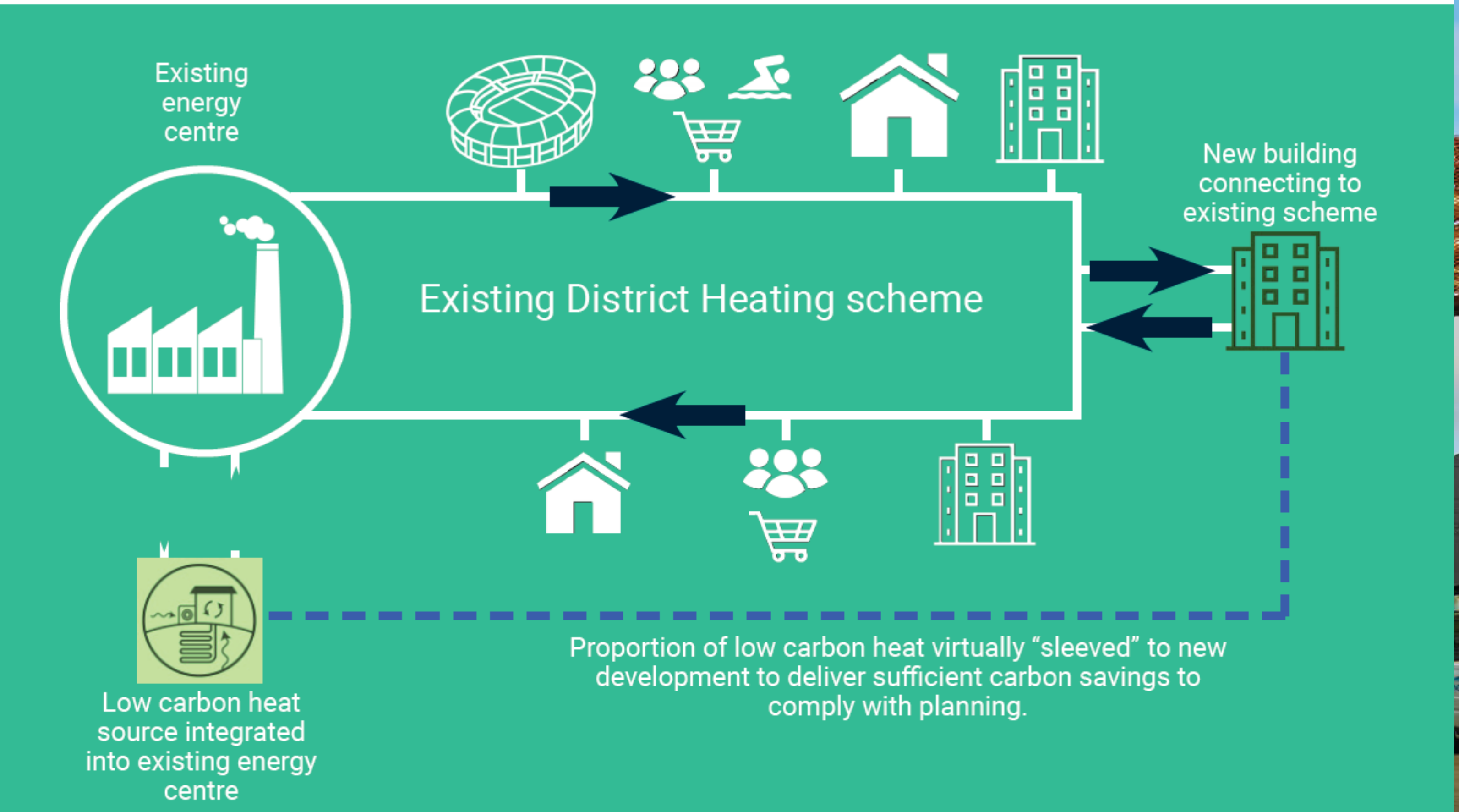
Sleeping 'Low-Carbon Heat'

The principal of 'sleeving' renewable electricity through the electricity network to end users via power purchase agreements is a well-established mechanism for connecting customers to renewable energy production at least cost. It enables end users to report carbon savings associated with the use of renewable electricity and meet carbon reduction targets (see also above for green gas supply). Adopting a similar approach to 'sleeving' low-carbon heat through a heat network would maximise the potential of new low or zero carbon technology added into an existing network and reduce the cost of transition.

For example, a single large heat pump could be installed in an existing energy centre instead of new individual building-level heat pumps, at lower capital cost and improved operational efficiency (i.e. increased running hours). The low-carbon heat would be "sleeved" through the network to the new development in perpetuity to safeguard compliance with building regulations and planning policy. This is easily achieved through the incorporation of appropriate obligations/penalties in the Master Supply and/or Energy Services agreements. This approach would need to be recognised by Planning Authorities and Building Control, as a compliant approach to Part L and planning policy.

This approach will ensure that new developments connecting to existing networks can continue to be compliant with future planning and Part L of the Building Regulations, BEIS have made early indications that Sleeving may be treated as an acceptable means of carbon accounting in the next edition of Building Regulations due to be updated in 2022. Additionally, with spare plant capacity, existing customers on the network could also choose a "lower-carbon heat supply tariff". This provides opportunity to increase consumer choice and potentially to crowd-fund network transition investment. Without the introduction of sleeving, existing networks may be unable to connect new developments and quickly become stranded assets, with no incentive for ESCO operators to invest in decarbonisation initiatives (until the introduction of regulation).

Figure 5. Diagram outlining principle of Sleeving



Technologies

The following provides an outline of technologies considered, the benefits they could bring and assessment of the challenges for deploying them.

The joint EQUANS, LLDC and URW decarbonisation studies will review the options available for introducing low-carbon sources of heat generation and the outputs of the first study will select up to 3 technologies to take forward to more detailed feasibility and design.

6.1 Cogeneration/Combined Heat and Power

Good quality CHP producing both power and heat is a well-established technology enabling the efficient use of primary energy and a cost-effective way of reducing carbon emissions. The ongoing growth of wind and solar power generation will eventually reduce the operational hours of inefficient thermal assets, such as coal and gas turbines (without heat recovery), and thereby reduce the frequency with which the operation of good quality CHP saves carbon. Due to the intermittency of wind and solar generation, there will still be many occasions across the year when 'flexible' thermal generation is required and from an energy efficiency and carbon perspective, is best met by good quality CHP. Therefore, there will continue to be an important role for good quality CHP in district heating particularly when integrated alongside electrical heating and thermal stores to balance supply and demand using digital technology to optimise operation/energy efficiency/carbon savings. In addition, as work accelerates to scale green gas production to decarbonise the gas grid, the substitution of natural gas with lower-carbon gases in CHP is likely to become increasingly cost competitive providing additional optionality for achieving heat decarbonisation at scale. EQUANS recognises a market framework which properly values these benefits and incentivises efficiency system operation will be required and continues to work with a wide-range of stakeholders to achieve this transition.

6.2 Heat pumps / Low grade heat recovery

Heat pumps use a refrigeration cycle to raise lower grade heat to levels required for the end use. The heat pump itself is a mature technology readily available throughout the UK. The key challenges around heat-pumps are primarily around the source of heat and corresponding availability (initial deployment as well as year-round availability of heat) and associated influence on quantum of low carbon heat that can be provided, efficiency of heat generated and cost impact. Even with higher levels of efficiency than combustion plant, the cost of generating heat will be higher compared to gas CHP.

Large commercial scale heat pumps have the ability to raise flow temperatures above that of domestic scale heat pumps whilst maintaining good efficiencies. Lower temperatures on the network will improve heat pump efficiencies and enable them to supply a higher proportion of heat into the network. Ensuring connecting building are designed and built to maintain appropriate low flow temperatures is key to enabling efficient operation of the wider network. EQUANS' technical standards ask that secondary network are designed to meet the following parameters and minimise loses:

- The nominal secondary system flow temperature is to be 70°C
- The nominal return temperature from the Secondary Network at the Substation is to be 40°C.
- (An alternative temperature may be used at the discretion of the Developer, but the maximum volume weighted average return shall be no higher than 45°C)
- Secondary networks are designed, installed and commissioned in line with best practice, including the recently updated CP1 2020 Heat Networks: Code of Practice for the UK.

