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Milton Keynes City-wide Heat Network Feasibility Report: Work Package 2

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1 INTRODUCTION

1.1 Heat Decarbonisation and Heat Networks within Milton Keynes

Milton Keynes Council's (the Council) Sustainability Strategy 2019 – 2050 is a long-term vision to create a world leading sustainable city which embraces innovation, creates high quality jobs, and recognises it has a vital role in tackling the global challenges of climate change.

The Council is delivering a sustainability strategy which seeks to create an integrated energy system. To achieve these ambitions, the Council are developing a heat decarbonisation strategy, principally focussed on the development and optimisation of heat networks.

Based on mapping data, most residential properties across Milton Keynes appear to be served from the local gas distribution network, with only 5-25% having alternative solutions. If the Council is to successfully decarbonise these properties, they will need to consider either connection to heat networks, individual or communal heat pumps or the potential for hydrogen, a fuel which is currently under investigation by the UK Government.

In May 2021, the Council applied for Heat Network Delivery Unit (HNDU) funding to determine the feasibility of heat networks within Milton Keynes. This application was successful and in October 2021 work commenced with the appointed contractor, Anthesis (UK) Limited.

The purpose of this report is to provide a concise summary of the work undertaken by Anthesis and Local Partnerships for the Council to consider further the next steps and recommendations made.

1.2 Aims of the project

The aims of the project were to build on existing studies undertaken by the Council to determine:

- Whether the four heat network opportunity areas ('opportunity areas') previously identified, via heat mapping exercises, are appropriate for further feasibility. These areas included:
    i. Eastern Expansion
    ii. Lakes Estate
    iii. ThamesWey District Heat Network (DHN) – an existing district heat network within central Milton Keynes
    iv. Milton Keynes Waste Recovery Park (MKWRP) in Wolverton
- Techno-economic modelling for the four identified opportunity areas, to aid assessment and prioritisation of the opportunities.
- The feasibility of a city-wide heat network (connecting identified opportunity areas) providing low carbon, affordable heat to the city's residents and businesses.
- To identify additional opportunities, if now available.
- Detailed techno-economic feasibility study (TEF) for one or more of the opportunity areas, as appropriate.

The intention of this work is to help inform local planning policy approaches and identify district heating opportunities where funding under current and proposed national government schemes might be available.

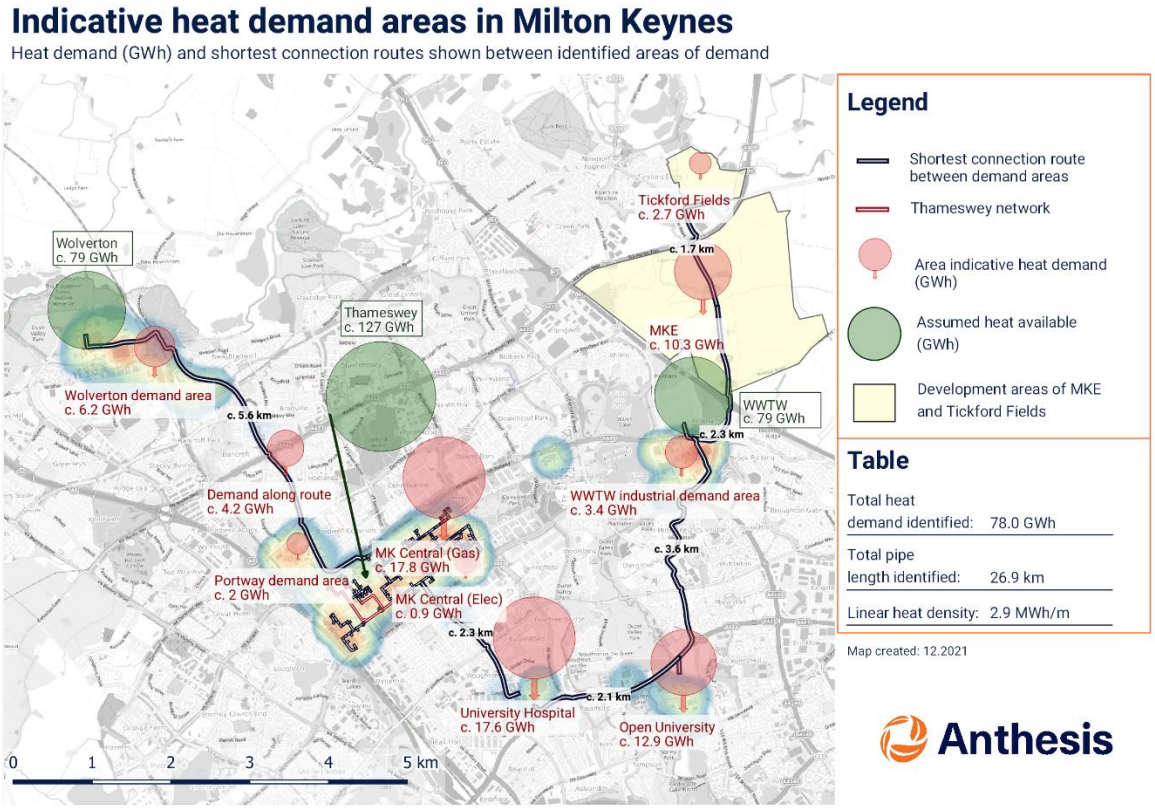
It should be noted that analysis for the report was restricted to the main grid squares rather than the local authority boundary to focus on maximising heat load and heat density which are key requirements for a commercially viable heat network.

