


District Heating Viability Study

Cherry Orchard Residential Development.

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Comments

Disclaimer

Executive Summary

Waterman Moylan have been appointed by the Land Development Agency as Mechanical and Electrical engineering consultants on the proposed residential development at Cherry Orchard. The proposed development will deliver over 1,000 residential units in a mix of high density apartments, medium density apartments and lower density housing and duplex units.

This report was prepared in response to the requirements within the Dublin City Council Development Plan that requires that the feasibility of implementing district heating solutions or the provision of a solution that would be district heating enabled.

The first and primary objective of any system provided to meet the space heating and hot water needs of a residential development is compliance with the requirements of Technical Guidance Document Part L 2022 of the Building Regulations. This sets the minimum targets for various aspects of the energy performance of buildings and provides a calculation method for assessing overall compliance. All of the systems put forward in this report can be designed such that they can achieve compliance with these minimum requirements.

The intention of the DCC Development Plan 2022-2028 is to promote the development of off-site district heating networks (i.e. not within the proposed development site) that can utilise heat sources such as geothermal heat or waste heat from a variety of industrial processes.

There are two existing district heat networks established in the greater Dublin area, one being the Dublin Docklands District Heating Network and the other being the Tallaght District Heating Network. Neither of these schemes are intended to be extended to serve the proposed residential development at Cherry Orchard. The SEAI and Codema have undertaken studies to investigate potential sources of waste heat within the greater Dublin area and have identified a number of potential sources within the vicinity of the Cherry Orchard site. However there are currently no plans to develop heat networks that could capture and distribute this waste heat, nor are there any organisations tasked with investigating such a system.

In preparing this study, a number of potential methods for meeting the thermal energy demands of the site were assessed. These included connection to a 3rd Party Off-site network from "Day 1" (notwithstanding the fact that no such network will be available - this was included for comparison purposes only), the provision of an on-site district heating networks where heat would be generated on site and systems based on the use of individual heating systems within each dwelling.

The systems assessed were as follows

System 1	Off Site 3rd party heat network
Systems 2	On-Site heat network fed via gas fired boilers only which would operate for a maximum of 5 years while waiting for connection of a 3rd party off site network.
System 3	On-site heat network fed by a combination of air source heat pumps, gas fired CHP units and gas fired boilers
System 4	On-site heat network fed only by electrically powered systems, primarily air source heat pumps.
Systems 5	Individual exhaust air heat pumps within apartments.
Systems 6	Individual air source heat pumps within houses.

In addition to these systems, the implications of delivering a site that is "district heating enabled" were also assessed. This involves providing plant space, sitewide pipework and making provision within each apartment block for pipework (or space for pipework) from the ground level to each apartment unit.

Each of the above systems were assessed in terms of various metrics. These include the efficiency with which they will operate, the carbon emissions they will generate, the running costs that will be borne by occupants, the spatial requirements within the site and the capital costs of implementing the system.

Given that it is clear that an off-site 3rd party network will not be available from the first day of occupancy, the analysis conducted looked at the impact on the overall carbon emissions of the site over a 35 year period with different scenarios assessed for when a 3rd party network might become available to serve the site. These scenarios included 5 years, 10 years, 15 years, 20 years and 30 year timelines to the connection of the site to the off-site network

7 scenarios were assessed and are presented in detail within the report. The scenarios are labelled A to G within the report and can be summarised as follows

Scenario A

The 3rd Party Off-Site District Heating Network is assumed to be available from first occupancy in Cherry Orchard.

Scenario B

3rd Party Off-Site District Heating Network is assumed to be available within a defined period of time after first occupancy **(maximum 5 year period)**

Scenario C

3rd Party Off-Site District Heating Network is assumed to be available at a point in the future however no defined period of time after first occupancy has been identified for the availability of the DHN. The interim arrangements would consist of an on site district heating centre and district heating network containing Heat Pumps, Combined Heat and Power and Gas fired boilers

Scenario D

3rd Party Off-Site District Heating Network is assumed to be available at a point in the future however no defined period of time after first occupancy has been identified for the availability of the DHN. The interim arrangements would consist of a district heating centre containing only Heat Pumps or other electrically driven technologies – there would be no fossil fuel consumption in site

Scenario E

3rd Party Off-Site District Heating Network is assumed not to be available for the 35 year assessment period. An on-site District Heating Network assumed to serve all high and medium density elements of the site. The district heating centre is assumed to contain only Heat Pumps or other electrically driven technologies – there would be no fossil fuel consumption in site.

Scenario F & G

3rd Party Off-Site District Heating Network is assumed not to be available for the 35 year assessment period. All high and medium density elements of the site are assumed to be served by individual heating plant in the form of Exhaust Air Heat Pumps. Low density housing is assumed to be served by individual air source heat pumps within each dwelling. The only difference between F & G is the inclusion of measures to make the site district heating enabled in Scenario F. This has no impact on carbon and running cost analyses but does impact on capital costs.

The methods of assessing each of the systems and the parameters such as fuel cost and carbon conversion factors were agreed with the DCC Technical Support Division, Environment and Transportation Department and Codema (acting on behalf of DCC) before the study was conducted. It should be noted that data used within this report for the carbon performance and cost of heat that could be delivered by the 3rd party off-site network are theoretical and are based on data provided by SEAI/Codema.

This "scenario assessment" looked at how the various heating systems would be combined over the 35 year assessment period to deliver the most carbon efficient overall solution for the site and determine what timeframe the 3rd party off-site network would have to be available in order to delivery overall carbon savings.

The results of an analysis conducted prior to the commissioning of this study found that a solution that involved individual heat pumps within each apartment & house would offer the most technically advantageous solution for the site and would deliver the lowest running costs and lowest carbon emissions. The findings of that study are supported and confirmed by the analysis conduction within this report. As such, **Scenario G**, involving the use of exhaust air heat pumps and air source heat pumps is deemed to be the "counterfactual" systems against which the performance of the alternative approaches would be assessed.

Scenario A offers the best performance in terms of carbon emissions and running costs and offers capital costs that are line with the counter factual scenario. However as there are no known 3rd party off-site district heating networks available for connection to the site this scenario can be discounted.

Scenario B also offers beneficial carbon and cost in use performance but can also be discounted as there are no known 3rd party off-site district heating networks available for connection to the site. While the 5 year window does bring about the possibility that a district heating network would become available, the assessment of Scenario B assumes a temporary derogation on compliance with Part L would be available, thereby allowing temporary gas fired heating plant to be used for the first 5 years. Without any known plans for a 3rd party network in the vicinity of the site, it will not be possible to enter into detailed design and construction phases of the project with a strategy based on temporary plant or the possibility of a derogation on Part L compliance.

Scenario C is the only proposed solution that involves the longer term use of fossil fuels on site. This would be contrary to the Land Development Agencies brief for the site. The analysis shows that Scenario C will have a higher running costs than the counterfactual system and will have higher carbon emissions than the counterfactual system unless the 3rd party network is available within 12 years of occupancy. The capital costs for Scenario C are also 18% higher than those for the counterfactual system. Therefore, based on a combination of factors, Scenario C can be discounted.

Scenario D involves the use of an on-site district heating system utilising air source heat pumps. At the time of writing this report, it is unclear if large commercial heat pumps can be correctly accounted for within the regulatory compliance procedures set out by the SEAI for residential developments and this may present compliance problems for the development if this approach were to be adopted. The analysis shows that Scenario D will have a higher running costs than the counterfactual system and will have higher carbon emissions than the counterfactual system unless the 3rd party network is available within 21 years of occupancy. The capital costs for Scenario C are also 17% higher than those for the counterfactual system. Therefore, based on a combination of factors, Scenario D can be discounted.

