EdgeConnex DUB05
Heat Recovery Feasibility

20D102 Heat Recovery Feasibility

17/02/21

ethos
ENGINEERING

EdgeConnex DUB05

Heat Recovery Feasibility

20D102

CURRENT ISSUE			
Issue No:	03	Issue Date:	22nd February 2021
Sign Off	Originator:	Checker:	Reason for Issue:
Print Name:	Ben O'Leary	Gary O'Keeffe	Planning Application

PREVIOUS ISSUES (Type Names)				
Issue No:	Date:	Originator:	Checker:	Reason for Issue:
01	28th January 2021	Ben O'Leary	Gary O'Keeffe	For Discussion
02	17th February 2021	Ben O'Leary	Gary O'Keeffe	For Discussion

Table of Contents

1. Site Introduction

EdgeConneX Ireland Limited are applying for permission for development at this site of 22.1hectares that is located within the townland of Ballymakaily to the west of the Newcastle Road (R120), Lucan, Co. Dublin.

The development will consist of the construction of two no. single storey data centres with associated office and service areas; and three no. gas powered generation plant buildings with an overall gross floor area of [illegible] that will comprise of the following:

- Demolition of abandoned single storey dwelling, remaining agricultural shed and derelict former farm building;
- Con[illegible] with 24 no. standby diesel generators with associated flues (each 25m high) that will be attached to a single storey goods receiving area / store and single storey office area (2,[illegible]sqm) located to the west [illegible]es;
- amendments to the internal access road and omission of access to loading bay permitted under SDCC Planning Ref. SD[illegible] / ABP Ref. PL[illegible] that include the relocation of permitted, and new, internal security gates; and new internal access roads to serve the proposed development that will provide access to [illegible] and sheltered bicycle parking to serve the new data centres;
- [illegible]on plants (9,286sqm) within three individual buildings and ancillary development to provide power to facilitate the development of the overall site to be located within the south [illegible] part of the overall site. G[illegible] high) will facilitate, once operational the decommissioning of the temporary Gas Powered Generation Plant within its open compound as granted under SDCC Planning Ref. SD[illegible]042 / ABP Ref. [illegible]ed flues (each 25m high), and Gas Plant 3 ([illegible]sqm) will contain 21 no. Generator units (19+2) with associated flues (each 25m high). These Plants will be built to provide power to each data centre, if and when required. The Gas Plants will [illegible] power [illegible];
- New attenuation pond to the north of the site;
- Green walls are proposed to the southern elevation of each Power plant, as well as to the northern [illegible]m compound; and a new hedgerow is proposed linking the east and west of the site; and
- Proposed Above Ground Gas installation compound to contain single storey kiosk ([illegible]sqm) and boiler room [illegible]

The development will also include ancillary site works, connections to existing infrastructural services as well as fencing and signage. The development will include minor modifications to the permitted landscaping [illegible] The site will remain enclosed by landscaping to all boundaries. The development will be accessed off the R120 via the permitted access granted under SDCC Planning Ref. SD[illegible] / ABP Ref. PL06S.30[illegible].

An [illegible] Generation Plant. An Environmental Impact Assessment Report (EIAR) has been submitted with this application.

2. Report Introduction.

The objective of this report is to address point 1 of FI request; to review the EdgeConnex DUB05 design and demonstrate the possibility for reuse of waste heat from the site by facilitating connections to any district heating scheme that may be developed in the future. Data centres contain large amounts of computer equipment which generate heat. The majority of this heat is currently rejected to atmosphere. This report outlines the key considerations around district heating and its application to the DUB05 Date Centre

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'. Heat networks can address the 'energy trilemma' by meeting 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 will be to deliver a high standard of service to customers, who will have had good long-term experience using gas-fired boilers. Therefore, a high quality installation offering good reliability, a long life, low carbon intensity of heat supplies and low operating costs will be key. The cost-effectiveness of the heat supply will also depend on achieving low-cost finance over a long period of time and funders will also be looking for long term performance and reliability.