1.3 Areas under review

1.3.1 Work Package 1 (WP1)

WP1 concluded in March 2022. This feasibility study sought to determine the viability of a city-wide heat network by linking together the opportunity areas identified (see Appendix 1), making use of waste heat supplies available and linking areas of current high and future heat load.

Figure 1: Potential maximally heat dense network linking demand areas with potential supply sources across Milton Keynes



A full techno-economic analysis was then undertaken for one of the opportunity areas identified. Using a ranking and prioritisation exercise, the Lakes Estate was identified for this analysis.

I Potential for a City-wide heat network

The study identified three heat sources within Milton Keynes:

- Cotton Valley Wastewater Treatment Works (WWTW)

- MK Waste Recovery Park
- Existing ThamesWey DHN energy centre (third party owned, gas fired systems)

The study concluded the following:

- The most likely district heating opportunities for Milton Keynes appeared to be the utilisation of waste heat either from the MKWRP or Cotton Valley WWTW.
- The most likely load centres remain Central Milton Keynes (CMK) and the Eastern Expansion area (a major residential extension, planned to the east of Milton Keynes)
- A district heating system linking these sources to CMK may be commercially viable with financial intervention (e.g., grant funding) and sufficient customer support (i.e., contractual commitments to heat supply) and local policy support such as heat zoning[1]. There is also the existing ThamesWey DHN system in this zone which requires a decarbonisation strategy, but does not appear sufficiently large (i.e., have sufficient existing demand) to justify these investments by themselves.
- Further detailed design development recommended building on the existing ThamesWey DHN system, with potential linkages to the CMK and Milton Keynes University Hospital (MKUH).
- The Lakes Estate was prioritised for TEF. The TEF concluded that district heating was less cost-effective, when considered in isolation, than alternative solutions at the Lakes Estates.

1.3.2 Work Package 2 (WP2)

Following the conclusion of WP1, Work Package 2 (WP2) was commissioned to carry out a detailed feasibility of a potential heat network, supplied by MKWRP, delivering heat to CMK and MKUH.

The study sought to test the viability of the DHN against two alternate options (also known as 'counterfactuals' for delivery of low carbon heat within the city. These options have been identified below:

Figure 2: Scenarios summary

Scenario	Summary
Counterfactual A	Additional residential and commercial customers to be served by **Air Source Heat Pumps (ASHPs)**. Existing networks at ThamesWey and the University Hospital to continue operating as usual until 2030, at which point switching to an ASHP solution.

[1] The Department of Business, Energy and Industrial Strategy (BEIS) closed a consultation on Heat network zoning in Nov 2021.

(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1024216/heat-network-zoning-consultation.pdf)

Counterfactual B	Additional residential properties to be served by **direct electric** heating. All other loads to be served as described in Counterfactual A
S1 –Waste Heat to MK Central Only	A **heat network solution** supplying heat from **MKWRP** to deliver heat to existing ThamesWey customers, as well as additional residential and commercial customers. The hospital operates as defined in Counterfactual A.
S2–Waste Heat to MK Central + Hospital	**Waste Heat to MK Central+ Hospital** – A heat network solution supplying heat from MKWRP to deliver heat to existing ThamesWey customers, as well as additional residential, commercial customers, and the hospital.