Scenario E is effectively the same as Scenario D but without any suggestion that a 3rd party DHS network would be available during the assessment period. Carbon emissions, running costs and capital costs are all higher than the counterfactual system. Therefore, based on a combination of factors, Scenario E can be discounted.

Scenario F is involves the use of individual heat pumps within each residential unit and is therefore the same as the counterfactual scenario. However Scenario F includes measures to ensure the site is "district heating enabled". As the systems proposed in Scenario F are the exact same as those in the counterfactual case (Scenario G) the performance in terms of running costs and carbon emissions are identical. The capital costs of the **active systems** installed on Day 1 are also identical however there are significant additional costs associated with the provision of additional plant space, below ground heating pipework, space within each building for DHS sub-stations and the installation of pipework within the common areas of each apartment block. The costs associated with this additional installation is significant and make Scenario F the most costly of all scenarios assessed, with an estimated cost uplift of 35% over the counterfactual scenario. Therefore, based on capital costs, Scenario F can be discounted.

Scenario G is involves the use of individual heat pumps within each residential unit and does not include allowances to make the site "district heating enabled"

With Scenario A & B discounted due to the fact that there is no known or planned district heating network in the vicinity of the site and Scenario C discounted due primarily to the on-site use of fossil fuels, the only other scenarios to consider are Scenario D, E and F.

Scenario D offers a potential of carbon savings, but only if a 3rd party DHS network becomes available within 21 years. However, the running costs from day 1 will be higher than Scenario G and initial capital costs are also higher

Scenario E would involve higher running costs, higher carbon emissions and higher capital costs

Scenario F offers identical performance to Scenario G but the addition of a provision for district heating adds substantial capital costs to the project.

In developing this report and conducting the associated desktop study, Waterman Moylan have extensively researched possible approaches that could be adopted to meet the thermal energy needs of the proposed development and have investigated options for delivering a site that is "district heating enabled".

It is the view of the authors of this report that the provision of the an on-site district heating system that would include central plant and the associated distribution network would incur higher capital costs, higher running costs and cause increased carbon emissions when compared to an approach that includes individual heat pumps within each dwelling, As such, the implementation of an interim solution involving any of the on-site district heating approaches was discounted.

Furthermore, the 35% increase in capital costs associated with Scenario F, over and above the equivalent costs of the counterfactual scenario, means that it is not financially feasible to include the measures that would be required to deliver a site that would be district heating enabled. It is therefore the recommendation of this report that the scheme be developed based on Scenario G, a solution based on individual heat pumps within each residential unit that does not provide a district heating enabled development.

Content

1. Introduction

Waterman Moylan have been appointed by the Land Development Agency to provide Mechanical, Electrical and Sustainability related services to for the proposed development at Cherry Orchard, Dublin 10. The overall development will consist of the construction of approximately 1,100 dwellings, with additional commercial, retail and childcare facilities.

The development includes a mix of low density affordable housing and medium & high density cost rental, social and age friendly apartments and/or duplex units.

This report identifies the energy standards with which the proposed development will have to comply and also sets out the overall strategy that will be adopted to achieve these energy efficiency targets.
The dwellings will be required to minimise overall energy use and to incorporate an adequate proportion of renewable energy in accordance with Building Regulations Part L 2022, Conservation of Energy & Fuel (hereinafter referred to as Part L 2022).

The report will also address the requirements and Policies of the Dublin City Council Development Plan 2022-2028 as follows

CA10	Climate Action Energy Statements
CA15	Waste Heat, District Heating and Decentralised Energy
CA16	The Dublin District Heating System (DDHS)
CA17	Supporting the Potential of District Heating in Dublin City
CA18	Capture and Utilisation of Waste Heat

2. DCC Development Plan Objectives & Policies

The Dublin City Development Plan 2022-2028 sets out the following policies in relation to energy in use and the use of district heating / waste heat networks.

2.1 CA5 Climate Action Energy Statements

In order to ensure that all future development integrates the principles of energy efficiency in the built environment and the use of efficient and renewable sources of energy, all applications for significant new developments, or for significant refurbishment projects shall be required to submit a **Climate Action Energy Statement** as part of any overall design statement for a proposed development.

This statement shall also provide outline information relating to the anticipated energy performance and CO_2 emissions associated with the development as well as information outlining how the potential of district heating and other low carbon energy solutions have been considered in relation to the development.

2.2 CA10 Climate Action Energy Statements

All new developments involving 30 residential units and/or more than 1,000 sq. m. of commercial floor space, or as otherwise required by the Planning Authority, will be required to submit a **Climate Action Energy Statement** as part of the overall Design Statement to demonstrate how low carbon energy and heating solutions, have been considered as part of the overall design and planning of the proposed development.

2.3 CA11 Energy from Renewable Sources

To support the production of energy from renewable sources, such as from solar energy, hydro energy, wave/tidal energy, geothermal, wind energy, combined heat and power (CHP), heat energy distribution such as district heating/cooling systems, and any other renewable energy sources, subject to normal planning and environmental considerations

2.4 CA12 Micro-Renewable Energy Production

To support and encourage the development of small scale wind renewable facilities / micro-renewable energy production.

2.5 CA14 Geothermal Energy

To support the exploration for, and development of, geothermal energy resources having regard to emerging government policy on geothermal energy.

2.6 CA15 Waste Heat, District Heating and Decentralised Energy

To actively encourage the development of low carbon and highly efficient district heating and decentralised energy systems across the city utilising low carbon heat sources such as renewable energy and waste heat recovery and to promote the connection of new developments to district heating networks where such systems exist/can be developed in a given area.

2.7 CA16 The Dublin District Heating System (DDHS)

To support the development and expansion of any necessary energy infrastructure which will deliver the low carbon Docklands and Poolbeg catchment of the Dublin District Heating System (DDHS) project including, its pipeline infrastructure and its energy centre with energy storage and back-up heat production.

2.8 CA17 Supporting the Potential of District Heating in Dublin City

To support the potential of district heating in Dublin City, all Climate Action Energy Statements submitted to the Council (see Policy CA9) shall include an assessment of the technical, environmental and economic feasibility of district or block heating or cooling, particularly where it is based entirely, or partially on energy from renewable and waste heat sources.

In addition:

- Climate Action Energy Statements for significant new residential and commercial developments in Strategic Development and Regeneration Areas (SDRAs), will assess the feasibility of making the development 'district heating enabled' in order to facilitate a connection to an available or developing district heating network in the area.
- Climate Action Energy Statements for significant new residential and commercial developments in the Docklands SDRA will assess the feasibility of making the development 'district heating enabled' in order to facilitate a connection to the Dublin District Heating System.

2.9 CA18 Capture and Utilisation of Waste Heat

To encourage proposed and existing developments and facilities (such as data centres) to capture and utilise otherwise wasted heat, and use waste heat either on-site, or in an adjoining, and nearby sites, in compliance with all relevant Energy Efficiency Regulations

2.10 Chapter 15

In addition to the specific policies set out above from Chapter 3 of the development plan, Chapter 15 provide further guidance regarding the use of district heating networks.

District Heating

Where district heating systems are not yet in operation, the applicant is required to demonstrate how the proposed heating system of the development can connect and facilitate future use of the district heating system once in place, see policy CA14, CA15, CA16 and CA17 for further information.