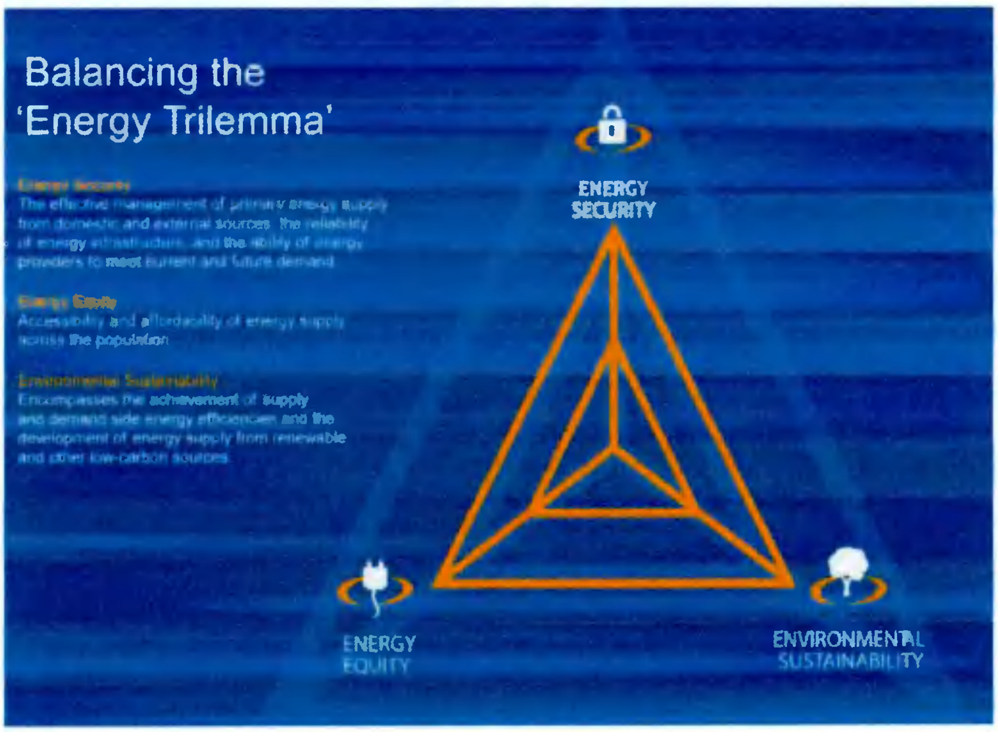


Figure 1: Balancing the 'Energy Trilemma' (worldenergy.org)