There are several sources of heat that could be connected to a heat pump on or around the Queen Elizabeth Olympic Park. The following considers various sources of heat that could be connected to a heat-pump to supply the ELE network:

6.2.1 Water source – river

The Kings Yard Energy Centre is immediately adjacent to the River Lea Navigation, so provides potential for deployment of this solution. To date a feasibility study has been commissioned and completed to investigate this solution, which is now being taken into the next stages of concept design development to determine the deliverability and further refine the solution outlined so far.

The feasibility study to date suggests a circa 3MW heat pump to be located in the Kings Yard Energy Centre, with abstraction point adjacent to the Energy Centre and discharge point circa 150m downstream. The system may also provide opportunities for 'free cooling', through rejection of low-grade heat to the river rather than through cooling towers so reducing the electricity consumption needed to generate CHW for the scheme providing further carbon savings.

- **Environmental** - considering a 3MW heat pump, carbon content of heat from this technology could be in the order 0.034 kgCO2/kWh to 0.045 kgCO2/kWh based on SAP 10.1 figure. Other key environmental considerations around the viability of a river source heat pump include Environmental Agency requirements around extract and discharge and associated impact on temperature on the river, which may impact viability and/or scale.
- **Availability & compatibility with heat network** – deployment availability due to proximity of the river and interconnection with the ELE network is good. Year-round availability of heat will however not be as consistent as river temperatures reduce during winter, so viability of heat extraction at reasonable CoPs will decrease. Form of refrigeration within the heat pump will be a consideration, cost and environmental consideration, to raise to a temperature appropriate for interconnection with the ELE network.
- **Space** – the Kings Yard energy centre has potential space available for the heat pump itself. Location of the network within the canal towpath and also equipment within the River itself may be the challenging aspects in this regard. This would need coordination with the Canals and Rivers Trust as well as the LLDC.
- **Cost considerations** – capital cost circa £1000-2000/kW installed, with OPEX at approximately 5% of the capital installation costs. Use of river water charge from the Canals and Rivers Trust would also be a consideration.
- **Market Maturity** – heat pump itself is a mature readily available technology. However, as with many of the heat pump solutions considered here the application of the heat pump and source of heat is the more novel element and comes with greater risk around deliverability, efficiencies and proportion of heat that can be achieved.

Figure 6: Heat pump solution within Kings Yard Energy Centre with abstraction and discharge points on the River Lea Navigation

6.2.2 Ground source – borehole

The ground stores thermal energy from the sun, maintaining fairly constant temperatures all year round in the order of 10-12degC at only tens of meters below surface level. Ground source heat pumps can come in the form of either open loop or closed loop. Closed loop can be horizontal or vertical, with commercial applications typically being in the form of vertical boreholes, circulating heat from the ground into a fluid contained within a pipework system. Open loop systems extract and discharge aquifer water.

With the ELE system having both heating and cooling requirements, there may also be opportunities to optimise the use of the boreholes utilising it as both source of heat and a source of heat rejection. Depending on form and depth of borehole there may also be seasonal heat and cooling storage potential, to optimise year-round balancing of the system.

A possible location of the heat-pump itself could be either the Kings Yard or Stratford Energy Centres. Initial discussions with a borehole provider suggest for a circa 1MW a closed loop system would require in the order of 60-65No boreholes at 200m depth and 8m separation between each of the boreholes. This would require an area in the order of 3000m2 (56m x 56m). Integration into foundations of new developments could be an option, but this tends to increase cost and would have limited output.

For an open loop 1MW system 1-2 doublets may be needed (so 2-4 boreholes in total) at a depth of 120m each with a separation distance of circa 100m.

A key challenge around both options is space, the closed loop being the most constrained in terms of area and therefore appears the most limited in the capacity that it could deliver. Similarly, the open loop location of the boreholes and interconnecting network infrastructure is a challenge.

- **Environmental** - considering a 1MW heat pump, carbon content of heat from this technology could be in the order 0.034 kgCO2/kWh to 0.045 kgCO2/kWh based on SAP 10.1 figure. Other environmental considerations will include for the open loop system extract and discharge considerations with the Environment Agency, which is influenced by the volume of water extracted from the aquifer each day.
- **Availability & compatibility with heat network** – availability of the scale of a borehole system that could be deployed appears limited but has potential to form part of the technology mix on the site. Year round availability of heat is good. As with all heat pump systems the form of refrigeration selected will be influenced by the temperatures required to be compatible with integration into the ELE network.
- **Space** – As above, this is a key constraint to the system.
- **Cost considerations** - capital cost circa £1500-2500/kW installed, with OPEX at approximately 5% of the capital installation costs.
- **Market Maturity** – heat pump itself is a mature readily available technology. However, as with many of the heat pump solutions considered here the application of the heat pump and source of heat is the more novel element and comes with greater risk around deliverability, efficiencies and proportion of heat that can be achieved. Existing commercial systems in the UK tend to be less than 1MW at present.

6.2.3 Sewage heat recovery – Thames Water Recycling plant, Old ford site.

Domestic hot water is used then flushed down drains, injecting heated water into the sewage system. The average temperature of sewer networks in the UK is in the order of 10-20degC, providing a stable source of low-grade heat year-round.

To date EQUANS has worked with SHARC Energy Systems to develop an outline feasibility study to identify the potential sources and capacity of sewage heat recovery system. The sewer system under the Greenway, in close proximity to the Fish Island and Pudding Mill Lane developments, as well as the existing heat network just to the south of the Stadium has been identified. Thames water have provided flow rates for this network, which in combination with the SHARC technology would suggest there may be in the order of 7MW capacity available. This could provide in the order of 35GWh of heat generation a year. These figures are dependent on further monitoring of the sewer system to establish the flow and return temperatures as well as year-round flow rates and further development of technical viability of deployment.

One of the challenges to the system in this location would be establishing appropriate space for heat recovery and heat pump kit on this site. This would need further discussion with stakeholders including Thames Water, LLDC and developers in the area.

- **Environmental** - considering a 1MW heat pump, carbon content of heat from this technology could be in the order 0.034 kgCO2/kWh to 0.045 kgCO2/kWh based on SAP 10.1 figure
- **Availability & compatibility with heat network** – availability of a source of heat and potential year-round access to heat appear good at present. As with all heat pump systems the form of refrigeration selected will be influenced by the temperatures required to be compatible with integration into the ELE network.

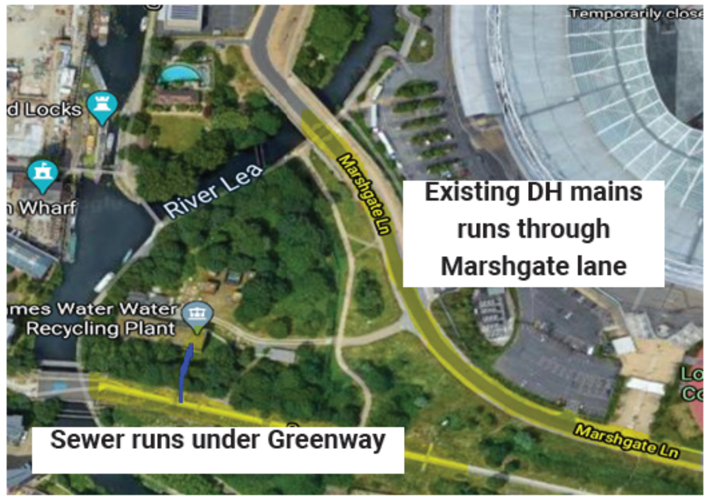


Figure 7. Location of sewer in relation to existing DH Network

- **Space** – As above, discussions LLDC highways and Thames Water will be key to the viability
- **Cost considerations** - capital cost circa £1000-2000/kW installed, with OPEX at approximately 5% of the capital installation costs.
- **Market Maturity** – heat pump itself is a mature readily available technology. However, as with many of the heat pump solutions considered here the application of the heat pump and source of heat is the more novel element and comes with greater risk around deliverability, efficiencies and proportion of heat that can be achieved. There have only been a handful of sewer heat recover systems delivered in the UK to date, these have so far been less than 1MW.