Climate Action and Energy Statement

The purpose of this statement is to demonstrate how low carbon energy and heating solutions have been considered as part of the overall design and planning of the proposed development. Having regard to the above, the statement, which shall be prepared by a certified engineer, shall address:

- the technical, environmental and economic feasibility of on-site renewable energy generation including solar PV and small scale wind power
- the technical, environmental and economic feasibility of at a minimum, the following high-efficiency alternative energy supply and heating systems
- decentralised energy supply systems based on energy from renewable and waste heat sources
- co-generation (combined heat and power)
- district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable and waste heat sources
- heat pumps
- include an assessment of embodied energy impacts.

District Heating Enabled' Development

In addition to the requirements set out above, Climate Action Energy Statements for significant new residential and commercial developments, in SDRAs will be required to investigate local heat sources and networks, and, where feasible, to demonstrate that the proposed development will be 'District Heating Enabled' in order to facilitate a connection to an available or developing district heating network.

Any such investigation should have regard to the heat demand density of the area in which the proposed development is located.

Where it is not feasible for a development to be district heat enabled, the statement must provide a clear explanation as to why this is would not be the case, and must also demonstrate that the proposed development offers a similarly efficient and low carbon energy and heating solution.

For the avoidance of doubt, for a development to be 'District Heating Enabled', it should incorporate an efficient, low carbon building heat network, and/or a block communal heating network, in order to facilitate a future connection to a district heating network, without the need for significant additional retrofitting.

To this end, 'DH Enabled' development should provide for:

- an efficient, centralised, wet-based heat network within the building or within the area of the development as a whole (as appropriate);
- the allocation of sufficient space in plant rooms to accommodate suitable district heating equipment, such as heat exchangers etc.;
- the provision and safeguarding of suitable pipe routes throughout the building and complex;
- the provision and safeguarding of suitable district heating network connection routes at and beyond the site boundary

3. Building Fabric Assumptions

Before considering efficient building services or renewable energy systems, the form and fabric of a building must be assessed and optimised so as to reduce the energy demand for heating, lighting and ventilation. Target performance levels have been identified by the design team and are presented in Table 1 below.

3.1 Elemental U-Values

The U-Value of a building element is a measure of the amount of heat energy that will pass through the constituent element of the building envelope. Increasing the insulation levels in each element will reduce the heat lost during the heating season and this in turn will reduce the consumption of fuel and the associated carbon emissions and operating costs.

3.2 Air Permeability

A major consideration in reducing the heat losses in a building is the air infiltration. This essentially relates to the ingress of cold outdoor air into the building and the corresponding displacement of the heated internal air. This incoming cold air must be heated if comfort conditions are to be maintained. In a traditionally constructed building, infiltration can account for 30 to 40 percent of the total heat loss, however construction standards have improved significantly in this area in recent years.

With good design and strict on-site control of building techniques, infiltration losses can be significantly reduced, resulting in equivalent savings in energy consumption, emissions and running costs.

3.3 Thermal Bridging

Thermal bridges occur at junctions between planar elements of the building fabric and are typically defined as areas where heat can escape the building fabric due to a lack of continuity of the insulation in the adjoining elements.

Careful design and detailing of the manner in which insulation is installed at these junctions can reduce the rate at which the heat escapes. Standard good practice details are available and are known as Acceptable Construction Details (ACDs). Adherence to these details is known to reduce the rate at which heat is lost.

3.4 Proposed Construction

Table 1 below identifies the U-Value, air tightness and thermal bridging requirements set out in Part L 2022 and also identifies the values that will be targeted for this development.

Improving on the values to a greater degree than is indicated in Table 1 will reduce overall energy consumption however the values proposed already meet or exceed the Part L 2022 requirements and further improvements in the fabric will be of limited benefit (refer to Section 3.3.4 for an assessment of triple glazing)

U-Values	**Part L 2022 Compliant Values**	**Proposed Specification**
Floor	0.18 W/m^{2}K	0.12 – 0.18 W/m^{2}K
Roof	0.16W/m^{2}K	0.12 - 0.16 W/m^{2}K
Walls	0.18 W/m^{2}K	0.12 - 0.18 W/m^{2}K
Windows	1.4 W/m^{2}K	1.0 - 1.4 W/m^{2}K
Air Tightness	5 m^3/m^2/hr	< 3 m^3/m^2/hr
Thermal Bridging	0.08	< 0.08

Table 1 – Building Fabric Compliance Options

4. Heat Sources & Renewable Energy Options

All new dwellings must meet overall energy and carbon performance levels and must have a portion of their annual energy demand provided by renewable energy sources.

The overall performance levels are defined by a ratio derived by comparing the energy/carbon consumption of the proposed dwelling to that of similar dwelling with defined characteristics.

The renewable energy source can be thermal energy such as ***solar thermal collection***, ***biomass boilers*** or ***heat pumps*** or it can be electrical energy as generated by ***photovoltaic solar panels*** or ***wind turbines.*** The minimum renewable energy contributions defined in Part L 2022 Part (b) is 20% of the total energy consumption for the dwelling.

Two main fuel sources are generally available for developments of this nature, natural gas and electricity. Each present distinct options for compliance with the new standards. Solutions involving gas as the primary fuel source will typically include a solar technology such as PV panels to meet the renewable energy requirements while solutions relying on electricity will include heat pump technology.

The final selection and combination of technologies will most likely be selected from these options based on a more in-depth technical and financial appraisal of the technologies which will be carried out during detailed design.

4.1 System 1 - District Heating from Off-site 3rd Party Network

This approach would involve the connection of all houses and apartments within the site to a 3rd Party, Off Site Network that would delivery heating energy in the form of low temperature hot water to the proposed development site.

It is anticipated that the network would be fed from waste heat sources in the vicinity of the site (such as Data Centres) and that a network of distribution pipework would be provided to supply heat to consumers in the area.

Defined connections points would be agreed and back-up heating plant would be provided within the Cherry Orchard site.

4.2 System 2 - District Heating from On Site Network with Gas Plant

This approach would involve the generation of heat in a central location on the site and the distribution of this heat to each apartment via a network district heating pipework. The central plant used to generate the heat would include only high efficiency gas fired condensing boilers. This measure would only be implemented as a interim solution while connection to a 3rd Party Off Site Network was awaited. (refer to Section 5.2 – Scenario B)

Heating pipework will be installed throughout the scheme to distribute the heat generated in the plant room throughout the apartment development, serving each apartment via a heat interface unit (HIU). The HIU will both control and meter the consumption of heat and hot water within each individual dwelling allowing occupants to set the times they need space heating and ensuring they are charged accordingly.

A single district heating plant centre could be provided that will be capable of providing adequate heat capacity to serve the high, medium and low density areas of the development.

4.3 System 3 - District Heating from On Site Network with Gas & Electric Plant (Heat Pump)

This approach would involve the generation of heat in a central location on the site and the distribution of this heat to each apartment via a network district heating pipework. The central plant used to generate the heat could include Air Source Heat Pumps, Combined Heat and Power (CHP) plan and high efficiency gas fired condensing boilers.

The Air Source Heat Pumps (ASHPs) utilise grid supplied electricity to extract thermal energy from a heat source, in this case, the external ambient air. While the electricity consumed is not considered renewable energy, the efficiency at which a heat pump operates allows a significant portion of the heat delivered to be considered as renewable energy. The amount of heat considered to be renewable is determined by the efficiency of the heat pump and the “primary energy conversion factor” for grid supplied electricity. Typically, approximately 40% to 50% of the heat supplied is considered to be renewable energy.