1.4 Outcomes of the review:

The review concluded the technical and commercial viability of a DHN in Milton Keynes. It also demonstrated that, when compared to alternate options for the delivery of low carbon heat in the City, a DHN connecting waste heat to CMK and hospital was the most cost and carbon effective option for the Council.

If the Council either delay or fail to progress the opportunity for a City-wide DHN, then the other options assessed, may become default options for the Council, businesses, and residents within the city.

1.4.1 Key opportunities

I Heat Supply: MKWRP

MKWRP is a national leading waste treatment facility operating within Milton Keynes. It is the only operating example within the UK. Of the three potential heat supplies investigated, MKWRP was considered to have the highest potential to offer a balance between low carbon and low-cost heat supply.

II Heat Offtakers: ThamesWey DHN

An existing district heating system is in place serving parts of Central Milton Keynes. The existing gas fired Combined Heat and Power (CHP) DHN system is currently under-utilised, despite its location, in an area of high heat use.

The existing system requires a decarbonisation strategy to decarbonise existing connected assets and increase appeal of future connection. This will require financial assistance (e.g., grant funding and/or investment) to realise.

III Heat Offtakers: MKUH

MKUH currently operate with a CHP and gas boiler led system. Its existing plant is coming to the end of its economic life and requires replacement in the near future. The hospital has identified the need to decarbonise its existing operations to transition to a low-carbon heat solution to align with the NHS Net Zero target of 2045. (It should also be noted that MKUH require a back up system to ensure business continuity)

1.4.2 Carbon emissions

Figures 3 and 4 show the likely carbon reduction trajectories for each of the modelled scenarios.

Figure 3: Carbon Trajectories for each scenario

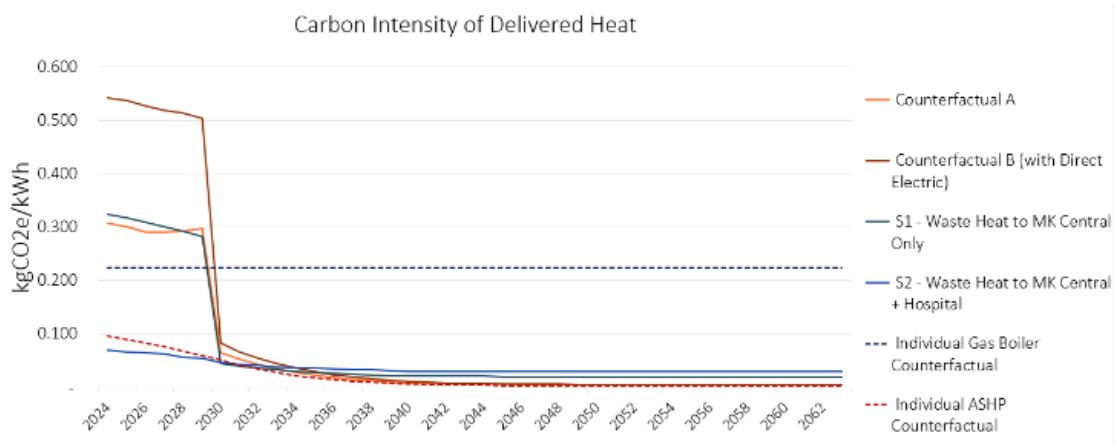
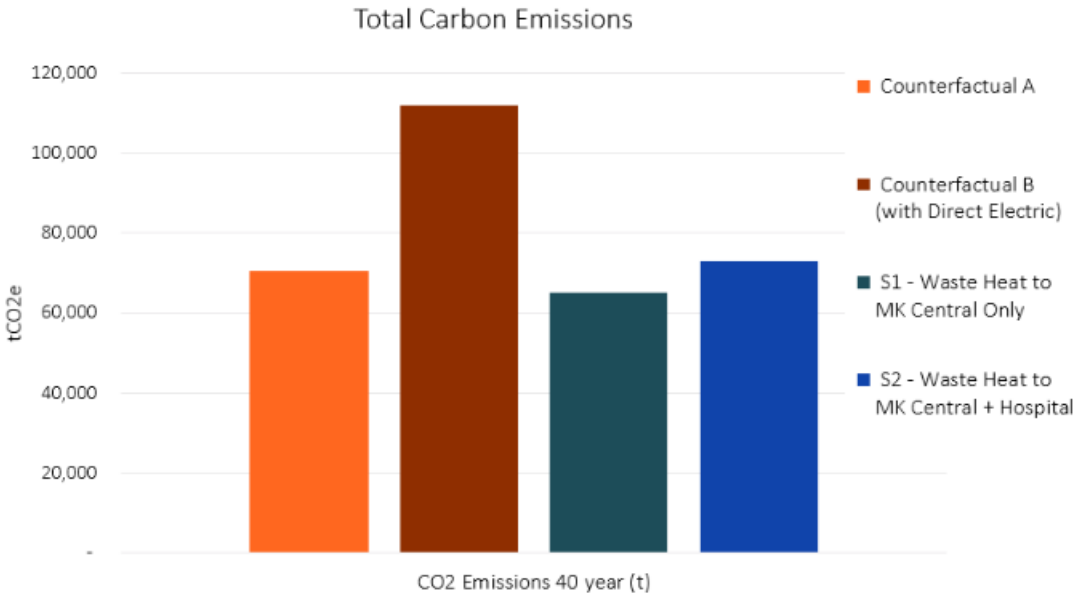