There may be further opportunities for waste heat recovery from other Thames Water sites, including the Abbey Mill pumping station, which is currently undergoing major works by Thames Water as part of the super sewer works. The current work is likely to restrict opportunities for heat recovery for the next few years, but once built will be one of the larges sewers in the UK. We will explore future opportunities at Abbey Mill through further discussion with Thames Water representatives.

6.2.4 Low-Grade Heat Recovery

Recovery of heat from industrial processes can provide a stable, clean (in terms of complexities around filtration being removed) form of low-grade heat. Examples of these applications include the Bunhill scheme in Islington recently connecting a 1MW heat-pump into the existing CHP led heat network system recovering heat from a London tube system. The GreenScies project, which EQUANS worked on the first phase of in collaboration with Southbank University, Islington Council and a number of other bodies, is also considering as part of the feasibility stages of the project the potential of heat recovery from data centres for integration into a heat network.

- **Data centre heat recovery** – no data centres with cooling heat rejection within close proximity of the site have been identified at this stage. However, this is a significant re-development area so we would suggest this could be a potential at some point in the future.
- **Heat from London Underground ventilation shaft** – ARUP are in the process of developing a study to identify potential locations that would enable heat recovery from ventilation shafts supplying tube lines. To date we understand a location near the Pudding Mill Lane development has been identified, which ARUP are currently in the process of exploring further.
- **Cooling tower heat recovery** – Similar to data centre heat recovery this would use the heat rejected to atmosphere. However, in this instance generation is associated with chilled water demand for space cooling, the availability of heat is therefore far more seasonal (unlike data centres which is relatively stable throughout the year), with greatest generation during summer when heat loads are at their lowest.

Figure 2. Overview of ELE and incremental decarbonisation opport

6.2.4.1 Low-Grade Heat Recovery – TfL Tube Vent Shaft

The Pudding Mill Lane site is one of seven sites examined for the potential to recover heat for injection into heat networks. EQUANS met with the consultant engineers mid-February 2020, and later in October 2020, to understand the initial work undertaken. The current study suggests using circa 645kW heat pump which would recover in the order of 2.96GWh of heat a year from a vent shaft of this scale (using the existing fan coil), depending on the temperatures received. EQUANS has responded to the TfL Market Sounding Question to further evaluate the opportunity, and met with the TfL team in March 2021 where they advised that further details on the process would be released in July 2021.

- **Environmental** - considering a 1MW heat pump , carbon content of heat from this technology could be in the order 0.034 kgCO2/kWh to 0.045 kgCO2/kWh based on SAP 10.1 figure
- **Availability & compatibility with heat network** - - availability for deployment as a source of heat appears good however dependability and availability of heat when it is most required all year-round is a challenge. As with all heat pump systems the form of refrigeration selected will be influenced by the temperatures required to be compatible with integration into the ELE network.
- **Space** – space for a heat pump may be available adjacent to the vent shaft, on TfL land. Further discussion with TfL would be required, viability of this will be informed by the ARUP study.
- **Cost considerations** – capital cost may be in the region of £500-1500 kW installed, however highly dependent on location. OPEX circa 5% annually of installed heat pump costs.
- **Market Maturity** – heat pump itself is a mature readily available technology. However, as with many of the heat pump solutions considered here the application of the heat pump and source of heat is the more novel element and comes with greater risk around deliverability, efficiencies and proportion of heat that can be achieved. Heat recovery from chilling systems is not a common system in place at present.

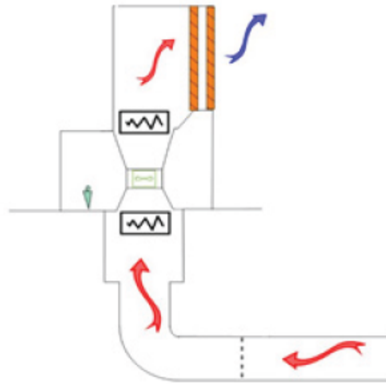


Figure 8. Schematic of Heat Pump

6.2.4.2 Low-Grade Heat Recovery – Cooling Towers

Heat recovery from the cooling towers on the Energy Centres appears to have good potential at this stage, with circa 60MW of heat rejection capacity that could be utilised.

- **Environmental** - considering a 1MW heat pump, carbon content of heat from this technology could be in the order 0.034 kgCO2/kWh to 0.045 kgCO2/kWh based on SAP 10.1 figure
- **Availability & compatibility with heat network** - availability for deployment as a source of heat appears good however dependability and availability of heat when it is most required all year-round is a challenge. As with all heat pump systems the form of refrigeration selected will be influenced by the temperatures required to be compatible with integration into the ELE network.
- **Space** – space within the Kings Yard and Stratford energy centres may be a possibility.
- **Cost considerations** – capital cost may be in the region of £500-1500 kW installed, however highly dependent on location. OPEX circa 5% annually of installed heat pump costs.
- **Market Maturity** – heat pump itself is a mature readily available technology. However, as with many of the heat pump solutions considered here the application of the heat pump and source of heat is the more novel element and comes with greater risk around deliverability, efficiencies and proportion of heat that can be achieved. Heat recovery from chilling systems is not a common system in place at present.

6.3 Biomass/Biofuel

The Kings Yard Energy Centre currently hosts 3MW of biomass boilers (woodchip) and has capacity for space in the energy centre and fuel capacity also for additional biomass boiler. The existing biomass boilers provides element of base load, but as the scheme grows additional biomass boilers can be run most of the year towards base load contribution. In addition, one of the gas boilers at Stratford Energy Centre is equipped with duel fuel burner and set up with an oil tank, which will take biofuel as a source to generate heat. Further investigation is underway on the technical modifications that might require to run alternative low carbon fuels with the manufacturers of these boilers. If feasible this might be the lowest cost option to contribute towards decarbonisation of the heat network.

Further stakeholder engagement will be required with environment department of the local council and Environment Agency.

- **Environmental -** considering additional 1MW biomass boiler, carbon content of heat from this technology could be in the order 0.027 kgCO2/kWh based on SAP 10.1 figure.
- **Availability & compatibility with heat network –** availability of a source of heat and potential year-round access to heat appear good at present. One of the biggest advantages is the operating temperatures required are compatible with integration into the ELE network.
- **Space –** as above, space available for additional capacity in the energy centre.
- **Cost considerations -** capital cost circa £500-1000/kW installed, however emissions scrubbing technology to ensure air quality may add significant additional costs.
- **Market Maturity –** biomass boiler itself is a mature readily available technology.
- **Cost of heat generation –** fuel costs are currently higher than natural gas. Without stronger policy support for a stable and appropriate carbon price, fuel switching would put upwards pressure on tariffs compared to those currently receiving heat via gas combustion technologies.

6.4 Green Gas

The combustion of natural gas produces ~210 gCO2/kWh depending upon the mixture of gases imported into the distribution network at any time (e.g. increasing proportions of Qatari LNG increase emissions, whilst increasing proportion of North Sea gas, reduce it). Substituting natural gas (either in total or in blended proportions) with biogas or hydrogen reduces these emissions by 60-100% (Depending on feedstock). Existing combustion plant can readily accept biomethane (upgraded biogas with properties equivalent to natural gas) without adjustment whereas other green gas blends (Including hydrogen) will need plant adjustments or investment.

Local production of biogas for direct combustion at the volumes needed is not viable for ELE (see below). The biogas would need to be transported by road as CNG or shipped via the existing natural gas grid using certificates as proof of origin and ownership (RGGOs - "Renewable Gas of Guaranteed Origin"). There is an established and growing market for green gas supply via the gas network, allowing purchasers to report carbon savings in accordance with Government's greenhouse gas reporting guidelines.

We will consider green gas as a short-term measure to optimise the current systems operational carbon emissions and well as following national and local research and development defining scope and role that hydrogen may play in heating.

6.5 Energy from waste

The site in closest proximity to the ELE Heat network is the North London Waste Authority's Energy from Waste plant in Edmonton, which is currently supplying heat to Enfield council's Lea Valley Heat Network.

