BURNS & McDONNELL

WASTE HEAT RECOVERY STATEMENT

DUB1 CAMPUS, DUBLIN IRELAND

DECEMBER 2022

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Introduction

The objective of this report is to address Planning Application Ref: SD21A/0241 Consent Decision ref:0616 dated 16-May-2022 Condition 3 issued by South Dublin County Council:

(a) *Proposals for waste-heat recovery and ongoing delivery to a local heat-network shall be provided and implemented on site as relevant, in conjunction with the commencement and operation of the proposed development. Prior to the commencement of development, a timeframe for implementation of waste heat proposals shall be submitted for the written agreement of South Dublin County Council, unless otherwise agreed in writing.*

(b) *Such proposals shall include all necessary infrastructure for waste heat recovery from the proposed development and delivery through a primary waste-heat water circuit to either, the boundaries of the site or to an Energy Centre (when constructed as part of local heat network distribution) for connection to heat network. Such proposals shall be submitted for the written agreement of South Dublin County Council, unless otherwise agreed in writing*

(c) *Where waste heat recovery and utilisation proposals have been explored and, subject to the written agreement of South Dublin County Council, have been deemed to be technically or otherwise unfeasible, details of future proofing of the building fabric, heat recovery and conversion systems and safeguarding of pipework/infrastructures routes up to the site boundaries to facilitate future waste heat connection to a local district heating network, shall be submitted for the written agreement of South Dublin County Council or as otherwise agreed in writing.*

REASON: To promote the utilisation and sharing of waste heat and comply with Policy E5 of the South Dublin County Development Plan 2016-2022.

The SDCC Development Plan 2016-2022 Policy E5 states:

ENERGY (E) Policy 5 Waste Heat Recovery & Utilisation
It is the policy of the Council to promote the development of waste heat technologies and the utilisation and sharing of waste heat in new or extended industrial and commercial developments, where the processes associated with the primary operation on site generates waste heat.
E5 Objective 1: To promote the development of waste heat technologies and the utilisation and sharing of waste heat, in new or extended industrial and commercial developments, where the processes associated with the primary operation on site generates waste heat.
E5 Objective 2: To promote the development of local energy partnerships among businesses in the County.
E5 Objective 3: To promote increased energy self sufficiency across business sectors.

The Site

Data Centres are recognized as a type of facility where the process power to IT Equipment and the cooling power required to maintain reasonable operating temperatures creates a significant amount of waste heat. Warm air from the data halls is cooled by passing it through water-cooled air handling units. Most of the transferred heat is discharged to atmosphere via chiller units at roof level. Although the total quantity of heat is large, the temperature difference in the water circuits is about 7.7ºC - in engineering terms "low-grade" which means it cannot be used as a direct energy export for heating buildings. It could have export potential for another process which uses low grade heat such as growing plants in polytunnels.

The DUB1 campus also has a Multifuel Power Generation Plant (MFGP) which can generate up to 100MW of electricity to make up a shortfall in the local utility power supply. This is generated by 10 large generators powered by mains gas or by Hydrogenated Vegetable Oil, or by standard diesel. The design has built in this flexibility to ensure resilient power is always available for the data centres. The engines in the generators have cooling jackets and cooling water is passed through radiators on the roof to expel the heat from the engines. This report examines the extent to which this waste heat could be exported for re-use.

There is, however, no district system in the area that the campus could provide heat to at present.

The development of heat networks (or district heating) is increasingly recognised as an important component in our future energy strategy and is a recommendation of the 2015 Codema report titled 'South Dublin Spatial Energy Demand Analysis'. The base data underlying this analysis dates back to 2014 and should be updated to take account of the significant changes in the energy profile and mix in the South Dublin area. It still is useful in anticipating the growth in demand across the county. Heat networks should aim to meet the following strategic aims:

- To reduce greenhouse gas emissions through the use of a wide range of low carbon and renewable heat sources.
- To improve security of energy supply by diversifying the energy sources for heating and reducing our dependence on fossil fuel imports.
- To offer a supply of heat that is good value and that contributes to reducing fuel poverty.