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

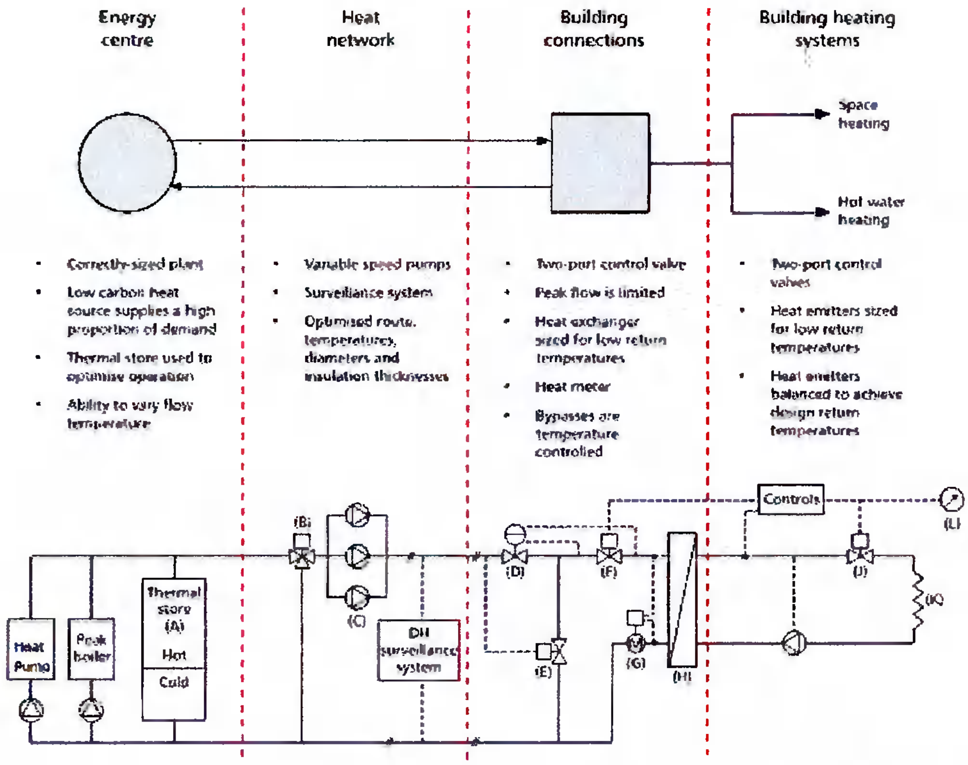


Figure 2: Illustration of some typical features of an efficient heat network

3. 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 will 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 as shown in Figure 11. 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.

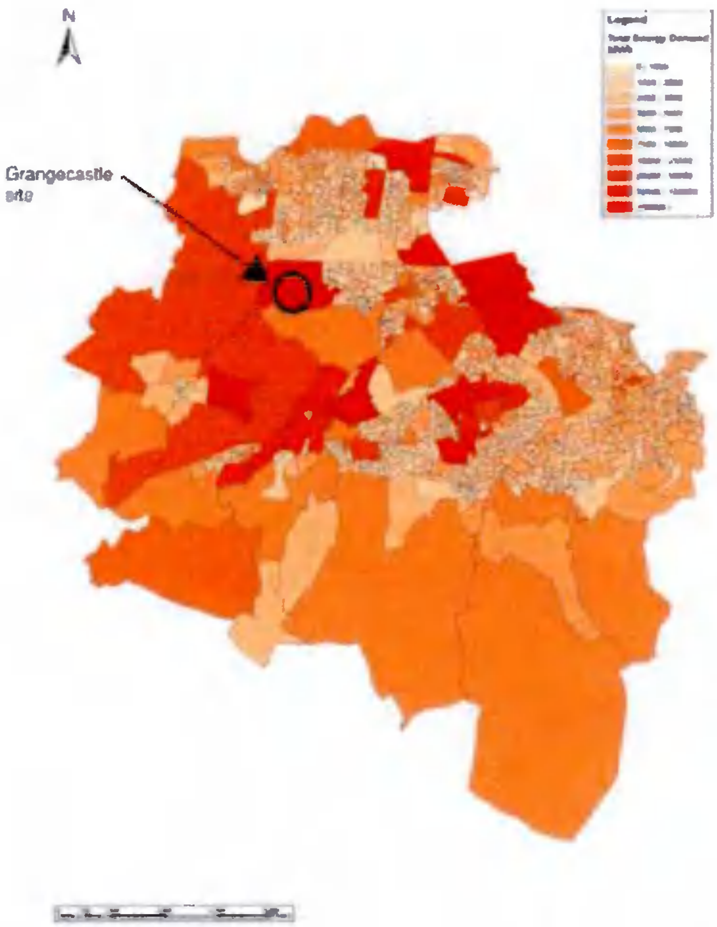


Figure 3: South Dublin CoCo Total Energy Demand Map (MWh)

The Codema report states that the metric generally used to establish initial feasibility of DH systems is any heat density >150TJ/km². 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 in Clonburris should also be planned to have possible district heating connection.

ED Name	Area km²	TJ/km²
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

Figure 4: Possible DH route to future Clonburris (4km)