Figure 4: Total carbon emissions for each scenario over a 40-year period



All scenarios perform well compared to a gas-led system.

Scenario 2: Waste heat to CMK and the hospital, initially has the lowest carbon intensity of delivered heat due to the low carbon factor related to waste heat. All other scenarios have higher carbon intensities because they are initially running gas-based systems and due to the relatively high carbon factor of electricity at present.

Overall, the scenarios have very similar lifetime carbon emissions. This is because, as time progresses, the national grid is expected to decarbonise thereby reducing emissions related to electricity consumption. The counterfactual scenarios switch to ASHPs, which takes advantage of the grid decarbonisation.

However, it should be noted that a potential benefit of a DH solution is that they can reduce the impact on the electricity grid (see section 1.4.3) and do not rely as heavily on the decarbonisation of the grid to achieve carbon reductions. As the DH solution is predominantly using heat from the MKWRP, this reduces the dependency on external factors, and therefore reduces the risk of providing and achieving low carbon heat supply to the city of Milton Keynes.

1.4.3 Commercial analysis

Outputs from the Techno Economic Model (TEM) were assessed to determine the financial viability of developing, delivering, and operating a city-wide heat network. To determine the financial viability, heat demand, energy balances and capital cost data has been extracted from the TEM and combined with market-based assumptions on customer pricing and operational costs.

To be financially viable the project should return a positive return on investment whilst supplying customers at a price point below the counterfactual. To be investable by the private sector it is assumed that a 10% pre-tax, real rate of return is required, which consistent with market analysis carried out by BEIS.

The overall IRR for the project, extending to the hospital is 6.6% pre grant. This presents a commercially attractive opportunity despite the additional capital expenditure required. However, it should be noted that the extension of the network may facilitate further connections and overall heat demand not included in the model. This would reduce capex cost per kWh and ensure the capacity to cope with any future demand.

1.4.4 Key challenges for Milton Keynes

The key challenges identified for Milton Keynes are:

i. Current electrical distribution infrastructure is under stress, both for supply (in certain locations) and for additional embedded generation (e.g., PV and wind turbines) across Milton Keynes. This is ahead of additional load anticipated from both from increased transportation demand (i.e., vehicle charging), any electrification of individual or communal heating systems or further deployment of Low/Zero Carbon electrical systems as part of built assets (e.g., PV).
    - Western Power Distribution is the District Network Operator (DNO) for Milton Keynes.
    - There are three bulk electrical supplies to Milton Keynes at 33kV, likely supplied from the 132 kV substation at Bradwell Abbey. The bulk electrical supplies are located at Bradwell Abbey, Stony Stratford and Bletchley.
    - Stony Stratford is already overloaded, Bradwell Abbey has limited spare demand capacity and whilst Bletchley has headroom for both supply and additional generation, this does not include future requirements from the Eastern expansion site.
    - Both Stony Stratford and Bradwell Abbey are already constrained on additional generation connections, which may impact the future connection of additional renewables.

Table 1: Electrical demand and spare capacity reported by Western Power Distribution for local 33 kV substations

33kV Substation	Peak Demand (MVA)	Spare Demand Capacity (MVA)
Stony Stratford	128.98	-11.98 (overloaded)
Bradwell Abbey	71.9	45.10
Bletchley	127.81 (+27.46 for MKE)	45.73-73.19
Totals	**328 MVA**	**78.85-118 MVA**

ii. The low built density of the planned town approach reduces the viability of district heating as an alternative heat supply infrastructure.

iii. Several key geographical constraints exist through Milton Keynes which will need to be navigated with the assistance of the Highways and Planning Teams if the project were to go ahead. These include:
   - The M1 motorway – a major North/South road system in England, to the east of the town
   - The A5 Trunk road – running to the west of the city • Other major A roads including the A421
   - Two railways – the West Coast mainline to the west of town, and the Oxford to Bedford line currently under upgrade as part of the East-West rail link
   - The Grand Union canal, and river Ouzel – relatively substantive waterways

iv. Long term impact of the pandemic of demand and use of energy in the city centre and the impact that this might have on the viability of district heating.