A major challenge of waste heat recovery is to deliver a high standard of service to customers, which requires a high-quality installation offering good reliability, a long life, low carbon intensity of heat supplies and low operating costs. The cost-effectiveness of the heat supply will also depend on achieving low-cost finance over a prolonged period of time and funders will also be looking for long term performance and reliability.

The principal ways in which the high-level strategic aims are achieved are through the following broad goals which need to be considered in each stage of the project:

- Correct sizing of plant and network
- Appropriate use of new technologies
- Achieving low heat network heat losses
- Achieving consistently low return temperatures and keeping flow temperatures low
- Use of variable flow control principles
- Optimising the use of low carbon heat sources to supply the network
- Delivery of a safe, high quality scheme where risks are managed and environmental impacts controlled

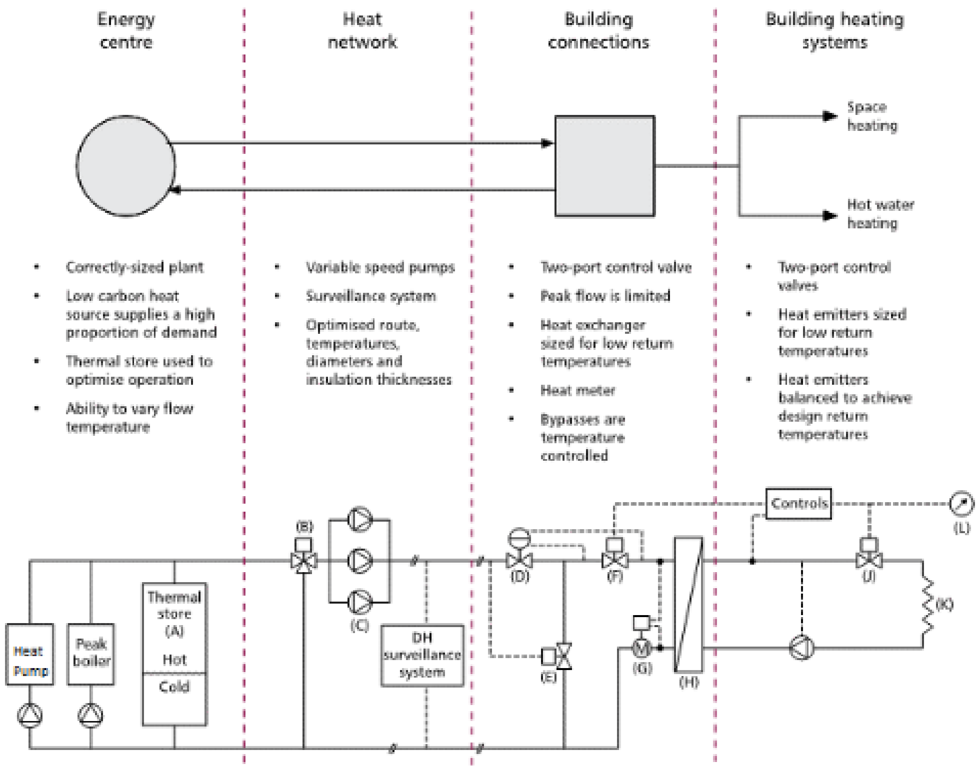

Figure 1: Illustration of typical features of an efficient heat network

SDCC Strategy

The following is extracted from the 2015 Codema report titled 'South Dublin Spatial Energy Demand (SEDA) Analysis' 'To combat the effects of climate change, to reverse the dependency on imported fossil fuels and to reduce energy costs across all sectors, South Dublin County aims to respond in a way that prioritises and unlocks local low carbon and renewable energy opportunities, in partnership with all stakeholders, to 2022 and beyond. One of the key findings of the SEDA was to identify priority areas for District Heating. The Codema report recommends that the areas identified within this SEDA that are deemed to be very suitable for DH schemes in terms of heat demand density should be prioritised by the Council when evaluating implementation of low carbon DH networks in South Dublin County.

Through supporting DH implementation, the Council can kick start a new method of delivering energy in South Dublin County which would result in lower energy costs, lower carbon emissions, and greater utilisation of local resources. The potential to use renewable and low carbon resources, such as CHP and deep geothermal sources, in DH systems in South Dublin County is most relevant in the ten highest Areas of Potential.