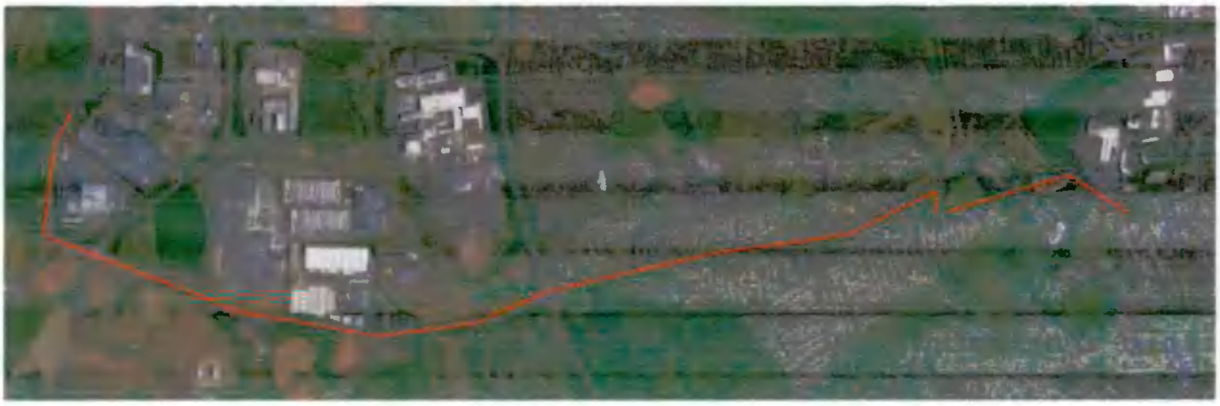


Figure 5: Possible DH route to Clondalkin and red cow (7.5km)

The site under consideration as part of this report is in Grangecastle. The nearest potential location for district heating from the Grangecastle site is in Clondalkin, which is approximately 5km (3 miles) away.

The images above show possible routes for the district heating network from the Grangecastle campus to areas of sufficient demand to make them feasible. Long distribution runs are not uncommon. The recently installed Queen Elizabeth Olympic Park in London features an 18km district heating network.

Connection to the Site Could be made from wither District Heating Route with the same entry point as shown in Appendix B.

At present there is currently no infrastructure provided for a district heating network.

4. EdgeConnex DUB05 Data Centre

4.1. System Description

The proposed DUB05 Data Centre will provide 2 Colos with a combined IT Capacity of 30.0MW The cooling demand to the data hall spaces is met via an Indirect air cooling system featuring roof mounted units manufactured by VERTIV (a data sheet for the current selection can be found in Appendix A which include the Munters Media performance cut sheet).

The units utilise a passive and active circuit maximising the use of passive circuit when ambient air allows to reduce energy consumption. Ambient air is used to condense the refrigerant which returns to the evaporator under gravity. Warm air from data centre evaporates the refrigerant which rises back to the condenser. No refrigerant pumping is required with gravity and syphon effect used to circulate refrigerant through heat exchangers leading to significant energy saving. Units indirect cooling cycle reduces the potential risk of contamination from external air pollutants, as no outside air is introduced for cooling.

The selection of this innovative technology is fundamental in minimising the impact of the cooling system on the environment by minimising the use of electrical energy required to power the equipment.

During passive phase operation when the ambient conditions allow a condensing fan array will run variable speed to condense the fluid which returns by gravity to the evaporator, which in turn cools the data hall return air. A process fan array will run to maintain the design supply temperature. During these hours (approx. 95% of the year) there will be no DX power consumption and unit fan speed control will operate to minimise power consumption.

The unit currently being considered as part of the specification is a twin circuit unit, each with 4 compressors per circuit. 6 Scavenger fans are used to pull ambient air across the condensers and 5 process fans recirculate air from the data hall across the evaporator. All components are contained within a single housing at roof level.

The Units will be installed on the roof for heat rejection from the data hall space. As the site is noise sensitive, due to the proximity of residential properties to the East of the site, acoustics for the plant selections was one of the key criteria. This has led to oversized condensers being selected, which are capable of achieving the required heat rejection at a reduced fan speed to meet the required noise criteria. The oversized condensers also require less fan energy due to the increased conductive heat transfer area and slower running fans, further reducing the overall power use.

The amount of heat rejected is dependent on the outside air temperature as during times of lower outdoor temperature the outdoor air is mixed with hot return air to achieve a constant supply air temperature. At winter ambient temperatures, the data centre reuses up to 70% of the heat generated by the servers to heat the incoming air to the space. It is only once ambient temperatures reach 20°C that the full heat load of the servers is rejected to atmosphere.

4.2. Options for heat recovery

There is currently one option for recovering heat from the condenser circuit. The first option is to run a set of heating pipes above the condenser to recover heat from the warm air. This is discussed in further detail below.