This is approximately 10km from the ELE site via highways as the crow flies with major river, rail and road crossings required, with cost of connection likely being greater than £30m. We have had initial discussions with Energetik, operators of Lea Valley Heat Network, to explore the potential of this connection and intend to work further with them to assess and develop the business case and potential for a feasibility study (by end 2022). These investigations will form part of the strategic master planning work we hope to do with surrounding local boroughs.

6.6 Solar

Solar deployment in the UK to date has been focused on generating electricity for local use (e.g. to heat and store water) or for export to the grid. Opportunities have been influenced by the availability of a "feed-in-tariff" which has offered an attractive return on investment. Across the park we have previously examined opportunities for solar PV deployment on the roof spaces of the Copper Box Arena and the London Stadium to sell electric directly via a private wire. However, investigations into the opportunities concluded that fitting solar PV would not be feasible due to the limited load bearing capabilities of either roof.

More recently we have been introduced by EQUANS Group to a Swiss based solar-thermal company, who have developed a high-temperature/high efficiency panel suitable for district heating. We have identified an available footprint on Westfield's car park that could provide 2MW to 3MW of solar thermal capacity which could be fed into the DH network or supplied directly to prospect developments near the proposed roof space. We are in the process of assessing the project's commercial and technical viability and once concluded, will present our findings to the LLDC and Westfield to agree next steps

6.7 Other Technologies

The following technologies were also considered but not looked into in any further detail for the following reasons:

- **Deep geothermal -** We will continue to review the potential for geothermal as new technologies emerge.
- **Air source heat pump –** Air source heat pumps have not been considered further at this stage due to limited availability of roof space, which already has a significant allocation cooling towers on the energy centres and developments around the site to PV, as well as relatively low CoPs that can be achieved when raising the temperature to a suitable level for compatibility with the existing network
- **Fuel cells –** this has been discounted at this stage due to the maturity and potential scale of heat this technology could provide. High capital costs due to material selection and source of base fuel for generation continue to be challenges to fuel cells at this time
- **Biogas from small scale Anaerobic Digestion –** A feasibility study was undertaken by EQUANS in 2017, in collaboration with Westfield Stratford, around the installation of a small-scale anaerobic digester at Kings Yard energy centre. The proposal was to divert organic food waste leaving the shopping centre, transporting it a short distance to the energy centre. A technical solution was reached; however, the project was not developed further due to a number of constraints, including:
  - Space constraints meant that only a small digester could be installed, eroding any economies of scale.
  - Quality of organic waste was low, and additional resource would have been required to inspect the waste being fed into the digester.
  - Business case would have required a large proportion of upfront capital to be grant funded to reach required investment criteria.
  - Finding a guaranteed, long term off taker for the substrate / fertilizer in the urban area was challenging, without paying to divert it.
  - The area around the energy centre is earmarked for residential housing and future developers would have objected to daily odorous deliveries of food waste.

Technology summary

The following summarises the viability of the different options considered and the solutions and/or mix of solutions that will be taken forward for further consideration.

Cogeneration/Combined Heat and Power

Good quality CHP producing both power and heat is a well-established technology enabling

Tech*	Technical Barriers / opportunities				Commercial Barriers / opportunities				Commentary
	Compatibility Network	Availability	Environmental	Space	Capital Cost	Operational Cost	Market maturity	Priority	Key opportunities or barriers
Gas CHP								1	**Action: Pursue robust accounting for carbon emissions savings and optimised operation (Q1 2022)** Gas CHP has been catalyst to the development of DH networks in the UK and even in the electrification of heat, gas CHP has an important role to play, both to plug the gap between in the intermittent nature of renewable energy generation (wind and solar) but also when integrated alongside electrical heating (heat pump) and thermal stores to balance supply and demand using digital technology to optimise operation/energy efficiency/carbon savings. Opportunity to further decarbonise with green gas with appropriate methodologies and policies for reporting carbon emissions savings.
Heat pumps - water, river source								1	**Action: Develop concept design, progress to investment case and installation (Q3 2022)** Water source application not yet fully commercia ised in DH application, environmental concerns around impact on water conditions a constraint, as well as availability of appropriate water sources and relatively high capital cost. Space to output a consideration as a well as compatibi ity of temperature regime. Potential deployment of this solution on the Kings Yard site has been explored through a study to date, demonstrating this solution may have some potential to contribute to the energy mix of the site
Heat recovery								1	**Action: Develop concept design progress to investment case and installation for ENGIE cooling towers (Q2 2022)** Recovery of low-grade heat from industrial processes, through the use of heat pumps. Availability of appropriate sources in proximity is typically the major constraint as well as compatibility of temperature regimes. Recovery of heat from the Kings Yard coo ing towers and has been found to have the greatest potential at this time, however availabi ity of heat when most needed is the greatest challenge
Vent shaft heat recovery (ASHP								1	**Action: Develop concept design, progress to investment case and installation** Heat recovery from underground ventilation application not yet fully commercialised in DH application, operation concerns around particulate cleaning, space availability, canal crossing as well relatively high capital cost. TfL tube vent shaft near the Pudding Mill Lane development offers potential for demonstrator.
Biomass / biofuel								2	**Action: improve future cost assumptions and ascertain stakeholder support** Biomass and biofuels can include a wide range of technologies from burning of woodchips and pellets to use of biomethane or biodiesel and potentially pyrolysis technologies. Space (for fuel storage as well as de ivery routes), air quality and fuel security are critical considerations for these technologies and put constraints on application. ELE's original strategy for future expansion of the site included space provision for a further biomass installation to the existing biomass boiler. However, the ELE area is part of an Air Qua ity Management Zone, so further deployment of biomass on the ELE site though it could potentially reduce CO2 emissions may have a detrimental impact on other environmental considerations such as air qua ity. Green Gas Certificates, as a form of off-site injection into the system, has been considered and their app ication.

Tech*	Technical Barriers / opportunities				Commercial Barriers / opportunities				Commentary
	Compatibility Network	Availability	Environmental	Space	Capital Cost	Operational Cost	Market maturity	Priority	Key opportunities or barriers
Energy from Waste								2	**Action: work with stakeholders to develop business case for Edmonton EfW and secure funded needed for feasibility work (Q4 2022)** Can include a wide range of heat sources including heat from waste incineration to syngas generation through anaerobic digestion or pyrolysis processes. Availability of appropriate sources in close proximity to a site are typically a major barrier. Distance from the closest site has been identified as the key barrier to deployment, which needs to be tackled in collaboration with others including the GLA and neighbouring local authorities.
Green Gas								2	**Action: collaborate widely to develop business case and safeguards needed to assure additionality (Q2 2022)** This has been identified has having a high potential for reduction in carbon content of the heat network. Cost and impact on end consumer heat charges being the greatest challenge.
Heat pumps – sewage source								3	**Action: Keep under review.** Appears to be some potential for deployment of this solution. The technology is however relatively immature particularly at scale.
Solar thermal								3	**Action: Develop concept design, progress to investment case and installation** Mature readily available technology. Availability of appropriate roof space, output to space a consideration, as a well as compatibility of network temperature regime. Traditional solar thermal typically generates heat at < 60degC. High temperature solar thermal systems are starting to enter the market but are still relatively immature at this stage. For the ELE site competition for roof space with PV cells is the most significant influence on deployment and potential scale of heat input that could be provided.
Deep geo'								3	**Action: Keep under review** Availability and high capital cost are the most significant barriers. Highly dependent on location. We will continue to review as new technologies emerge.
Fuel cells								x	Current high capital and operational costs tend to be prohibitive at present. Not yet at fully commercia ised technology, but interesting developments in static plants.
Heat pumps - air source								x	**Action: Keep under review** Mature readily available technology. Space to output a consideration as a well as compatibility of network temperature regime. Limited availabi ity of roof space, due to allocation to PVs and also compatibi ity of temperature regimes, this has not been taken forward as an option at this stage. Not suitable for deployment on ELE.

Priorities

With a view to integrating additional low-carbon heat into the scheme before the end of 2022, the high-level assessment completed to date suggests the following priorities:

Priority 1: secure funding for concept design and investment cases in the next 3-12 months:

1. Valuing the benefits of CHP in compliance and policy.
2. Deployment of heat pumps to utilise ambient heat in the ground and open water.
3. Deployment of heat pumps to utilise heat rejected from chillers at Stratford Energy Centre and the TfL vent shaft at Pudding Mill Lane (for demonstration purposes).
4. Progress development of business case for EfW connection as the potential long-term solution.