Many of these areas are located within the same Electoral Division area, and so could be grouped with other adjoining / nearby areas of high heat density, thereby representing the area's most viable for district heating projects. There should be particular focus on utilising currently wasted heat sources, found in areas identified in the SEDA that have high levels of commercial activity and industrial processes.

The opportunity to use these heat sources which are currently going to waste, and at the same time reduce cooling costs, is currently not fully recognised, and the local authority should encourage the utilisation of waste heat to supply nearby heat demands. Further analysis of the location and size of waste heat sources and the opportunity to recover such waste heat is recommended.

It is clear therefore that the council are interested in utilising District Heating and utilising waste heat sources such as those found in data centres. The above report will inform future planning policies at the council. District heating has already been proposed and is being implemented in the Dublin Docklands utilising the waste heat from incinerators currently under construction in Poolbeg. All new buildings in the docklands will have provision for future connection to the scheme. The scheme will be capable of providing heat to 80,000 households.

The UK has many such schemes and there is particular emphasis currently in London on decentralised heat and power generation and heat networks.

http://www.londonheatmap.org.uk/Content/home.aspx. The technologies are sufficiently mature to allow for the roll out of such scheme in Dublin provided there is the political will to do so.

The recovery of waste heat from datacentres has advantages over incineration in that the heat produced is clean and there are no issues with regard to toxins etc., however, the low temperatures of the waste heat generated from the data centre reduce the effectiveness of this waste heat.

The Codema report states that the metric generally used to establish initial feasibility of DH systems is any heat density >150TJ/km^2. Their analysis also provided a table with the top 10 areas in terms of heat demand in TJ/km2 illustrated below. Most of the areas are located in Tallaght with two in Clondalkin. Therefore, in order to maximise the use of the District heating scheme, a line would need to be provided to Tallaght. Future developments