A CHP unit uses gas as its energy source to create electricity which can be utilised within the proposed development. This process of creating electricity results in the generation of “waste heat” which can then be used to meet a proportion of the heating and hot water demands of the housing development. Since the waste heat is captured, it can be considered to be renewable energy and therefore contributes towards the overall 20% renewable energy requirement.

High efficiency gas fired boilers would be provided to meat peak demands.

Heating pipework will be installed throughout the scheme to distribute the heat generated in the plant room throughout the apartment development, serving each apartment via a heat interface unit (HIU). The HIU will both control and meter the consumption of heat and hot water within each individual dwelling allowing occupants to set the times they need space heating and ensuring they are charged accordingly.

A single district heating plant centre could be provided that will be capable of providing adequate heat capacity to serve both the high and low density areas of the development.

4.4 System 4 - District Heating from On Site Network with Electric Plant Only (Heat Pumps & Other Direct Acting Electric Plant)

This approach would involve the generation of heat in a central location on the site and the distribution of this heat to each apartment via a network district heating pipework. The central plant used to generate the heat would include Air Source Heat Pumps and direct acting electric water heaters.

The heat pumps analysed for this study have certified data for flow temperatures of 55ºC. Most DHS networks require flow temperatures of 62 ºC to 65 ºC to satisfy the demand for domestic hot water within apartments. It would be expected that the heat pumps would provide approximately 80% of the energy demand with direct acting boilers providing the additional 20%.

The Air Source Heat Pumps (ASHPs) utilise grid supplied electricity to extract thermal energy from a heat source, in this case, the external ambient air. While the electricity consumed is not considered renewable energy, the efficiency at which a heat pump operates allows a significant portion of the heat delivered to be considered as renewable energy. The amount of heat considered to be renewable is determined by the efficiency of the heat pump and the “primary energy conversion factor” for grid supplied electricity. Typically, approximately 40% to 50% of the heat supplied is considered to be renewable energy.

Heating pipework will be installed throughout the scheme to distribute the heat generated in the plant room throughout the apartment development, serving each apartment via a heat interface unit (HIU). The HIU will both control and meter the consumption of heat and hot water within each individual dwelling allowing occupants to set the times they need space heating and ensuring they are charged accordingly.

A single district heating plant centre could be provided that will be capable of providing adequate heat capacity to serve the high medium and low density areas of the development.

NB ***This approach may present difficulties from a certification point of view and agreement with SEAI and possibly Building Control / Department of Environment would be required to overcome the problems that currently exist with the certification of large heat pumps. SEAI***

require that the hot water efficiency data which is used in the Part L / BER calculations is calculated and certified in accordance with the EN 16147 Standard.

At the time of writing this report, Waterman Moylan are aware of one supplier that can offer 90kW heat pumps that are certified to this standard, with the remainder of manufacturers offering 20kW to 30kW models. The anticipated peak demand for the site is estimated at 1.5MW to 2.0MW. On this basis a minimum of 17no 90kW heat pumps would be required to meet peak demand.

It would not be technically feasible or practical to design an entire district heating plant centre using over 50no individual 20kW to 30kW machines and it would be seen as a commercial risk to progress a design for the entire site based on the one available 90kW model due to the risk of it becoming unavailable or being uncompetitive commercially.

4.5 System 5 - Exhaust Air Heat Pumps

Exhaust Air heat pumps (EAHPs) utilise grid supplied electricity to extract thermal energy from a heat source, in this case, the internal air within the apartment. While the electricity consumed is obviously not renewable energy, the efficiency at which a heat pump operates allows a significant portion of the heat delivered to be considered as renewable energy. The amount of heat considered to be renewable is determined by the efficiency of the heat pump and the “primary energy conversion factor” for grid supplied electricity. Typically, approximately 40% to 50% of the heat supplied is considered to be renewable energy.

EAHPs operate by extracting air from wet rooms and kitchens within the apartment and passing this air through a heat exchanger in the heat pump before it is exhausted to outside. As such, they take the place of a centralised mechanical extract ventilation system as well as providing heating and hot water. The heat recovered from the exhaust air is then used by the heat pump to generate hot water to meet heating and domestic hot water demands.

There are a number of manufacturers offering products of this type and the certified seasonal efficiencies of some models can exceed 500% in heating mode and 220% to 250% in hot water mode. These efficiencies can deliver Part L 2022 compliance in most circumstances but in some instances may need supplementary PV panels in order to meet the required energy targets.

Exhaust air heat pumps only require an indoor component as the air needed is extracted from the dwelling and ducted to the compressor within the heat pump.

4.6 System 6 – Air Source Heat Pumps

Air source heat pumps (ASHPs) use the same physical principles as EAHPs in that they also utilise grid supplied electricity to extract thermal energy from a heat source. However, in this case of ASHPs, the external ambient air is the heat source.

Air source heat pumps require an indoor and an outdoor component. The outdoor unit is the evaporator which extracts the thermal energy from the ambient air while the indoor unit typically includes the heating buffer tanks and the hot water cylinder for the dwelling. The outdoor unit is typically located in the back garden of a dwelling.

In recent years, the design of ASHPs has improved bringing about higher efficiencies and reduced costs. This, in turn, has led to an increase use of this technology in large scale housing developments. Certified seasonal efficiencies of some models can exceed 500% meaning that the use of this technology can easily deliver compliance with current Part L requirements.

5. Scenario Assessment

The following sections set out the various scenarios that have been tested in the analysis. Each are based on the heating systems set out in Section 4. The scenarios include either one of the Systems described in Section 4 or a combination of these Systems with certain assumptions made regarding the time period each of the systems will be used for.

5.1 Scenario A (System 1)

The 3rd Party Off-Site District Heating Network **(System 1)**, is assumed to be available from first occupancy in Cherry Orchard.

The operating parameters of the system **(System 1)** are assumed to be as follows

Primary Energy Conversion Factor	1.05	kWh / kWh
Carbon Conversion Factor	0.018	kgCO_2 / kWh
Cost per Unit Heat	0.07	€/kWh(1)
Average/Overall System Efficiency	100%	

(1) Information provided by DCC/Codema - The final rate will be determined by multiple commercial factors that can vary over time. A typical metric at this early stage to charge 5-10% less than the counterfactual. The counterfactual being individual ASHPs in this case.

The DHN is assumed to serve all high, medium and low density elements of the site (analysis of low density elements excluded from this report)

5.2 Scenario B (System 1 + System 2)

3rd Party Off-Site District Heating Network **(System 1)**, is assumed to be available within a defined period of time after first occupancy **(maximum 5 year period)**

For the purpose of this assessment, it is assumed that a short term derogation on Part L / nZEB compliance would be granted by DCC / Dept of Environment due to imminent connection of the 3rd party DHN. The interim arrangements would consist of an on site district heating centre and district heating network containing only gas fired heating plant **(System 2)**

The operating parameters of the system **(System 1)**, when operational after 5 years, are assumed to be as follows

Primary Energy Conversion Factor	1.05	kWh / kWh
Carbon Conversion Factor	0.018	kgCO_2 / kWh
Cost per Unit Heat	0.07	€/kWh(1)
Average/Overall System Efficiency	100%	

The operating parameters of the system **(System 2)**, are assumed to be as follows

Primary Energy Conversion Factor	1.1	kWh / kWh

Carbon Conversion Factor	203	$kgCO_2$ / kWh
Cost per Unit Heat	0.07	€/kWh(1)
Average/Overall System Efficiency	95%	

(1) Information provided by DCC/Codema - The final rate will be determined by multiple commercial factors that can vary over time. A typical metric at this early stage to charge 5-10% less than the counterfactual. The counterfactual being individual ASHPs in this case.