Priority 2: engage with stakeholders to develop understanding of the risk and opportunities and build consensus on timetable for solutioning and implementation (3-6 months).

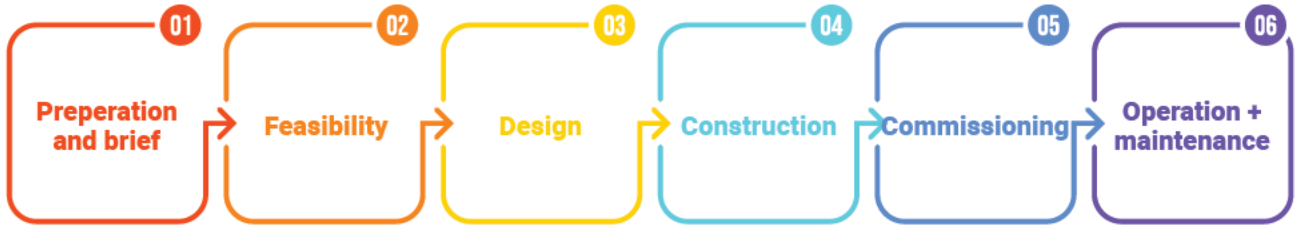
5. Additional biomass capacity and replacement of natural gas with biofuel
6. Costs and feasibility of other sources of waste heat identified (e.g. Abbey Mills pumping station).
7. Cost and availability of green gas and systems needed to provide assurance of enduring carbon savings/additionality.

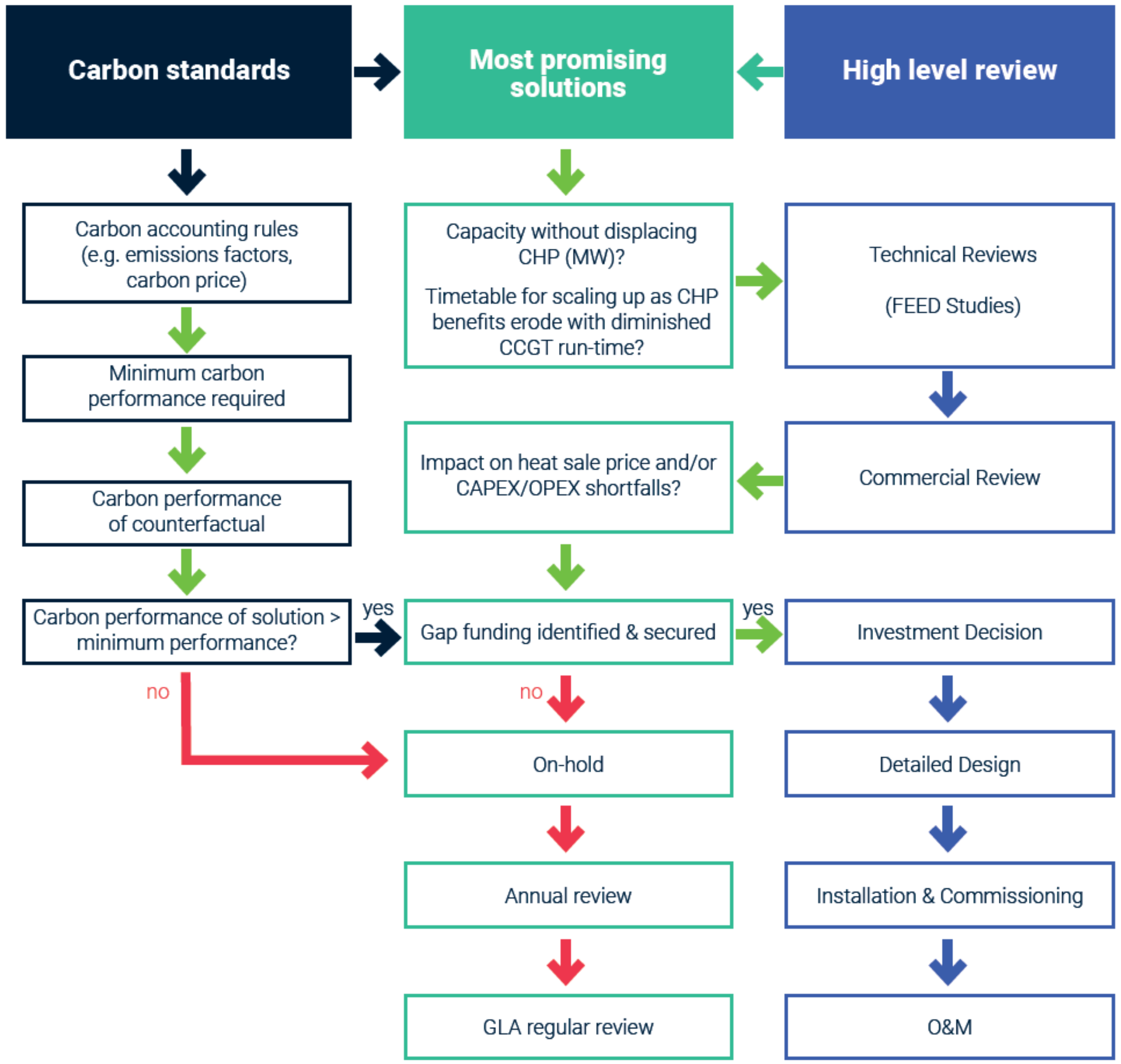
Priority 3: keep under review the case for pursuing opportunities to install:

8. Heat pumps for the recovery of waste heat from sewage
9. Solar thermal across the Olympic Park buildings

Programme

Our programme through to installation will follow that as identified by Code of Practise for Heat Networks, wherein we are stage 2 i.e., Feasibility phase for each of these technology options.





Our high-level plan for the next 12 months is shown in the executive summary. Once funding is secured to develop the roadmap and techno-economic feasibility studies, more detailed project plans can be developed.

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PART OF THE ENGIE GROUP

Addendum: Techno-Economic Feasibility Study of Decarbonisation Options for East London Energy – Report 1 Update

March 2022

EQUANS are undertaking a techno-economic feasibility study to assess the options available for introducing additional low-carbon sources of heat generation to the East London Energy (ELE) scheme and developing detailed plans and roadmap for strategically decarbonising the heat network. The energy network distributes heat across 20km of network to 7,000 existing homes and 100 commercial premises, alongside cooling to 11 sites.

The key objectives of the overarching decarbonisation study are to:

- Identify the preferred option(s) to decarbonise the whole network by 2035. Allowing connected customers to meet corporate objectives and EQUANS to comply with policy.
- To enable compliance with building regulations. This will require decarbonisation of the network and identification of options that enable continued connection of new developments.
- Ensure a fair net zero transition to existing customers and identify ways to minimise any cost associated with introduction of low carbon technology

To keep pace with the transition of the electricity network to lower-carbon forms of generation, the Queen Elizabeth Olympic Park (QEOP) energy network will need to reduce natural (fossil fuel) gas consumption and utilise other lower-carbon forms of energy. This will require capital investment, impact operation and maintenance regimes and costs, and could put upwards pressure on customer bills. The overarching study appraises the technology options, investment requirements and cost impacts to identify the optimal roadmap to net zero emissions from the QEOP energy network, consistent with the ambitions of the London Legacy Development Corporation (LLDC), Westfield Stratford City (Westfield) and many of the developers active in the local area. With an agreed roadmap built through collaboration and consensus, funding will potentially be sought (e.g. via the Green Heat Networks Fund, and other sources) to make the investments needed and to sustain growth of the network as regeneration of the surrounding areas continues.

Since commissioning in 2011, the scheme is estimated to have saved ~97,000 TCO_2. Increased decarbonisation of the national electricity grid means that without new investment in alternatives to natural gas, annual CO2e emissions from the scheme will increase from their baseline of 36,548T today, to 60,980T in 2035. Acting now will help existing and new buildings connected to the network transition to Net Zero and will result in substantial carbon savings in the 2020s and beyond.