4.2.1. Option for Heat Recovery Coil Within the Air Handling Unit

This involves installing a network of pipes above the condenser/scavenger fan array. Water would be circulated through this network of pipes to recover heat from the fan exhausts. Obstructing the fan exhausts with a network of pipes would cause an additional pressure loss to the fans within the condensers. Currently the fans have their speed limited to achieve the desired noise criteria and additional condensers provided to ensure that the heat could be rejected. If the pressure drop across the condenser coils increases, there will need to be an associated increase in fan volume to achieve the same level of heat rejection. This will impact the noise output from the condensers, and will likely draw complaints from the nearby residents.

Ownership of the plate heat exchanger would need to be considered as well as access.. As the site is secure, any plant access would have to be provided at the site boundary, with any personnel or vehicular access provided immediately outside of the secure site boundary. In the event that access to this plantroom is required this will need to be managed by the on-site security team.

Additionally, as identified previously in this report, the condensing temperature during passive phase mode is lower than when the system operates in active phase. The system would operate in passive mode when the demand for heat would be at its greatest (i.e. winter). The lower condensing temperature would likely negate any benefit for heat recovery that could be achieved. To achieve the maximum potential heat recovery benefit the compressors would need to operate all year round, which would impact on the buildings overall power utilisation effectiveness (PUE) and overall carbon emissions (due to higher electrical usage).

4.3. Design Modifications Required

For the heat recovery option described above, the current arrangement for the cooling would be unchanged from the standard configuration. During the winter months, or at periods when the ambient temperature is low enough, the system will operate in passive mode. The condensing circuit temperatures are lower than they would be when operating as a traditional air-cooled condenser therefore any heat that could be recovered from the system would be minimal. To achieve any form of waste heat recovery, the compressors would need to operate to get the condensing circuit temperature above 40°C in both circuits. This would affect the overall PUE of the facility. There is also the additional pressure drop to consider across the condenser fans.

The operation of the district heating scheme would be based on heat recovery from the data centres using the principal of a water loop heat pump (WLHP). This will be achieved by utilising air to water heat recovery coils which will transfer the waste heat from the data centre to a water loop at approximately 35°C. This water loop would then be pumped to an external District Energy Centre which will contain industrial scale (MW) water to water heat pumps which will raise the temperature of the water loop from 35 °C to 90°C for transmission through the district heating network. The high temperature is required in order to keep pipe sizes small and pumping power low. A feasibility report would need to be commissioned in order to decide on the final flow and return temperatures in the DH network.

To ensure a satisfactory level of service it is normal practice to include gas-fired boilers as standby plant should the primary heat source fail. Such boilers are often also used to help meet peak demands during the coldest weather, often referred to as top-up duty. The low carbon plant that supplies the majority of the heat to the scheme is normally a higher capital cost and it would be uneconomic to size this plant to supply the peak demands.

Figure 7: Example of a large scale Heat pump up to 20MW (Friotherm)