1.5 Feasibility Report Recommendations

Review the potential to reduce capital costs:

- Obtain quotes to improve the accuracy of capital cost estimates
- Undertake an optimisation exercise to pipework sizing and assess routing the initial length of pipework through MKWRP
- Assess opportunities for consolidation of the proposed network and ThamesWey's planned network so that one set of pipework may be installed in the same sections of road where new ThamesWey connections are planned.
- Engagement should be carried out with heat customers to discuss current secondary network temperatures and whether they can be reduced.

Heat supply:

- Continue to track the performance of MKWRP to ensure modelling conditions are representative of reality
- Carry out further work to test how a reduced availability of the MKWRP would affect the economics of the relevant schemes.

Heat demand/ offtake:

- Further engagement with ThamesWey is recommended to discuss location for offtake heat
- Further stakeholder engagement, particularly with developers to assess and refine heat demand scenarios.

Network routing:

- Engage with utilities, network rail and other key stakeholders to clarify connection locations and requirements.

1.6 Next Steps

The Council is at a critical juncture in its heat decarbonisation strategy. Both feasibility Work Packages 1 and 2 have provided strong evidence of the technical and commercial viability of a city-wide heat network utilising waste from the MKWRP and potentially other sources.

The next step for the Council is to make a clear decision on how this project can move to delivery and its role in support of this.

There are options available to bring in grant funding and/or private sector investment to support the further development of the feasibility work and business case, and for capital investment in the infrastructure. To access this funding the Council needs to make decisions in a timely manner to avoid being timed out of grant funding opportunities.

It should be noted that if the Council either delay or fail to progress the opportunity for a city-wide DHN, then the other options assessed, may become the default options for the council, businesses and residents within the city. As the study has concluded these options are more expensive and have higher carbon intensities than the DHN. Furthermore, significant work will be required to ensure an effective roll out across the city in support of the Council's net zero targets.

Appendix 1: Opportunity Areas

The following areas were identified for consideration during the WP1 feasibility study:

I Eastern Expansion and Tickford Fields

- A major residential extension to the city has been planned to the east of Milton Keynes, known as MK East (MKE).
    - This comprises a total of circa 4600 residential homes, with associated community infrastructure (retail, schools, leisure etc) and warehousing planned to be constructed through to 2040.
    - The development is a greenfield site to the east, and directly adjacent to the M1 motorway, south of the A422 and west of the A509.
- The development is in the early planning stages.
    - There are two phases expected, aligned with anticipated building regulation amendments up to 2030.
    - These developments will require some form of green energy infrastructure (e.g., enhanced electrical networks or district heating) to facilitate construction.
    - A major part of the energy supply capacity for these developments is understood to have already been procured by the developer from district network operator (DNO) Western Power Distribution (WPD). This will require a new primary substation to be constructed as part of the development with an estimated £1M charge required for DNO upgrades and circa £13.5M for the substation and cable installation to the MKE area.
    - The developer is taking a ‘fabric first’ approach to minimise space heating demand in housing but is not proposing building ‘zero carbon homes’ or to ‘Passivhaus’ standards at this stage.
    - Highly variable electrical demands are envisaged from the planned warehousing, assumed to be distribution facilities. These may be very lightly loaded, if providing storage for general goods, or very heavily loaded if providing for example chilled food storage, or acting as a centre for electric fleet utilisation, and charging
- The redevelopment of the Tickford Fields area, currently owned by the council to the Northeast of the City, is also planned.
    - This is at an early stage, therefore there is currently no appointed developer or public details of master planning for this site.
    - Some aspirations for the site future have been developed, which provisionally includes an estimated 930 homes, some small retail, leisure, and a primary school.
- Cotton Valley sewage treatment works, owned by Anglian Water, is adjacent to the M1 and the A509 and could provide a resource to provide heat to the Eastern Expansion and Tickford Fields.