To date, the potential decarbonisation technologies available have been explored in the context of their local availability, the policy environment, timing, barriers, and opportunities to expedite decarbonisation. A three-tiered approach to decarbonisation has been taken:

- **System optimisation and efficiency improvements** – Adapting and getting the most out of existing assets, reducing temperatures and losses, and benefiting from wider energy system carbon and price signalling.
- **Incremental installation of low carbon technology** – Investigating local lower carbon generation and heat source opportunities for part of the scheme demand, or as incremental steps. e.g. Heat Pumps meeting a percentage of the network total heating or cooling demand.
- **Strategic decarbonisation** – Wholesale decarbonisation options for the entire scheme and growth opportunities e.g. Energy from Waste connection.

The first stage of the work was undertaken in late 2021 and included options appraisal of a long list of technology options. The table below gives a high-level overview of carbon reduction which could be achieved by each technology evaluated.

Technology	Capacity Assumed (MW)*	Carbon Reduction (%) **
Green Gas	N/A	92
Additional Biomass	1	8
Water Source Heat Pump	3	23
Chiller Heat Pump	3	15
Sewer Source Heat Pump	3	18
Ground Source Heat Pump	3	12
Solar Thermal	2.4	3
TfL Vent Shaft	0.7	3
EfW	10	62
Major Air Source Heat Pumps	10	71
Biofuel CHP	20	75
Geothermal	20	~75
**Assumed MW available is to give indicative number e.g. EfW potential for greater capacity*		
***Based on SAP 10.1 carbon factors. Carbon reduction compared to current operation.*		

The first stage of work concluded that incremental technologies could decarbonise ELE but could limit growth, and constraints may mean that they could struggle to meet the scale required. As a result, a combined strategic focus on the long-term site wide options as well as immediate smaller scale technologies is being taken to decarbonise ELE.

Three strategic technologies have been short listed from a long-list of 20 potential low-carbon heat sources, for further detailed assessment:

- Energy from Waste
- Geothermal
- Heat Pumps

In addition, EQUANS will continue to pursue opportunities for project level incremental decarbonisation and system optimisation activities. We are pursuing two heat pump projects, ~3MW each, at Stratford City and Kings Yard energy centres and have been successful in securing funding from the Heat Network Efficiency Scheme for an optimisation study for a number of blocks connected to the ELE network. We will work with connected partners to continue to identify optimisation opportunities for the existing assets and seek funding where possible to achieve this.

The next stage of the study is to complete the options appraisal of the 3 preferred strategic technology options to refine a timeline to implement the technologies. EQUANS will continue to work with key stakeholders to achieve the carbon milestones set out in our roadmap.

London Legacy
Development Corporation

Preparing for a 1.5°C future

Framework and guidance for new buildings | February 2021

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Executive summary

This documents sets out LLDC's vision and aspirations for the built environment within the context of the climate emergency. It provides pragmatic guidance on the delivery of exemplar developments when preparing for a 1.5°C Paris Agreement proof future.

Purpose of this document

This should be one of the first documents that anyone involved in delivering a new development for LLDC should consult, while also providing a handy day-to-day reference.

This framework and guidance has been designed to form the basis of project discussions, brief setting, design reviews and pre-planning/post-occupancy audits. It will inevitably need to be tailored to suit each project, but will demonstrate exemplar aspirations and enhance planning policy requirements.

Whilst the focus is on preparation to meet a 1.5°C future, the targets set out in this document can also be seen as an evidence base for the new baseline for LLDC development guidance, which steps up the requirements outlined in current LLDC policy "Your Sustainability Guide to Queen Elizabeth Olympic Park 2030"

Over the past eight years, LLDC and partners have been delivering against the LLDC Sustainability Policy: "Your Sustainability Guide to Queen Elizabeth Olympic Park 2030" together with the "Legacy Communities Scheme: Development Specification and Framework".

These documents committed LLDC to a number of carbon targets including zero carbon homes and an embodied carbon reduction target. Since LLDC developed these sustainability requirements, the policy landscape (revised London Plan and the current state of affairs, such as climate emergencies being declared), the industry's knowledge and understanding have shifted and developed.

LLDC has therefore reviewed its ambition and intends to use this framework to show how progress can be made on new developments in preparing for a 1.5°C Paris Agreement proof future.

Structure of this report

This report covers the following:

1. Context - What it takes to prepare for net zero carbon and a 1.5°C future. The context of LLDC and London planning policy together with latest industry guidance.
2. Targets - The setting of meaningful and stretching key performance indicators (KPIs) for new developments to aim for.
3. Design guidance - on how to achieve the KPIs.

Key performance indicators

The report outlines the key performance indicators (KPIs) that are recommended for new developments by LLDC, in order to meet prepare for a 1.5°C future.

** The Energy Use Intensity target cannot be met inside the district heating network concession area but should be reported and compared against this baseline. A baseline of 55kWh/m².yr should be targeted for non-residential.*

Context

LLDC - preparing for a 1.5 degree future

London Legacy Development Corporation recognises the urgency of the climate emergency and wish to put in to practice a robust framework for delivering net zero developments. The industry definition of net zero carbon has been re-evaluated in recent years. In light of this, LLDC wish to re-align their targets to remain at the forefront of industry and innovation.

The industry is on a path to zero carbon

We are in a climate emergency and we are all required to step up, whether through our building designs, the way we procure and deliver our buildings, or the content and strength of the client brief. LLDC have taken a step further on this journey by committing new developments to meet the latest industry guidelines and target the industry definition of net zero carbon by 2030. This document outlines a robust framework and guidance for the whole team and delivery chain to follow and measure against in order to achieve this goal in practice. Delivering net zero carbon is an attainable target and in recent years has been clearly mapped out. The content of this report makes clear reference to the most relevant and current guidance available.

LLDC Aspirations

In 2019 the UK Government amended the Climate Change Act and adopted a target for achieving net zero emissions by 2050. LLDC understands the necessity to act now and lead by example through new developments.

Whilst current policy focuses on carbon reductions and drives change through a set percentage better than the regulatory minimum. LLDC have made it their aspiration to deliver 1.5 degree buildings i.e. buildings which are truly net zero carbon and therefore compatible with the United Nations Paris Agreement objective of limiting global warming to 1.5 degrees Celsius above pre-industrial levels. Whilst these targets are ambitious, with the right strategy in place and through adhering to industry consented approaches they can be achieved.

Green recovery plan

The Mayor of London has committed the GLA to "tackle the climate and ecological emergencies and improve air quality by doubling the size of London's green economy by 2030 to accelerate job creation for all." This includes committing London to reach net zero by 2030 which is linked to the recovery mission statement. LLDC see the Covid-19 recovery plans as an opportunity to recalibrate and invest in infrastructure in a more environmentally conscious way.

Leadership

LLDC has a long standing reputation for delivering future-ready exemplar neighbourhoods that have built on the global success of Queen Elizabeth Olympic Park. LLDC recognises that they must align themselves to current industry guidance and standards in order to maintain a front-running position. There is a unique opportunity for LLDC to show great leadership by demonstrating best practice where policy is currently failing to deliver zero carbon.

Key actions to meet net zero carbon

Targeting the right actions from the outset and designing-in opportunities is essential. The key actions to be addressed include:

- **Limit operational energy consumption.** Designing buildings to limit the amount of energy used for heating, hot water, lighting, ventilation and appliances.
- **Reduce embodied carbon and target circular economy.** Reducing the amount of carbon needed to produce, transport and construct the building through strategic design, good material choices and consideration for repair and maintenance.
- **Design for low carbon and efficient heating .** Maximising the efficiency of the building systems, particularly for heating and hot water. Ensuring they are fossil fuel free and from low carbon sources.
- **On-site renewable electricity generation.** Maximising opportunities for renewable generation on site e.g. through good roof and PV design.
- **Measure and verify performance.** Meter, monitor and report on energy consumption and renewable energy generation post-completion for the first 5 years for residential and non-residential developments.
- **Zero operational carbon balance.** Aim to generate 100% of the energy consumption on-site through renewables.
- **Reduce overheating.** Undertake modelling using CIBSE TM 59 or TM 52 to demonstrate the risk of overheating has been reduced.
- **Reduce water consumption and heat loss from pipework.** Meet the AECB Good Practice Water Standards.