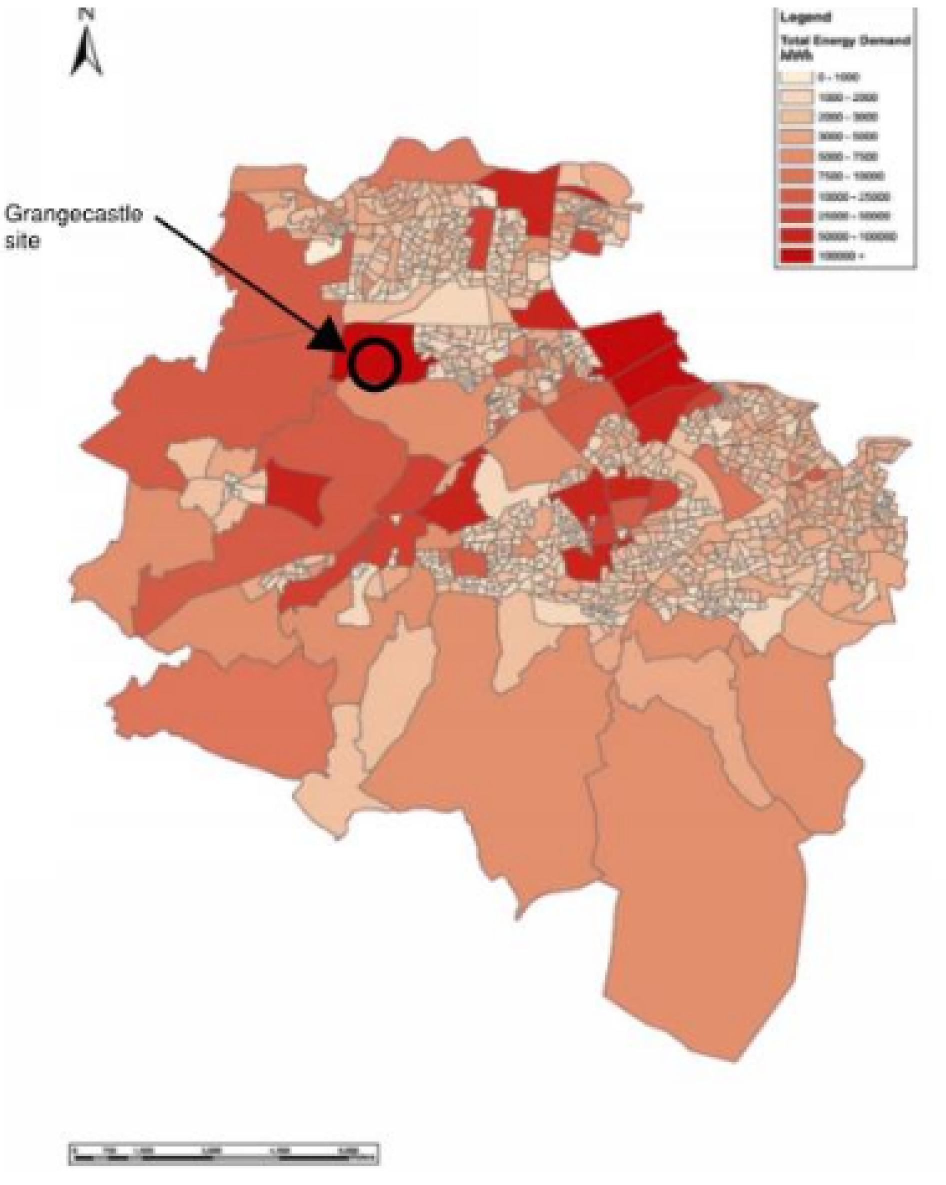

Figure 2: South Dublin CoCo Total Energy Demand Map (MWh)

in Clonburris should also be planned to have possible district heating connection.

ED Name	Area km^2	TJ/km^2
Tallaght-Springfield	0.005	1212
Tallaght-Springfield	0.010	743
Tallaght-Springfield	0.009	711
Templeogue Village	0.005	554
Tallaght-Springfield	0.003	442
Tallaght-Kingswood	0.034	432
Clondalkin Village	0.065	429
Templeogue Village	0.059	405
Clondalkin-Monastery	0.028	394
Tallaght-Oldbawn	0.039	358

The site under consideration as part of this report is in on the New Nangor Road and is part of the Grange Castle South Business Park. At present there is currently no infrastructure provided for a district heating network, and the nearest potential location for district heating from the Grangecastle site is in Clondalkin, approximately 5km (3 miles) away. The connection is therefore unfeasible as there is no system to provide heat to. Further technical studies would be required to establish routes, potential demand and a robust cost model. The total waste heat output of the several large existing and planned data centres in this area would suggest that a coordinated approach with a waste heat distribution network in the Grange Castle campuses could provide a substantial reservoir of heat energy.

Vantage DUB1 Data Centre Campus - System Description

The consented DUB1 Campus comprises two data centres with a combined IT energy load of 52MW (32MW+20MW). A third building on an adjacent site may add a further 20MW, subject to planning consent.

The cooling demand to data hall spaces is met through a chilled water hydronic system, generated by roof-mounted air cooled chillers. Internal conditioning is met via computer room air handlers (CRAHs) connected to this system.

Each chiller is provided with an integral chilled water pump. Piping for the critical chilled water system is in a ring topology above the roof and is concurrently maintainable.

The total (peak) waste heat energy available has the potential to be a maximum of 25% of the active IT load, circa 13MW for the DUB1 campus. This heat output would be the peak condition, where the data center is running at full capacity in the warmest ambient conditions of the year.

Some of the data hall waste heat is used to heat the offices and support areas – typically 200-300kW as part of energy efficiency measures for the facility.

Although the data center is intended to be running continuously, the heat output available for recovery is seasonal. This is because the return temperature of the water will be a function of the ambient air temperature. When the ambient air temperature is low, the amount of heat will in turn be lower. Heat recovery potential is greater in summer than in winter – the inverse of demand for heat energy for a district heating system.

Multifuel Power Generation Plant – System Description

The electricity connection supply agreement with EirGrid for a main supply to the campus mandates that the customer provides a 100MW on-site power plant which can feed energy into the national grid when required. As it will be some time before a full utility supply will be available, Vantage will build a new on-site power plant with 11 x 9.78 MW generators. The engines are capable of running on natural gas, or a natural gas/hydrogen mix, or HVO bio-diesel to ensure resilience of power to the facility. Each engine has a cooling circuit with roof-mounted radiators to remove excess heat from the engines. The total waste heat energy available is assessed at 25MW at full load.