The DHN is assumed to serve all high, medium and low density elements of the site

5.3 Scenario C (System 1 + System 3)

3rd Party Off-Site District Heating Network **(System 1)** is assumed to be available at a point in the future however no defined period of time after first occupancy has been identified for the availability of the DHN. For the purpose of this assessment, it is assumed that no derogation on Part L / nZEB compliance would be granted by DCC / Dept of Environment as no defined time period exists for the availability of the 3rd Party DHN. The interim arrangements would consist of an on site district heating centre and district heating network containing Heat Pumps, Combined Heat and Power and Gas fired boilers **(System 3).**

The operating parameters of the system **(System 1)**, when operational after XX years, are assumed to be as follows

Primary Energy Conversion Factor	1.05	kWh / kWh
Carbon Conversion Factor	18	$kgCO_2$ / kWh
Cost per Unit Heat	0.07	€/kWh(1)
Average/Overall System Efficiency	100%	

(1) Information provided by DCC/Codema - The final rate will be determined by multiple commercial factors that can vary over time. A typical metric at this early stage to charge 5-10% less than the counterfactual. The counterfactual being individual ASHPs in this case.

The operating parameters of the system **(System 3)**, are assumed to be as follows

Primary Energy Conversion Factor	1.39	kWh / kWh
Carbon Conversion Factor	212	$kgCO_2$ / kWh
Cost per Unit Heat	0.16	€/kWh
Average/Overall System Efficiency	170%*	

**Efficiency based on combination of various components of DHS system and accounts for Primary Energy and Carbon Conversion Factors.*

The DHN is assumed to serve all high, medium and low density elements of the site

5.4 Scenario D (System 1 + System 4)

3rd Party Off-Site District Heating Network is assumed to be available at a point in the future however no defined period of time after first occupancy has been identified for the availability of the DHN. For the purpose of this assessment, it is assumed that no derogation on Part L / nZEB compliance would be granted by DCC / Dept of Environment as no defined time period exists for the availability of the 3rd Party DHN. The interim arrangements would consist of a district heating centre containing only Heat Pumps or other electrically driven technologies – there would be no fossil fuel consumption in site **(System 4).**

The operating parameters of the system **(System 1)**, when operational after XX years, are assumed to be as follows

Primary Energy Conversion Factor	1.1	kWh / kWh
Carbon Conversion Factor	18	$kgCO_2$ / kWh
Cost per Unit Heat	0.07	€/kWh(1)
Average/Overall System Efficiency	100%	

(1) *Information provided by DCC/Codema - The final rate will be determined by multiple commercial factors that can vary over time. A typical metric at this early stage to charge 5-10% less than the counterfactual. The counterfactual being individual ASHPs in this case.*

The operating parameters of the system **(System 4)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	$kgCO_2$ / kWh
Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	280%*	

**Efficiency of central heat pumps estimated based on certified data (UE813 2013 @ air 7, water 55) with an allowance for direct acting electric boilers to increase flow temperatures to 65 degrees required to satisfy hot water demand within dwellings)*

The DHN is assumed to serve all high, medium and low density elements of the site (analysis of low density elements excluded from this report)

5.5 Scenario E (System 4 + System 6)

3rd Party Off-Site District Heating Network is assumed not to be available for the 35 year assessment period. An on-site District Heating Network assumed to serve all high and medium density elements of the site. The district heating centre is assumed to contain only Heat Pumps or other electrically driven technologies – there would be no fossil fuel consumption in site **(System 4).** Low density housing is assumed to be served by individual air source heat pumps within each dwelling **(System 6)**.

The operating parameters of the system **(System 4)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	$kgCO_2$ / kWh

Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	280%	

**Efficiency of central heat pumps estimated based on certified data (UE813 2013 @ air 7, water 55) with an allowance for direct acting electric boilers to increase flow temperatures to 65 degrees required to satisfy hot water demand within dwellings)*

The operating parameters of the system **(System 6)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	$kgCO_2$ / kWh
Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	320%*	

**Efficiency of individual heat pumps within housing units estimated based on certified data (UE813 2013 @ air 7, water 45 (50%) and air 7, water 55 (50%) to account for the mix of heat pump operations in space heating mode and hot water mode)*

In addition to the measures above, additional provision would be made to ensure the site was "District Heating Enabled" as defined in the DCC Development Plan.

5.6 Scenario F (System 5 + System 6)

3rd Party Off-Site District Heating Network is assumed not to be available for the 35 year assessment period. All high and medium density elements of the site are assumed to be served by individual heating plant in the form of Exhaust Air Heat Pumps **(System 5).** Low density housing is assumed to be served by individual air source heat pumps within each dwelling **(System 6)**

The operating parameters of the system **(System 5)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	$kgCO_2$ / kWh
Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	350%*	

**Efficiency of exhaust air heat pumps within apartments estimated based on certified data (UE813 2013 @ air 7, water 45 (50%) and air 7, water 55 (50%) to account for the mix of heat pump operations in space heating mode and hot water mode)*

The operating parameters of the system **(System 6)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	$kgCO_2$ / kWh

Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	320%*	

**Efficiency of individual heat pumps within housing units estimated based on certified data (UE813 2013 @ air 7, water 45 (50%) and air 7, water 55 (50%) to account for the mix of heat pump operations in space heating mode and hot water mode)*

In addition to the measures above, additional provision would be made to ensure the site was "District Heating Enabled" as defined in the DCC Development Plan.

5.7 Scenario G (System 5 + System 6)

3rd Party Off-Site District Heating Network is assumed not to be available for the 35 year assessment period. All high and medium density elements of the site are assumed to be served by individual heating plant in the form of Exhaust Air Heat Pumps **(System 5).** Low density housing is assumed to be served by individual air source heat pumps within each dwelling **(System 6)**

The operating parameters of the system **(System 5)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	kgCO_2 / kWh
Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	350%*	

**Efficiency of exhaust air heat pumps within apartments estimated based on certified data (UE813 2013 @ air 7, water 45 (50%) and air 7, water 55 (50%) to account for the mix of heat pump operations in space heating mode and hot water mode)*

The operating parameters of the system **(System 6)**, are assumed to be as follows

Primary Energy Conversion Factor	1.75	kWh / kWh
Carbon Conversion Factor	224	kgCO_2 / kWh
Cost per Unit Heat	0.24	€/kWh
Average/Overall System Efficiency	320%*	

**Efficiency of individual heat pumps within housing units estimated based on certified data (UE813 2013 @ air 7, water 45 (50%) and air 7, water 55 (50%) to account for the mix of heat pump operations in space heating mode and hot water mode)*

6. Spatial Requirements

6.1 Scenario A

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems
Site wide distribution pipework (Medium & Hight Densiy)	Considerable	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	Impact of additional riser space on each apartment block to be assessed.
Site wide distribution pipework (Low Density)	Significant	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Back-Up Plant Room	Considerable	100m2 for gas only or electric only back up plant

6.2 Scenario B

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems
Site wide distribution pipework	Considerable	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	Impact of additional riser space on each apartment block to be assessed.