4.4. Application of DH to Grangecastle waste heat scheme

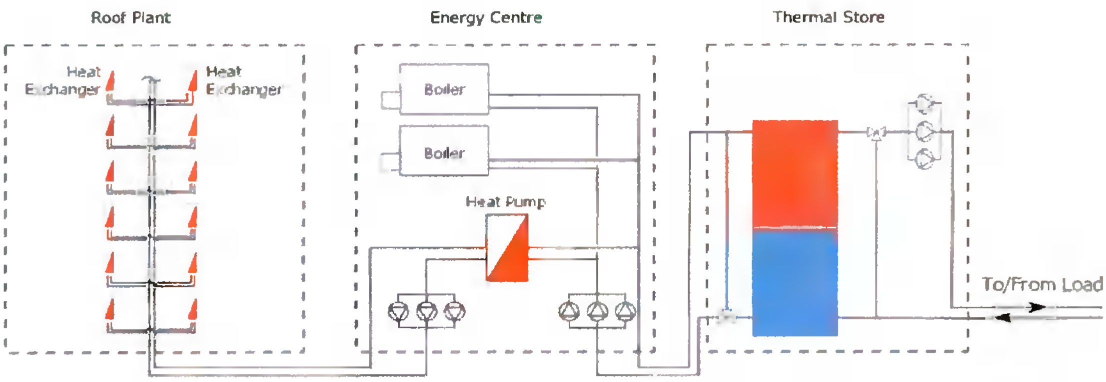


Figure 8: Example of District Heating System Schematic

The above diagram outlines a possible solution for the heat recovery network from the EdgeConnex Data Centre. Each heat exchange in the roof plant area represents either the heat exchanger noted earlier in the report. The network consists of a large water circuit on the site linking the Air Handling Heat Recovery coils to an energy centre where water to water heat pumps raise the temperature to 80-90°C for distribution. The heat pumps are supplemented by high efficiency gas fired boilers to accommodate peak demand. A Thermal storage arrangement allows the system to smooth out peaks and troughs in demand before final distribution to the end user.

Space would need to be provided on site for a plantroom containing pump sets, water treatment plant (including ethylene glycol to prevent the water in the pipework freezing) and a plate heat exchanger, which will act as a hydraulic separation between the district heating network and the customer side interface. Any issues with the district heating network can then be resolved without impacting the operation of the data centre facility and avoid non data centre staff having to gain access to the site for any maintenance.

Ownership of the plate heat exchanger would need to be considered as well as access to the plantroom. As the site is secure, any plantroom access would have to be provided at the site boundary, with any personnel or vehicular access provided immediately outside of the secure site boundary.

5. Conclusion

The use of a waste heat recovery system for the development is not technically feasible due to the limitations of the temperatures available within the return air and subsequently the heat exchanger, particularly during the winter months. Based on the current system arrangement which utilises passive condensing and evaporative circulation arrangement that still meets the cooling demand during the winter months without the operation of the compressors or refrigerant pumps, resulting in much lower discharge air temperatures.

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 in order to make such schemes financially viable.

The adoption of waste heat recovery from the EdgeConnex Data Centre provides a number of technical difficulties and its implementation would be dependent on the availability of the district heating network infrastructure externally to the site and end users with sufficient demand to absorb the available heat. The Application of the options outlined in the report would have significant impact on the design of the data centres both in terms of the buildings physical size and the day to day operation of the cooling systems. Should district heating scheme be implemented as a fundamental energy saving strategy then the data centre could be connected as outlined in Appendix B.

Appendix A

Appendix B

Liebert® DSE 500 Packaged Solution

VERTIV™

Product Selection

Edgeconnex Dublin

2/20/2019

Liebert® DSE 500 Packaged Solution

Site Information

City: Dublin Altitude: 278 ft.

	Unit Performance								Supply Air Fans					DX Cooling System			Unit Load Information		
Amb. Temp. (F)	Unit Net Cooling Capacity (kW)	Design Return Airflow (ACFM)	Return Air Temperature: DB (F)	Return Air Temperature: WB (F)	Design Supply Airflow (ACFM)	Supply Air Temperature DB (F)	Supply Air Temperature WB (F)	Standard Airflow (SCFM)	External Static Pressure (In.)	Internal Static Pressure (In.)	Filter Static Pressure (In.)	Total Fan Static Pressure	Fan Power Load (kW)	Compr. Electric Load (kW)	Cond. Fan Load (kW)	SCOP	Max Unit Electrical Load (kW)	Peak PUE	
86	451.3	69348	96.8	68	66656	75.2	60.8	65000	0.5	2.06	0.24	2.80	42.29	82.9	21.0	3.07	147.1	1.33	1
86	450.4	69969	102.2	68	67279	80.6	60.8	65000	0.5	2.08	0.25	2.83	42.6	76.5	21.0	3.19	141.1	1.31	1
95	451.3	69348	96.8	68	66656	75.2	60.8	65000	0.5	2.06	0.24	2.80	42.29	95.7	21.0	2.82	160.0	1.36	1
95	450.4	69969	102.2	68	67279	80.6	60.8	65000	0.5	2.08	0.25	2.83	42.6	89.5	21.0	2.92	154.1	1.34	1
86	479.2	69348	96.8	68	66489	73.9	60.4	65000	0.5	2.06	0.24	2.80	42.29	88.9	21.0	3.13	[illegible]	1.32	
86	508.6	69969	102.2	68	66931	77.8	59.8	65000	0.5	2.08	0.25	2.83	42.6	90.1	21.0	3.29	154.7	1.30	
95	459.1	69348	96.8	68	66609	74.8	60.7	65000	0.5	2.06	0.24	2.80	42.29	97.5	21.0	2.84	161.8	1.35	
95	487.7	69969	102.2	68	67057	78.8	60.2	65000	0.5	2.08	0.25	2.83	42.6	98.8	21.0	2.98	169.4	1.34	

