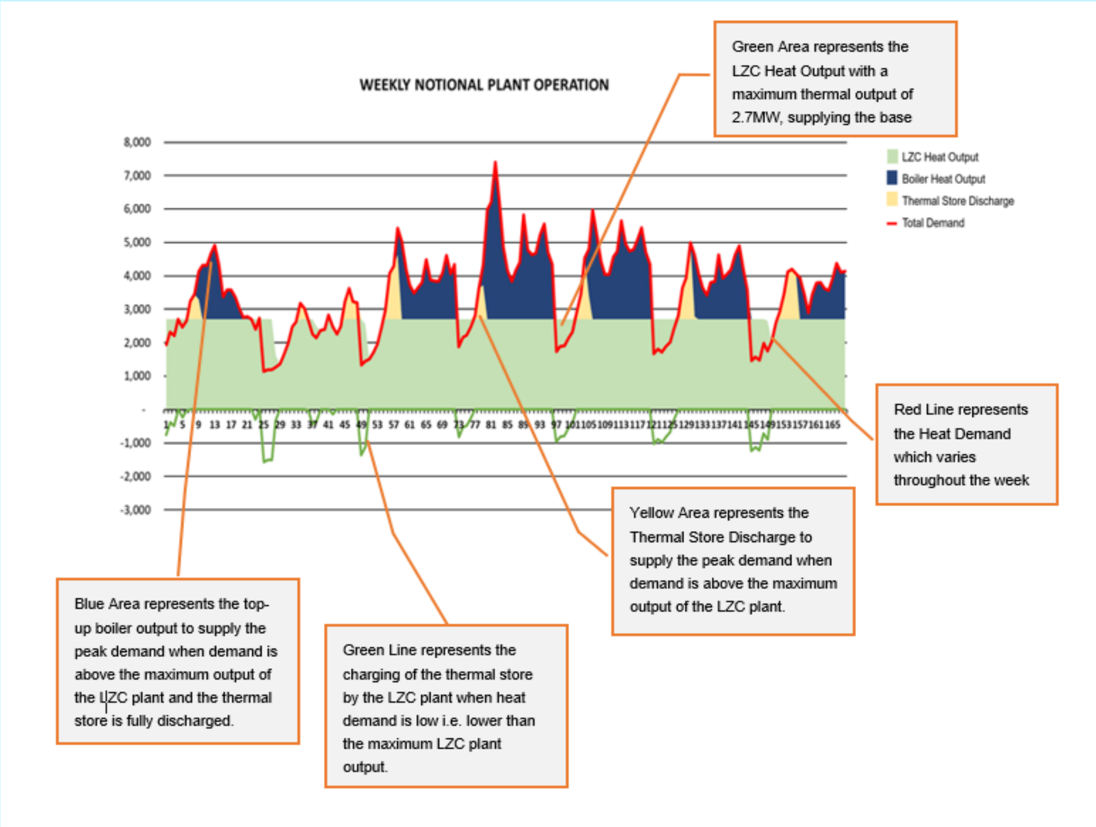
Given the above, the clear strategy from the outset for all LZC technology heat sources will be to balance the size the LZC and thermal storage plant to minimise capital cost whilst ensuring it meets the majority of the heat demand. The remaining peak heat capacity and resilience needs shall be met by gas fired boilers.

Box 4. Technical Background– Heat Demand Variability

Heat demand is highly variable in nature. The graphic below illustrates how a notional plant may operate with a combination of LZC plant, thermal storage and gas boilers.

The profile shown is a typical winter week, and it can be observed that the heat supply follows the demand with the thermal store providing heat in periods of peak demand and delaying the gas boiler activation.

In periods of low heat demand, the heat output from the LZC plant goes to charge the thermal store, when demand rises above the maximum heat output of the LZC technology, the thermal store is discharged. When the thermal store is fully discharged, and demand is still above the maximum output of the LZC the top-up gas boiler is activated.



Number of Energy Centres

Heat generation plant at the district scale (5MW+) is typically installed in dedicated energy centres. These may be standalone buildings or integrated as part of a wider development. There are two primary strategies for arranging these energy centres in a district heating network;

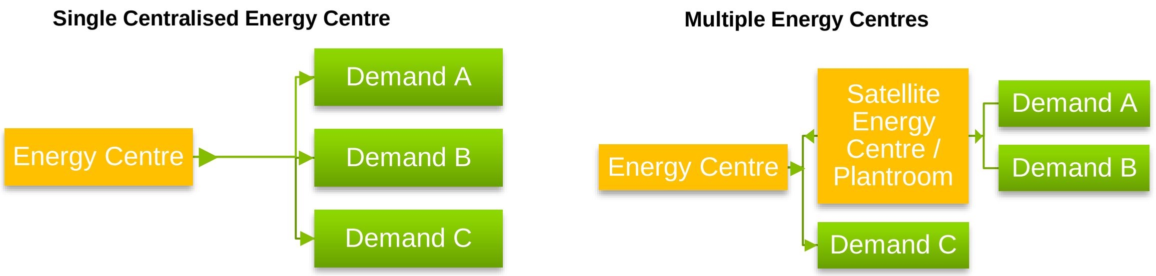


Figure 1: Strategies for arranging heat supply for the network

The table below summarises the relative benefits and disbenefits of the two primary strategies for arranging the heat supply.