Wider sustainability goals are not covered by this document but should consider the ecology of materials, sustainable transport, minimising waste and rainwater management, providing opportunities for low carbon life-styles and improving local biodiversity.

LLDC CORE VALUES

1 A responsibility to **deliver Paris Agreement proof 1.5 degree buildings**

2 An ambition to create **future-ready exemplar developments**

3 Collaborate to follow best practice and **deliver industry recognised targets**

4 Achieve excellence to be **zero carbon by 2030**

LLDC 2030 trajectory

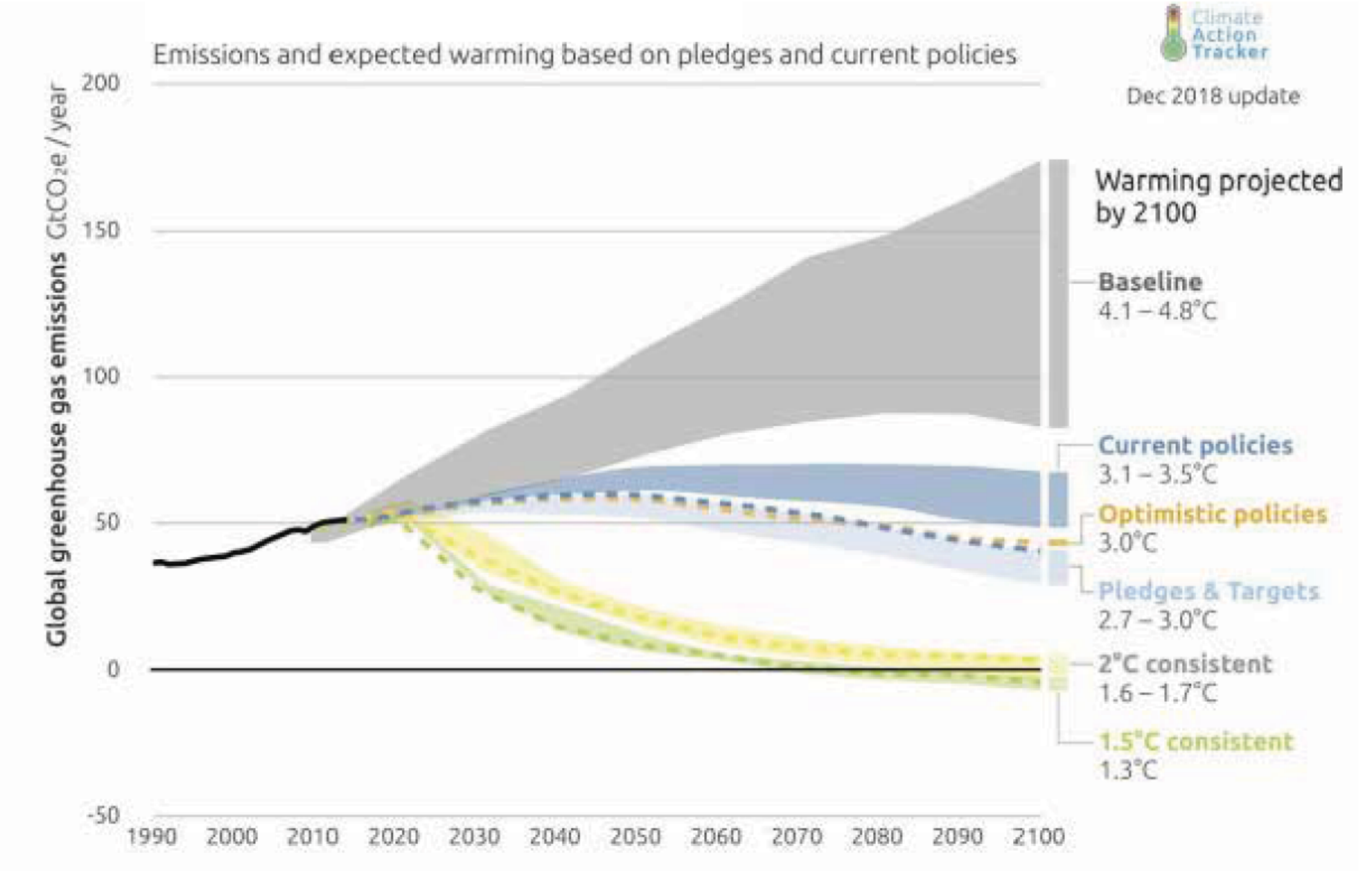
Currently LLDC are on a trajectory to miss their 2030 zero carbon target and urgently require an alternative pathway in order to secure a 1.5°C future.

LLDC need an alternative pathway to zero carbon

The primary reason for LLDC missing their 2030 zero carbon target is down to the lack of a decarbonisation plan for the district heat network to date. Therefore, under current operation every new connection to the network pushes LLDC further away from meeting a zero carbon objective.

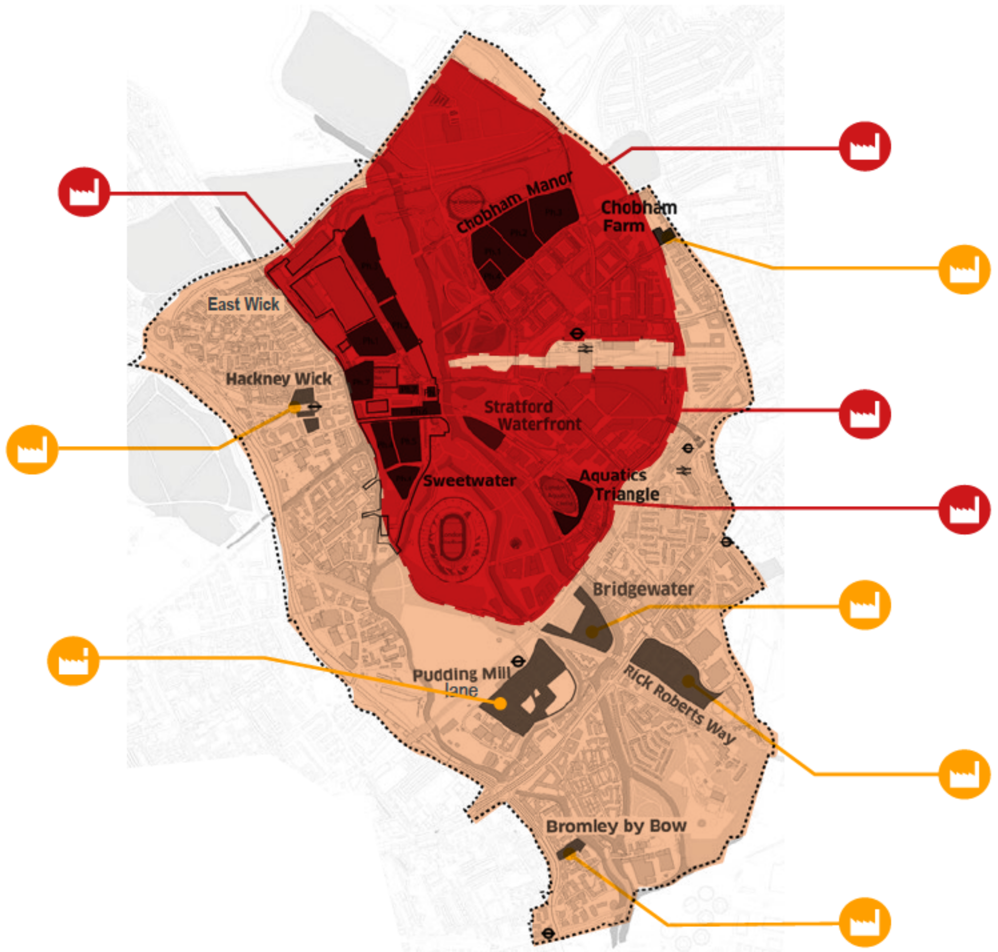
Warming projections demonstrate the necessity to act now

We are currently heading towards over 3°C global warming. LLDC alongside the rest of the industry must take urgent action to secure a 1.5°C pathway. Unfortunately, current policy is not enough to avoid catastrophic warming projections and the built environment must strive for more effective targets and low carbon technologies.