Notes:

1. Showing operating electrical load with digital compressor modulation instead of Peak Electrical Load

1) Net cooling capacities shown

2) Capacity tolerance is +/- 5%

3) ACFM is the actual airflow rate when measured at the specific temperature and barometric conditions that define a unique air density

6) SCFM is the unit airflow rate when converted to standard air density of 0.075 lb/ft3 at sea level

EES DP400 Rooftop II Reverse Airflow Unit Performance V5-0 18-3

Liebert® DSE 500 Packaged Solution

Unit Information

Unit Configuration	Rooftop Configuration II - Draw Thru
Supply/Discharge	Bottom Return- Bottom supply
Dimensions	
Width	157"
Length	264"
Height	161"
Operating weight (Lbs)	26,000

Supply Fan

Supply Fan Type	Airfoil - Direct Drive Plenum
Supply Fan Quantity	4
Supply Fan Motor Type	ODP
Variable Airflow	VFD
Supply Fan Max HP per Unit	4X 15 HP

Filters 4" MERV 8

Condenser

Condenser Fan Type	Axial
Condenser Fan Quantity	12
Condenser Motor Type	ECM

DX System

Compressor Type	4 Tandem Scroll (Fixed + Digital)
Condenser Coil	Microchannel - Aluminum
Evaporating Coil	6 row Fin & Tube
Refrigerant	R410a
Economization system	Liebert® EconoPhase™

Electrical Data

Voltage / Phase / Frequency	400/3/50
FLA	TBD
WSA	TBD
OPD	TBD

Controls

Type	Liebert iCOM Controls
Communication Protocol	BACnet

Program version:
2018.8.29

System Type	OASIS IEC2.0	Prepared by	Mark Fisher
Size	OASIS 400	Print date	9/4/2018
Genesys No	G193965-1	Project Name	
Name	20180903 BCel Dublin 14000kW		