Site wide distribution pipework (Low Density)	Significant	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Interim / Back-Up Plant Room	Considerable	150m2 for interim plant – likely to consist of gas boilers only. Gas boiler flues to be considered. This plant & plant room will then become the back up plant room for the 3rd party network.

6.3 Scenario C

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems
Site wide distribution pipework (Medium& High Density)	Considerable	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	Impact of additional riser space on each apartment block to be assessed.
Site wide distribution pipework (Low Density)	Significant	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Interim / Back-Up Plant Room	Considerable	150m2 for interim plant – likely to consist of gas boilers only. Gas boiler flues to be considered. 50m2 + for external heat pump units.

		This plant & plant room will then become the back up plant room for the 3rd party network.

6.4 Scenario D

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems
Site wide distribution pipework (Medium & High Density)	Considerable	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	Impact of additional riser space on each apartment block to be assessed.
Site wide distribution pipework (Low Density)	Significant	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Interim / Back-Up Plant Room	Considerable	150m2 for interim plant – likely to consist of gas boilers only. Gas boiler flues to be considered. 50m2 + for external heat pump units. This plant & plant room will then become the back up plant room for the 3rd party network.

6.5 Scenario E

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems
Site wide distribution pipework	Considerable	Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	Impact of additional riser space on each apartment block to be assessed.
Site wide distribution pipework (Low Density)	Significant	**Routes Only** - Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Interim / Back-Up Plant Room	Considerable	150m2 for interim plant – likely to consist of gas boilers only. Gas boiler flues to be considered. 50m2 + for external heat pump units. This plant & plant room will then become the back up plant room for the 3rd party network.

6.6 Scenario F

Plant Item	Impact on Site	Comments
District Heating Sub-stations in each block	Moderate	**Space Only** - Circa 15 to 20m2 per block
HIUs in each apartment	Minor	Not dissimilar to alternative systems

Site wide distribution pipework	Considerable	**Routes Only** - Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves;
DHN Network Distribution within Buildings	Considerable	**Space Only** - Impact of additional riser space on each apartment block to be assessed.
Site wide distribution pipework (Low Density)	Significant	**Routes Only** - Routing of pipes, locations of access chambers; co-ordination with other services; wayleaves; Impact on overall road-widths likely with knock on effects on site density and planning requirements
Back-Up Plant Room	Considerable	Space Only - 150m2 for interim plant – likely to consist of gas boilers only. Gas boiler flues to be considered. 50m2 + for external heat pump units. This plant & plant room will then become the back up plant room for the 3rd party network.

7. Part L Requirements, EU Taxonomy Regulations & Embodied Carbon

All of the approaches described within this document can be used to achieve compliance with Part L of the Building Regulations and, to varying degrees can exceed the minimum requirements in order to address EU Taxonomy targets.

7.1 System 1 - District Heating from Off-site 3rd Party Network

While the actual performance of this approach will depend on the source of heat and fuel mix used for the 3rd party Network, it is expected that approach should achieve compliance with the renewable energy and carbon targets of Part L and of EU Taxonomy,

However, it is less clear how it will perform in terms of overall energy use. The primary energy factors provided (based on the Tallaght DHN system) are high and may pose difficulties for compliance with Maximum Permissible Energy Performance Co-Efficient requirements in Part L.

7.2 System 2 - District Heating from On Site Network with Gas Plant

This approach will not achieve Part L Compliance and would only be adopted if there was certainty that a Off-site 3rd Party Network would be available to deliver heat to the site within 5 years of 1st occupancy and if a temporary dispensation could be granted from Building Control / SEAI on this basis.

7.3 System 3 - District Heating from On Site Network with Gas & Electric Plant (Heat Pump)

The extent to which a scheme design around a district heating solution can exceed minimum standards will vary depending on the mix of central plant selected and on the operational strategy designed in from the outset. Increasing the proportion of heat generated by heat pumps will increase the overall efficiency of the scheme, thereby reducing total primary energy consumption and carbon emissions.

Increasing the proportion of heat delivered by heat pumps requires that the total output of heat pumps provided is increased or the water storage ("buffer") capacity is increased to allow more heat to be provided. Either of these options will increase capital costs and potentially increase plant space.

Since the standard compliance approach for a district heating scheme does not include PV panels, the addition of PV panels could therefore be used to exceed minimum compliance standards and to achieve the additional 10% reduction in demand required to meet current Taxonomy requirements.

Of the possible solutions discussed in this report, this district heating approach is the only proposed approach that would include the use of on-site fossil fuels, namely natural gas. While this could be perceived as a negative, it is important to recognise that natural gas is seen as a vital "transition fuel" in the conversion from a fossil fuel based economy to a renewable & sustainable fuel based economy.

7.4 System 4 - District Heating from On Site Network with Electric Plant Only (Heat Pump)

If it were considered technically and financially feasible to provide central plant consisting entirely of heat pumps, it is expected that Part L compliance would be easily achieved and, similarly, compliance with EU Taxonomy requirements would also be achieved.

7.5 System 5 - Exhaust Air Heat Pumps

Exhaust air heat pump compliance is assessed individually on each apartment with little scope to change the proposed design in order to enhance overall performance.

However, typically, the energy performance delivered by the exhaust air heat pump solution is 10% better than minimum compliance standard and therefore the system can meet current EU Taxonomy requirements.

7.6 System 6 – Air Source Heat Pumps

Since PV panels are not required to achieve compliance with minimum standards, further improvements over and above compliance and current Taxonomy standards could be achieved with the addition of extra PV panels.

8. Financial Considerations

8.1 Capital Cost

An assessment of the capital costs of each scenario has been carried out based on analysis of returned tenders on similar projects over recent years (for mechanical and electrical costs within buildings) and on estimated rates for district heating pipework and civil works and building costs.

NB: Costs are initial estimates and should be considered order of magnitude only.

8.2 Mechanical and Electrical Systems Within Each Apartment

The following table sets out the plant items required within each apartment that will be required for the complete functionality of each system / scenario. Plant items or systems that are common to each system (e.g. hot and cold water services) are not listed and are excluded from subsequent costs.

Costs Within Apartment						
	Scenario A	**Scenario B**	**Scenario C**	**Scenario D & E**	**Scenario F**	**Scenario G**
Heating Plant (within apartment)	Heat Interface Unit	Heat Interface Unit	Heat Interface Unit	Heat Interface Unit	Exhaust Air Heat Pump	Exhaust Air Heat Pump
Heating Type	Water Based Radiators	Water Based Radiators	Water Based Radiators	Water Based Radiators	Water Based Radiators (increased size for lower circ temp)	Water Based Radiators (increased size for lower circ temp)
Ventilation Type	Mechanical Extract Ventilation	Mechanical Extract Ventilation	Heat Recovery Ventilation	Mechanical Extract Ventilation	Exhaust Air Heat Pump	Exhaust Air Heat Pump
Electrical System Impacts	Wiring to HIU	Wiring to HIU	Wiring to HIU	Wiring to HIU	Wiring to EAHP	Wiring to EAHP

8.3 Mechanical and Electrical Systems in Landlord Areas (within buildings)

The following table sets out the plant items required within the landlord area of each building that will be required for the complete functionality of each system / scenario. Plant items or systems that are common to each system (e.g. hot and cold water services) are not listed and are excluded from subsequent costs.