II Lakes Estate

- Planned regeneration project of social housing within the direct control of the Council.
    - The Lakes estate redevelopment encompasses 396 new units, of which 66 are new houses (mostly terrace form) and 330 apartments.

- There are 15 small commercial units of a variety of types proposed, mostly at ground floor level for the flat blocks.
- The scheme is to be developed in 2 phases.
- On trajectory for construction, having achieved outline planning.

- Initial estate design plan specified a district heating (DH) system and energy centre
  - The system proposed hybrid gas and heat pump heating solution.

III ThamesWey DHN

- An existing district heating system, ThamesWey DHN, is in place serving Milton Keynes city centre.
- ThamesWey Central Milton Keynes Ltd (TCMK) is a subsidiary of ThamesWey Ltd, a wholly owned subsidiary of Woking Borough Council.
- This is a legacy system serving 17 connections and fed from gas fired Combined Heat and Power (CHP) and gas boilers.
  - It is understood 6.3 MW_{th} 6.1 MW_e of CHP is co-located with 10 MW_{th} of conventional gas boilers.
- Although the system is located in an area of high heat use, the current network is under-utilised and will need to be decarbonised in line with Government strategy[2].

IV Milton Keynes Waste Recovery Park (MKWRP)

- In the North of Milton Keynes is MKWRP. This contains a national leading mechanical treatment, anaerobic digestion, and advanced thermal treatment waste facility, currently the only operating example within the UK. The facility processes the collected black bag waste from the Milton Keynes area
- The site currently produces heat which is used within the anaerobic digestion process and steam to produce electricity via a steam turbine.
- The facility has the capacity to produce 11 MWe with its turbine, though this is currently working at approximately 7MWe owing to calorific limitations on the residual material, which is a current bottleneck on the processing.
- There is a planned project at the facility to supply electricity for charging a local bus fleet via a Private Wire supply from the energy created from the waste.
- The facility utilises three quarters of the sit area therefore leaving approximately one quarter remaining of free land available, which has the potential in the future to accommodate additional energy reclamation processing facilities, were these to be required.

V Other areas for consideration

Milton Keynes University Hospital (MKUH) and the Open University (OU) are both located within Milton Keynes. Both MKUH and the OU have identified the need to decarbonise their existing operations, including heating systems and are working towards these objectives. They are also undergoing a review of their building assets and further

[2] Government strategy launched in December 2021 includes the Net Zero Strategy: Build Back Greener (https://www.gov.uk/government/publications/net-zero-strategy) and the Heat and Buildings Strategy (https://www.gov.uk/government/publications/heat-and-buildings-strategy)

measures required to address emissions reduction, particularly heating emissions from these.

- MKUH is a campus style hospital
    - Thermal energy use is moderately substantive with 7.15 MW_{th} peak capacity installed, estimated at circa 1.5 MW constant average heating load. This is, however, based on existing consumption which is expected to increase with expansion of the site.
    - Existing thermal energy is supplied from dual fuel boiler systems predominately fuelled by natural gas serving large heating systems. These are supported by two small Combined Heat and Power (CHP) systems (145 kW_e and 230 kW_e) with one of these at the end of its economic life and requiring major refit.
    - The hospital operates its own High Voltage electrical supply with a 4.5MVA import capacity.
    - As well as electrical supply from CHP, there is circa 850 kW_e of solar photo-voltaic (PV) systems on site generating zero carbon electricity.
    - There are also substantive cooling systems at the site
    - The hospital has historically explored interconnection with the ThamesWey DHN system, which is relatively local to the campus. This is not currently a priority because heat supplied from this system is currently from gas-fired CHP and not a low carbon heat source.
    - MKUH is independently investigating the installation of large Air Source Heat Pumps (ASHP) at the site serving existing or networked heating systems. This would include the expansion of electrical capacity at the facility to serve these additional loads.

- The OU operates a substantive campus at Walton Hall within Milton Keynes.
    - The OU, like the hospital is undertaking its own net zero carbon strategic planning across its built assets.
    - The campus has an existing district heating system serving circa 60 buildings and supplied from gas boiler plant.
    - Two major gas supplies feed the site, with a relatively recent district heating pipe network.
    - No CHP is present within the energy centre.
    - Several buildings around campus use natural gas directly in local plant to provide heat and hot water services.

Contact details
Vicky Kingston, Strategic Director – Energy, Local Partnerships
Email: Vicky.kingston@localpartnerships.gov.uk
Tel: 07876 594041