Technical data - System settings

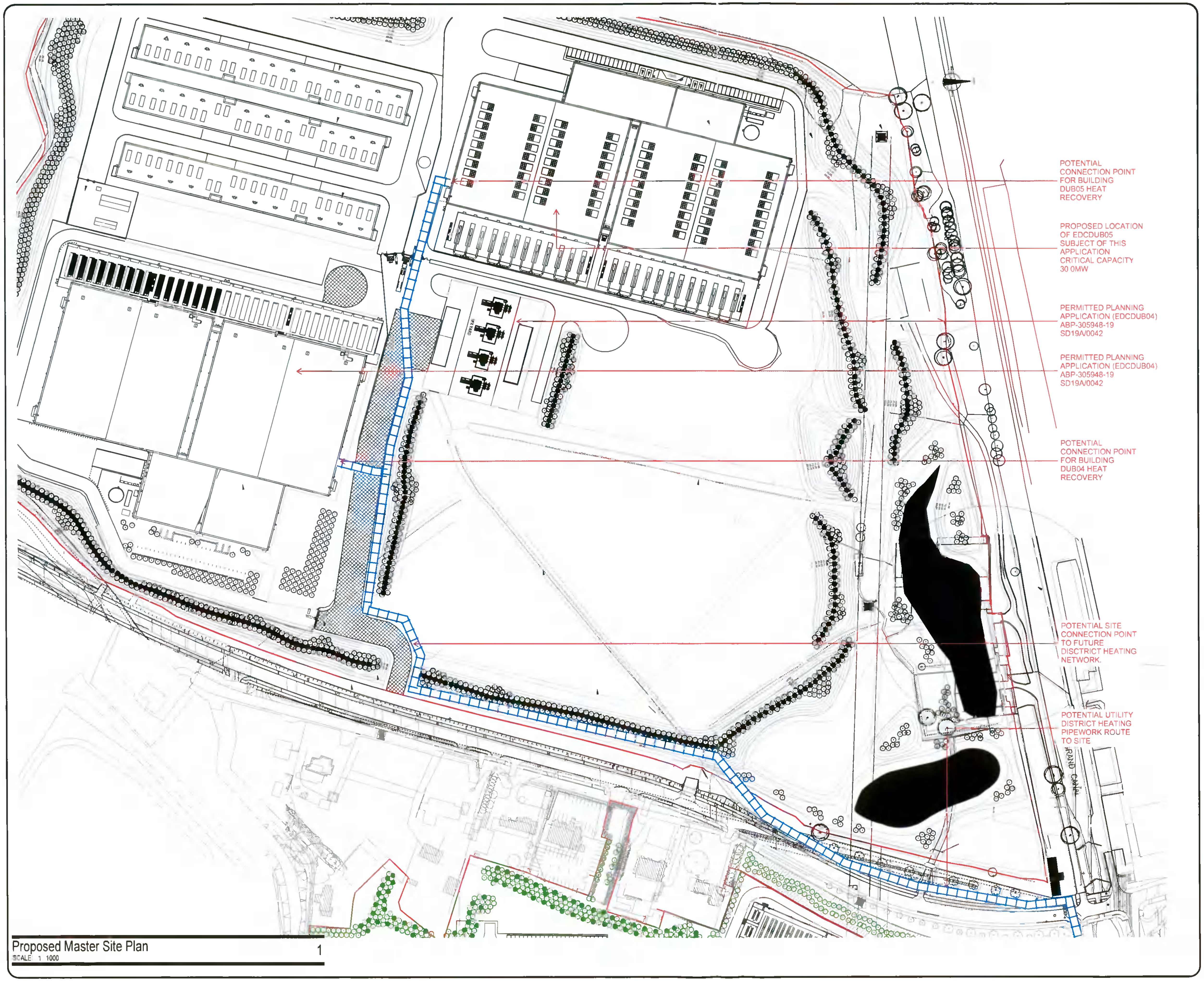
Main selections

Range Type	Released
Size	OASIS 400
Inspection side	Left
Process filter	Yes
Return Air Connection Orientation	Top
Supply Air Connection Orientation	Side
Internal return duct	Yes
Electrical Power Source	400/3/50 + N
O&M	GB
Dampers	Munters
Damper actuator	Standard
Working Platform	No
Trace heating	No
Weather protection	No
Lifting brackets	No
Site Movement - End Lifting Brackets	No
FAT Test	No
Extra sensor kit	No
Packaging	No

Electricity data

System rated current	90.50 A
Fuse	100.00 A
Cable area for fuse	0 in²
Breaker	100.00 A
Cable area for breaker	0 in²

	Standard	Peak	Peak Extreme
System Total Power	47.26	45.55	51.64 kW
System Total Amps	69.65	66.21	75.53 A



Proposed Master Site Plan 1
SCALE 1:1000

Gilligan Architects 20 Anglesea Road, Ballsbridge Dublin 4, Ireland TEL +353 1660 4255

BCEI
10400 Rodgers Road Houston, Texas 77070
Phone: 281-374-8644
Fax: 281-374-8992

ethos ENGINEERING

PINNACLE
CONSULTING ENGINEERS
WOOLVERSTONE HOUSE 61 BERNERS STREET LONDON, W1T 3NJ
Tel: 0207 0433410

edgeconnex®

EDCDUB04/05 - MASTER PLAN
DATA CENTRE

GRANGE CASTLE BUSINESS PARK, LUCAN, CO.DUBLIN, IRELAND

Rev	Date	Revision Note	Issued	Author
1	23/02/21	FOR PLANNING	EDC	BOL

True North

STATUS
PRELIMINARY

FUTURE DISTRICT ENERGY PIPE NETWORK ROUTE

Scale: 1:1000@A1

DRAWN: BOL
REVIEW: -
PROJECT NO. 18D077

SHEET NO:
M-P-01