The use of the MFGP is intermittent by nature. It is only active in periods where the supply produced by the grid is lower than the demand required. The MFGP would act as a ‘top-up’ to meet this shortfall in demand. This means the heat output available for recovery would be intermittent and would rarely output the maximum capacity it is sized for.

Strategy for Waste Heat Recovery – Data Centres

Despite it not being possible to connect to a district heating system due to the lack of infrastructure at present, the design has been future proofed to connect to one should it be installed in the future.

Space has been allocated for a dedicated plantroom for the provision of plate heat exchangers. This would facilitate the future connection of flow and return district heating pipework from outside the site. The source side would be connected to the return line of the chilled water circuit serving data hall spaces. The user side would connect into the district heating network.

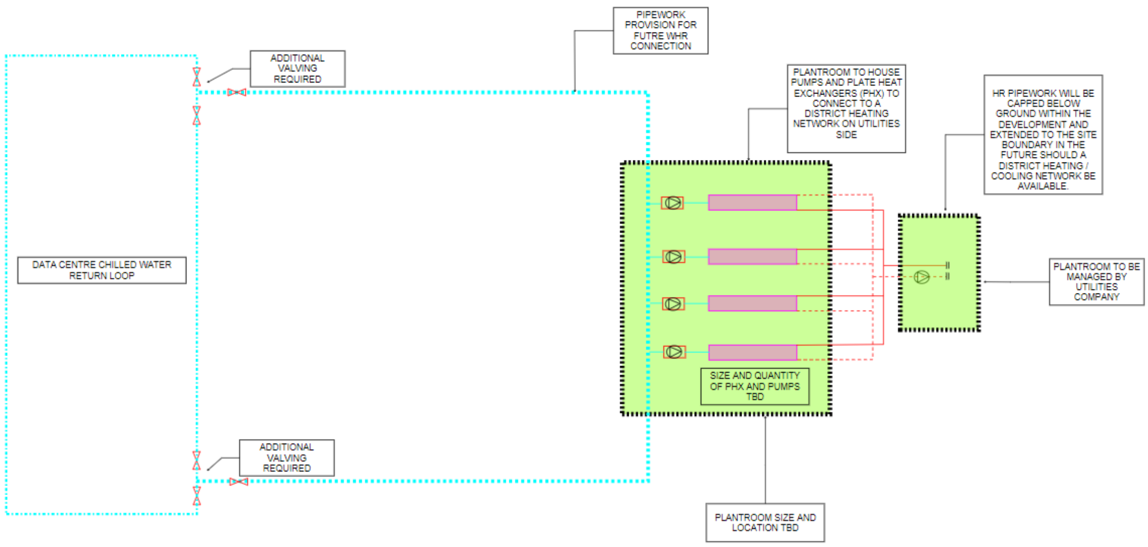

Figure 3: Data centre waste heat recovery loop

There is adequate space below ground to route the district heating pipework from outside the site to the district heating plantroom. Pipework will be installed from day one from the plantroom to the edge of the site, to facilitate the connection to the critical chilled water loop connected to a plate heat exchanger and thus eliminate the risk of intrusive works in the future to allow the heat recovery connection.

Design modifications required are as follows:

- Design, coordination and installation of above ground source-side pipework.
- Design, coordination and installation of plate heat exchanger plantrooms on site, as well as lodging the associated planning permission
- Selection and installation of circulating pumpsets and plate heat exchangers
- Coordination and installation of user-side pipework from the edge of the site
- Calculations for required pump pressure
- Development of schematics
- Additional scope to electrical and controls/automation

If the future district heating network does not get built, the proposed development will still use this waste heat as the primary heat source for space heating within the data centre buildings. A water source heat pump is used to upgrade the temperature of this water such that it is suitable for space heating.

Strategy for Waste Heat Recovery – MFGP Plant

Similarly, the waste heat for the MFGP can be recovered and transferred to a district network through a plantroom housing a bank of plate heat exchangers, although this remains unfeasible at present due to the lack of installed infrastructure.

The return water from the engines cooling circuit would pass through the heat exchangers before running to the roof-mounted radiators (which will pass off any further excess heat to atmosphere).