Table 1: Single Centralised Energy Centre vs Multiple Energy Centres

Single Centralised energy Centre		Multiple Energy Centres	
Plant to serve the entire network at full build out and is located at a single central location.		Initial energy centre, and pipe to / from it, is sized to serve only a share of the expected full demand, and possibly also the baseload of future phases and demands. In future, satellite energy centres are constructed within or close to the new phase(s) to house plant to meet the additional peak and possibly additional low carbon demand.	
Pros	**Cons**	**Pros**	**Cons**
One single energy centre to construct and maintain, potentially attracting economies of scale. **Single Energy centre to gain planning approval on.** **Greater certainty for later phases as plant space already secured**	Additional upfront capital expenditure for the energy centre building which may not be used for several years (until the scheme is fully built out) A single large energy centre will require a greater footprint and therefore be significantly more difficult to locate with the associated planning costs and risks being higher. The main network spine (pipework) will be larger and more expensive as it needs to be sized to serve the entire scheme from a single point.	Reduced up front capital expenditure due to smaller energy centre building and smaller diameter network pipe than the centralised option. Having more ECs gives us the ability to tap into local low - grade heat sources near the satellite EC's (applicable only to options considering heat pumps as the primary LZC technology)	Number of locations to operate and maintain potentially increasing operational costs. More complex to control with multiple plant in different locations.

Wood Green Energy Centre Strategy

Table Error! No text of specified style in document.**-2: Summary of Plant Shortlisted Strategies**

Heat Supply	**Description**
LZC Source	• **CHP** would be located within the main energy centre and would be installed from the outset of the network. CHP units have a lifetime of around 15 years. Due to space restriction the main energy centre can only house a single CHP unit (capacity up to approx. 3MW). As a result, the energy centre layout design does not allow for a modular expansion of the CHP capacity in accordance with increased energy demands, thus the CHP would either need to be sized to provide the full build out demand from outset of the scheme or a smaller CHP unit could be installed at the start of the scheme and replaced with a large unit after 15 years. • **Heat Pump** would be located within the main energy centre and would be installed from the outset of the network. The Heat Pump unit has an expected lifetime of around 20 years. The energy centre has enough space to accommodate a single Heat Pump unit, if further heat pump capacity is required, this could potentially be installed in energy centre/plantrooms and on rooftops, local to the extended sites. • **EfW** plate heat exchangers would be located within the main energy centre and would be installed from the outset of the network. The plate heat exchanger units have generally a lifetime of 25 years. The energy centre has sufficient space to accommodate the required two plate heat exchangers.
Thermal Store	Thermal Stores are large vessels which store hot water – these maximise the output from the LZC heat source by storing energy when there is low demand. Generally, only the LZC plant is utilised to charge the thermal store. Thermal Stores are commonly located near the LZC plant; however, they can also be placed at other locations on the network. Thermal stores have a narrow aspect ratio, they are usually tall but slim in shape e.g. a 100m³ thermal store is roughly 15m high and 3.5m wide. Due to its large height, thermal stores are often placed outside the energy centre. Placing the thermal stores outside makes installation and maintenance easier, however this approach has more potential to cause visual impacts. For the Wood Green Scheme, it is proposed that 3 50m³ thermal stores are sited within the main Energy Centre – but with option to add local storages if required to maximise the proportion of LZC heat being supplied. The Proposed energy centre area within Clarendon Square provides sufficient height and width to house the stores.
Top-up/Back-up Gas Boilers	District heating schemes are commonly designed with additional generation which provides back-up in case of planned or unplanned maintenance work. In addition, as the LZC heat technologies are sized to supply the base load, the back-up plant also serves as a top-up system in periods of peak demand Natural gas boilers are normally selected as the back-up/top-up plant, this is due to many factors including among others: technology maturity, low cost, low risk, no requirement for fuel storage, ability to modulate to the heat demand and rapid response. Generally, the top-up/back-up plant is installed within the main energy centre near the other plant components, if space is available. However, in some cases the back-up plant is located remotely in so called satellite energy centres e.g. within one or multiple consumers' building plant (please refer to the following section for more information on satellite energy centres). The strategy for the operation remains the same with the LZC plant providing the baseload and the back-up plant supplying the network for any shortfall at the peak period. For the Wood Green Scheme, it is proposed that the back-up plant is located within the main Energy Centre at Clarendon Square, which provides sufficient space to accommodate up to 20 MW of back-up plant, as the network grows and more loads are connected, additional back-up boilers may be required to supplement the main energy centre plant. This can be accommodated within satellite energy centres towards the NE of the site – as required.