Costs Within Landlord Areas						
	Scenario A	Scenario B	Scenario C	Scenario D & E	Scenario F	Scenario G
Temporay/Original Plant Type	None	Gas Fired Central Plant	Gas + CHP + Heat Pump Central Plant	Heat Pump Central Plant	None	None
Controls and Wiring	Local BMS & Fault Alarms	Full Motor Control Centre & BMS Controls	Full Motor Control Centre & BMS Controls	Full Motor Control Centre & BMS Controls	Scaled back BMS for water services & other alarms	Scaled back BMS for water services & other alarms
Back-Up Plant Type	Gas Fired / Electric Boilers	Retain Temporary Plant	Retain Temporary Plant	Retain Temporary Plant	None	None
Pipework Distribution within Buildings	Pipework in risers & corridors to apartments	Pipework in risers & corridors to apartments	Pipework in risers & corridors to apartments	Pipework in risers & corridors to apartments	Pipework corridors to apartments (space in risers)	None
Future Swap Out Works	None	Connections & Commissioning	Connections & Commissioning	Connections & Commissioning	Installation of pipework in risers + Connection & Commissioning	None

8.4 Sitewide Mechanical, Civil and Building Provisions

The following table sets out the works required at site level to provide plant space and district heating pipe networks.

Building & Civil Works						
	Scenario A	Scenario B	Scenario C	Scenario D & E	Scenario F	Scenario G
Building / Plant Space Requirement	100m2 for back-up plant	100m2 plant space	150m2 plant space	250m2 plant space	100m2 for back-up plant	None

External Pipework Distribution	1500m of trench + 3000m of flow & return pipework	1500m of trench + 3000m of flow & return pipework	1500m of trench + 3000m of flow & return pipework	1500m of trench + 3000m of flow & return pipework	1500m of trench + 3000m of flow & return pipework	None

8.5 Plant Replacement Assessment

Plant Replacement Assumptions						
	Scenario A	**Scenario B**	**Scenario C**	**Scenario D & E**	**Scenario F**	**Scenario G**
Apartment Heating Plant	75% replacement of HIUs within assessment period	75% replacement of HIUs within assessment period	75% replacement of HIUs within assessment period	75% replacement of HIUs within assessment period	100% replacement of EAHPs within assessment period	100% replacement of EAHPs within assessment period
Apartment Ventilation Plant	100% replacement of MEVs within assessment period	100% replacement of MEVs within assessment period	100% replacement of HRVs within assessment period	100% replacement of MEVs within assessment period	Included in EAHP replacement	Included in EAHP replacement
Central Plant Replacement Costs	Assumed to be borne by 3rd Party DHS provider	Assumed to be borne by 3rd Party DHS provider	Assumed 50% of central plant items replaced within assessment period	Assumed 50% of central plant items replaced within assessment period	N/A	N/A

8.6 Capital Cost Assessment

The table below sets out the estimated capital costs of each Scenario, based on the plant allocations set in in Sections 8.2 to 8.4 above and on analysis of returned tenders on similar projects over recent years (for mechanical and electrical costs within buildings) and on estimated rates for district heating pipework and civil works and building costs.

Costs Within Apartment						
	Scenario A	Scenario B	Scenario C	Scenario D & E	Scenario F	Scenario G
	€M	€M	€M	€M	€M	€M
Costs within Apartments	5.2	5.2	5.8	5.2	7.4	7.4
Costs with Landlord Areas	1.6	1.9	2.3	3.1	2.1	0.05
Costs for site works & buildings	2.2	2.2	2.3	2.5	2.2	0
Plant Replacement Costs	2.9	3.2	4.1	3.6	4.8	4,824,000
Grand Total	**11.9**	**12.5**	**14.5**	**14.4**	**16.6**	**12.3**
Difference from Counter Factual [€]	-404,000	146,000	2,245,000	2,096,000	4,275,000	0
Uplift Cost Per Unit [€]	-603	218	3,351	3,128	6,381	0

9. Operation Analysis

An analysis of the energy use and associated carbon emissions was prepared for each of the scenarios using estimated annual energy demand calculated by the DEAP methodology. While the DEAP methodology may not fully represent the actual in-use energy demand it does provide a means of comparing each system against a consistent usage pattern.

9.1 Carbon in Use

The first, and most important operation metric is carbon emissions. Using the carbon conversion factors presented in Section 5, the total carbon emissions over the 35 year assessment window have been calculated and the results are presented in Figures 9.1 to 9.4 below.

In each of the graphs, the data for Scenario A, B, E, F & G remain consistent, however the data for Scenario C & D vary to demonstrate how the total carbon emissions of these scenarios vary depending on the timeframe in which the district heating system will become available. The results presented show the overall carbon emissions assuming the 3rd party DHS Network becomes available after 10, 15, 20 and 30 years.

The key findings of the analysis, as presented in the graphs are as follows:

- Scenario F & G are deemed to be the baseline / counterfactual carbon performance. Both offer carbon performances that exceed Building Regulations Part L & NZEB performance levels.
- In each of the cases presented, it is evident that Scenario A and B offer the lowest carbon solution to meeting the energy demands of the site (3rd party DHS available at Year 0 or Year 5 respectively). This is based on theoretical / target carbon performance factors proposed by Dublin City Council / Codema
- Scenario C & D have the potential to offer carbon savings if a 3rd Party DHS network becomes available during the first 12 years and 21 years of occupancy respectively.
- Scenario E has one of the highest carbon emissions of each of the systems proposed, with the exception of Scenario C where a 3rd Party DHS Network becomes available after 14 years.

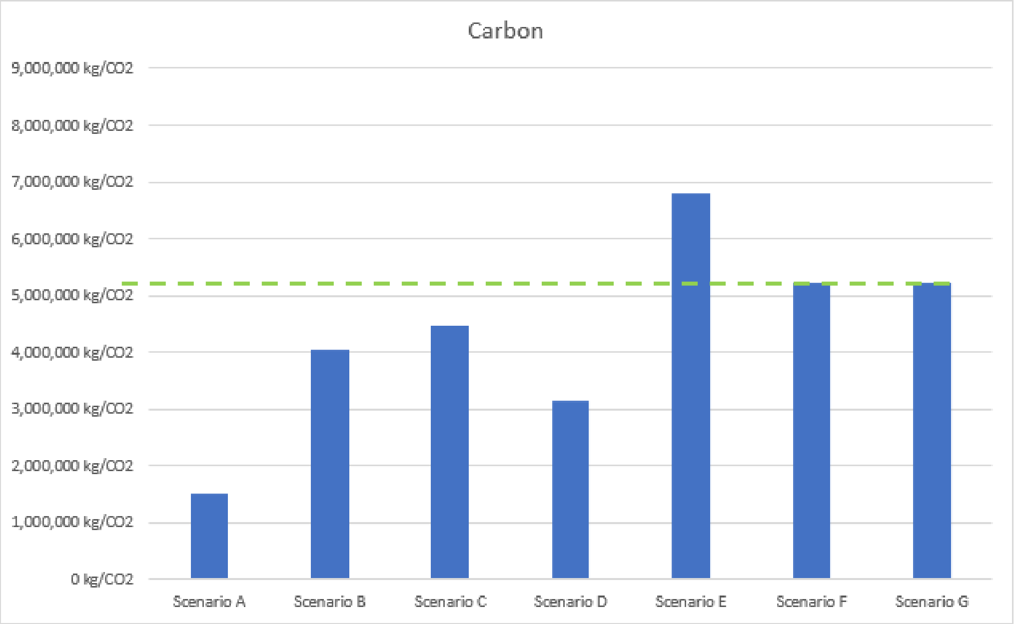

Figure 9.1 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***10 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