Pipework connections will be installed from day one running from the MFGP to the edge of the site to future proof the design and to eliminate the risk of intrusive works in the future.

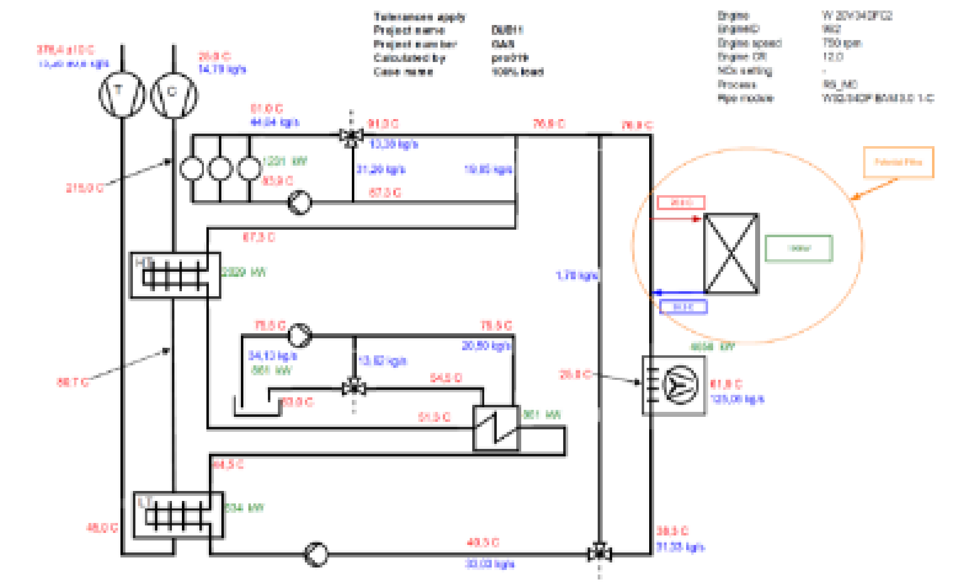

Figure 3: Data centre waste heat recovery loop

This system can provide up to 100kW of heat per engine if the district heating infrastructure is installed in the future. Nevertheless, due to the complexity of these engines, this option will only be viable if the flow and return temperatures on the source side can be maintained, i.e., 76.9 Deg C flow and 38.3 Deg C return temperatures.

Once the system on the user side is designed, the engine manufacturer will need to review the design on the user side to ensure it complies with the conditions required for engine operation.

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- Calculations for required pump pressure
- Development of schematics
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Conclusion

The use of a waste heat recovery system for the data center development is currently not feasible, although it can be achieved in the future once district heating infrastructure is installed. Provisions have been made at the design stage to install the additional underground pipework and include space allocations for dedicated plantrooms to house the heat exchangers. The heat output from the data center is likely to be seasonal, with the maximum output occurring during periods where the ambient air temperature is high.

The use of a waste heat recovery system for the MFGP is also unfeasible at present, although it could be provided in the future. Provisions at the design stage have been made to install the additional underground pipework and include a space allocation for dedicated plantrooms to house the heat exchangers. The heat output available for recovery from the MFGP is intermittent, and unpredictable since the power plant is only to be active when required to meet shortfalls in the grid. The nature of the engines, however, allow a very limited water temperature bracket for this design to be feasible in practice, and the design would need to be validated by the engine manufacturer if and once the user side has been designed.

While there are obvious advantages to data centre heat recovery, the main obstacle to the roll out of such a scheme would be in how the scheme would be financed. District heating would need to be a fundamental strategy adopted by Government if such schemes are to be progressed. There would also need to be a programme to phase out or restrict the use of fossil fuels. Only in such circumstances would a heat recovery scheme become viable. Such an approach is part of planning policy in many cities including London where the policies, strategies and frameworks are already in place. Density of development and heat demand are necessary to make such schemes financially viable.

The adoption of waste heat recovery from the Vantage DUB1 Data Campus would provide some technical challenges and its implementation would be dependent on the availability of the future district heating network infrastructure externally to the site and end users with sufficient demand to absorb the available heat.

Further design and feasibility work should be done by a District Heating specialist to determine if the variable and seasonal amount of waste heat from the campus could be utilised in a commercially viable way.

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