Global Warming projections clearly demonstrate that current global polices are not enough to secure a 1.5°C future.

Current trajectory
Not meeting zero carbon



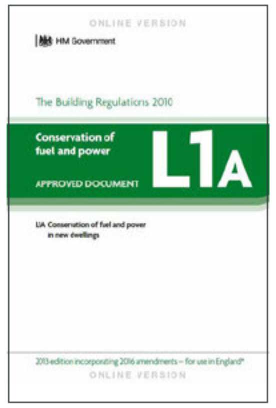
Alternative trajectory
Zero carbon target areas

- With no de-carbonisation plan within heat network concession area = cannot be zero carbon
- Planning policy supports endeavours to connect to existing heat network= cannot be zero carbon
- LLDC could demonstrate leadership to support zero carbon heat sources outside of heat network concession area = meets zero carbon

The maps above illustrates the state of play and a possible alternative trajectory that could allow LLDC to meet a 2030 zero carbon target outside of the concession area for the district heating network. This would involve using alternative low carbon heat sources instead of the district heat network. Whilst the decision to connect to the district heat network lies outside the remit of this report , the objective is to provide a clear evidence based strategy that gives LLDC the choice to target a more rapid zero carbon pathway. It is recognised that this decision is complex and multifaceted and as a consequence could have commercial and planning implications. However, in the long-term making a switch to industry recognised routes towards zero carbon sooner rather than later could pay dividends.

Current planning policy is helpful but does not go far enough

Energy targets and carbon reductions set out in Building Regulations and planning policy are far below what is required to get us to net zero carbon.



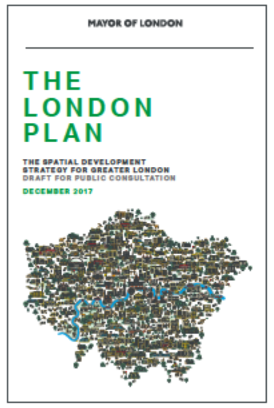
Building Regulations

Part L of the Building regulations covers the minimum standards for energy efficiency in the UK and are far below what is required to deliver net zero buildings. Specifically Part L1A 2013 for new dwelling and Part L2A 2013 for new buildings other than dwellings are the relevant versions to LLDC new developments.

A new version of Part L (2020) is under consultation, with another future version due in 2025. The changes proposed are equivalent to a 20- 31% reduction in regulated carbon emissions compared to Part L 2013 from 2020 and a 75-80% reduction from 2025.

The indicative changes were strongly objected by the construction industry as not going far enough, there was a very significant reaction to the Government consultation with a coordinated message and over 10 times the number of responses to the previous Part L consultation in 2016. In particular the consultation included proposals that impact local planning policy:

- Proposals to amend the Planning and Energy Act 2008 to restrict local planning authorities from setting higher energy efficiency standard for dwellings in planning policy.
- The 20-31% reduction in regulated carbon emissions compared to Part L 2013 is less than what has been required in London for the last seven years. It would actually represent a step backwards.



New London Plan

In December 2020 the Mayor formally approved the new London Plan and submitted it to the Secretary of State for final approval. It sets out the requirements for all major developments within the Greater London area.

Policy SI1 – improving air quality requires development proposals to consider and improve London's air quality. In particular designs should prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality.

Policy SI2 – Minimising Carbon Dioxide emissions requires major developments to be 'net zero carbon' by designing to the following energy hierarchy:

1. **Be lean:** use less energy and manage demand. Residential developments should achieve a 10% improvement over Part L through fabric energy efficiency measures only. Non residential developments should achieve 15% over Part L.
2. **Be clean:** exploit local energy resources and supply energy efficiently and cleanly.
3. **Be green:** maximise opportunities for renewable energy by producing, storing and using renewable energy on-site
4. **Be seen:** monitor, verify and report on energy performance.

A 35% on-site improvement over Part L 2013 is required and residential developments need to offset their residual regulated carbon emissions to achieve 'net zero carbon'. Developments can choose to achieve more savings on site and this reduces the carbon offset payments.

Additionally referable developments are required to provide evidence of a Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

Policy SI3– Energy infrastructure requires early engagement with relevant energy companies to establish future energy infrastructure requirements arising from large-scale developments and should be developed as part of the energy masterplan.

Existing networks will need to establish de-carbonisation plans. These should include the identification of low and zero carbon heat sources that may be utilised in the future, in order to achieve the Mayor's zero carbon target. Opportunities to maximise both secondary heat sources and renewable energy production on-site should be identified.

Policy SI4– Managing heat risk requires developments to minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure. Major development proposals should demonstrate through an energy strategy how they will minimise the overheating risk and over-reliance on mechanical cooling by following the cooling hierarchy. TM 59 should be used for domestic developments and TM 52 should be used for non-domestic developments.

LLDC Local Plan (2020 to 2036)

Policy S.2: Energy in new development requires developments to minimise carbon dioxide emissions to the fullest extent possible by application of the London Plan Energy Hierarchy.

Policy S.3: Energy infrastructure and heat networks supports proposals to provide new energy infrastructure, including proposals to generate energy from waste, to meet the future energy demand within its area where these are consistent with the Carbon Reduction and other policies within this Local Plan.

Proposals for new heat networks or extension to any existing heat network, or for renewable energy infrastructure, to serve development within or outside the Legacy Corporation area, are supported subject to such development proposals being consistent with all other relevant policies and evidence that appropriate management mechanisms will be put in place to ensure that end customers are protected in respect of the price of energy provided, and that heat losses from the network are minimised.

Applications for major development should demonstrate opportunities to connect to existing energy networks in the Legacy Corporation area or construct and connect to new energy networks, and to facilitate connections from existing development to those networks. All other development will be encouraged to connect to these networks where it is practical, feasible and viable to do so.

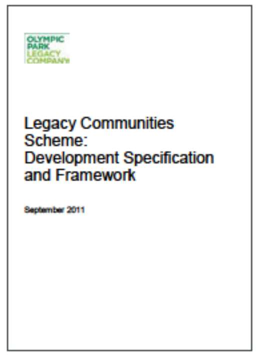
Policy S.4: Sustainable design and construction requires developments to demonstrate that they achieve the highest standards of sustainable design and construction. Major development are required to include evidence as part of a Design and Access Statement submitted at planning.

Policy S.9: Overheating and urban greening Proposals for new development should ensure that buildings and spaces are designed to avoid overheating and excessive heat generation internally and externally, while minimising the need for internal air conditioning systems, taking into account the new London Plan Policy SI4 and the Mayor's zero carbon target of 2050.

Your Sustainability Guide to Queen Elizabeth Olympic Park 2030 (2012)

Current LLDC guidance sets higher targets than London Plan:

- 65% reduction in emissions for residential developments
- Up to 35% of emissions mitigation through allowable solutions in surrounding communities
- 15% reduction in embodied carbon in new construction
- At least 25% recycled content of aggregate within new buildings and infrastructure (by weight).
- At least 20% of construction materials to be from a reused or recycled source (by value).


Legacy Communities Scheme:
Development Specification and Framework

September 2011

Legacy Communities Scheme: Development Specification and Framework (2011)

Building Emission Standards

Homes should be built with efficiency standards that as a minimum meet the Governments Fabric Energy Efficiency Standards (FEES). The current FEES standard limits space heating to 39kWh/m^2 for flats and mid terrace houses and 46kWh/m^2 for end terraces and detached homes.

Summary of current key planning requirements:

1. Residential developments should achieve a 10% improvement over Part L through fabric energy efficiency measures only. Non residential developments should achieve 15% over Part L.
2. Developments within Queen Elizabeth Olympic Park target a 65% reduction in emissions beyond Building Regulations for new homes. This is higher than the London Plan 35% requirement, however it is still not enough to achieve zero carbon.
3. Developments within Queen Elizabeth Olympic Park are also required to meet full FEES which puts emphasis on fabric efficiency by limiting space heating.
4. Where it is clearly demonstrated that the zero carbon target cannot be fully achieved on-site, any shortfall in regulated carbon emissions should be offset through the LLDC carbon offset fund.
5. Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce emissions.
6. Major developments must monitor and report energy performance for at least 5 years post construction