Tottenham Hale Energy Centre Strategy

Table Error! No text of specified style in document.**-3: Summary of Plant Shortlisted Strategies**

Heat Supply	Description
LZC Source	• **CHP** would be located either within the main energy centre or outside adjacent to it. If located outdoor, the CHP would be accommodated within a container sited on a dedicated compound. The CHP would be installed from the outset of the network. Due to space restriction, the main energy centre and area around it (if CHP is to be sited outdoor) can only house a single CHP unit (capacity up to approx. 1.7MW). As a result, the energy centre layout design does not allow for a modular expansion of the CHP capacity in accordance with increased energy demands, thus the CHP would either need to be sized to provide the full build out demand from outset of the scheme or a smaller CHP unit could be installed at the start of the scheme and replaced with a large unit after 15 years. • **Heat Pump** would be located either within the main energy centre or outside adjacent to it. If located outdoor, the Heat Pump would be accommodated within a container sited on a dedicated compound. If further heat pump capacity is required, this could potentially be installed in energy centre/plantrooms and on rooftops, local to the extended sites. The Heat pumps are proposed to be installed in a phased manner from the outset of the network. First phase of installation (circa 1,500 kWth), is to serve the core scheme during its build out, 2023 – 2029. A further 2,500kWth to be installed as the scheme builds out, extending into 2030 and onwards. • **EfW** plate heat exchangers would be located within the main energy centre and would be installed from the outset of the network. The plate heat exchanger units have generally a lifetime of 25 years. The energy centre has sufficient space to accommodate the required two plate heat exchangers.
Thermal Store	Thermal Stores are large vessels which store hot water – these maximise the output from the LZC heat source by storing energy when there is low demand. Generally, only the LZC plant is utilised to charge the thermal store. Thermal Stores are commonly located near the LZC plant; however, they can also be placed at other locations on the network. Thermal stores have a narrow aspect ratio, they are usually tall but slim in shape e.g. a 100m³ thermal store is roughly 15m high and 3.5m wide. Due to its large height, thermal stores are often placed outside the energy centre. Placing the thermal stores outside makes installation and maintenance easier, however this approach has more potential to cause visual impacts. For the Tottenham Hales Scheme, it is proposed that 3 x 75m³ thermal stores are sited adjacent to the main Energy Centre – but with option to add local storages if required to maximise the proportion of LZC heat being supplied: • Hale Village; has currently 100m³ of thermal store capacity • Broadwater Farm; has currently 15m³ of thermal store capacity • Retail Park; it is anticipated that approx. 200m³ of thermal store capacity could be installed within the Retail Park Plant room. The proposed area adjacent to the main energy centre provides sufficient height and width to house the stores.
Top-up/Back-up Gas Boilers	District heating schemes are commonly designed with additional generation which provides back-up in case of planned or unplanned maintenance work. In addition, as the LZC heat technologies are sized to supply the base load, the back-up plant also serves as a top-up system in periods of peak demand Natural gas boilers are normally selected as the back-up/top-up plant, this is due to many factors including among others: technology maturity, low cost, low risk, no requirement for fuel storage, ability to modulate to the heat demand and rapid response. Generally, the top-up/back-up plant is installed within the main energy centre near the other plant components, if space is available. However, in some cases the back-up plant is located remotely in so called satellite energy centres e.g. within one or multiple consumers' building plant (please refer to the following section for more information on satellite energy

	centres). The strategy for the operation remains the same with the LZC plant providing the baseload and the back-up plant supplying the network for any shortfall at the peak period. For the Tottenham Hale Scheme, it is proposed that the back-up plant is located within the main Energy Centre, which provides sufficient space to accommodate up to 14 MW of back-up plant, as the network grows and more loads are connected, additional back-up boilers may be required to supplement the main energy centre plant, this can be accommodated within satellite energy centres: • Hale Village; has currently 9MW of boiler capacity installed. • Tottenham Green; has currently 4MW of boiler capacity installed. • Broadwater Farm; has currently 5MW of boiler capacity installed. • Retail Park; it is anticipated that approx. 9MW of boiler capacity could be installed within the Retail Park Plant room.