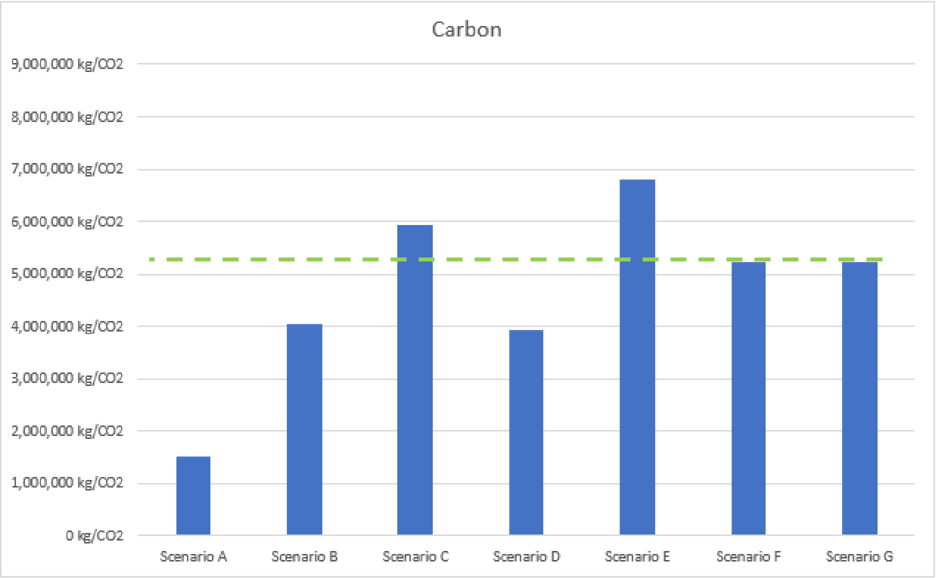

Figure 9.2 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***15 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

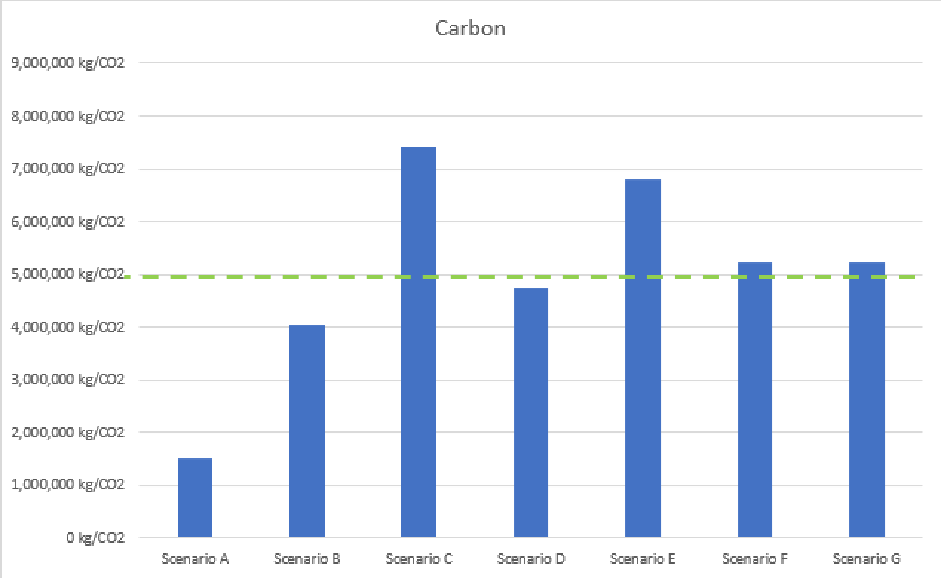

Figure 9.3 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***20 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

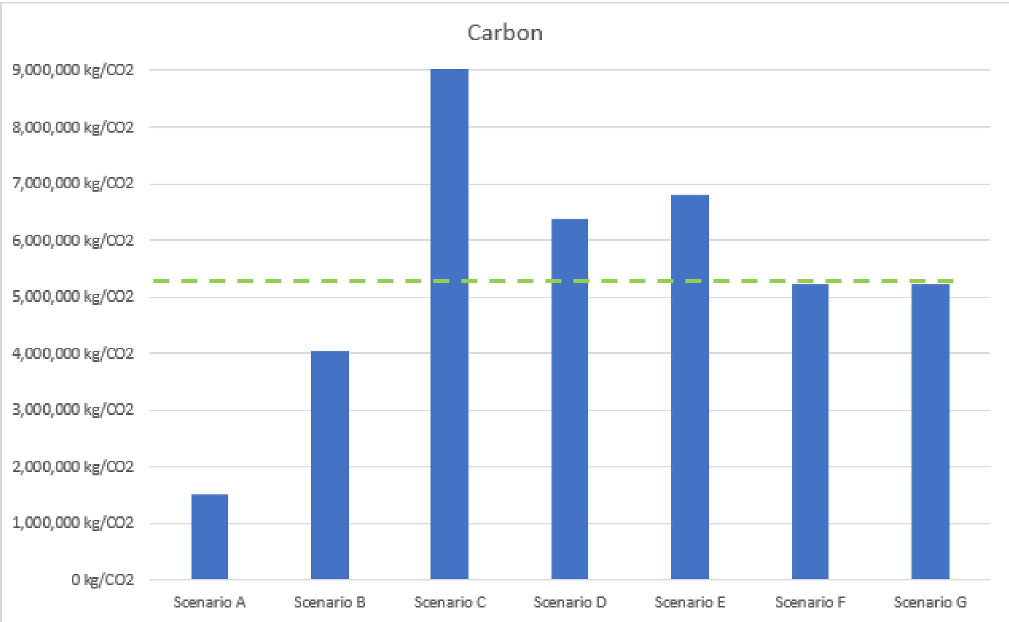

Figure 9.4 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***30 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

9.2 Operation Energy Costs

Cost in use is also an important consideration to consider. Using the cost per unit (kWHr) presented in Section 5, the total running costs over the 35 year assessment window have been calculated and the results are presented in Figures 9.5 to 9.8 below.

As with the carbon assessment in the preceding section, each of the graphs present data for Scenario A, B, E, F & G which remain consistent. However, the data for Scenario C & D vary to demonstrate how the running costs of each scenario varies depending on the timeframe in which the 3rd party district heating system will become available. The results presented show the overall running costs assuming the 3rd party DHS Network becomes available after 10, 15, 20 and 30 years.

The key findings of the analysis, as presented in the graphs are as follows:

- Scenario F & G are deemed to be the baseline / counterfactual carbon performance.
- Scenario A offers a 10% reduction in running costs when assessed against the counter factual scenario, assuming the 3rd Party DHS network is available at Year 0. This is based on theoretical / target energy costs proposed by Dublin City Council / Codema which define the unit cost of heat from the 3rd party network as being 10% less than the counterfactual.
- Scenario B offers approximately comparable running costs to the counterfactual Scenario. This is based on similar assumptions to those for Scenario A and on the assumption that the 3rd Party DHS network is available at Year 5.
- Scenario C, D & E all show an increase in running costs compared to the counterfactual scenario, even if the 3rd Party DHS Network becomes available after 10 years. This increase ranges from 5% to 30% depending on when the 3rd Party DHS network becomes available.
- Scenario E has one of the highest carbon emissions of each of the systems proposed, with the exception of Scenario C where a 3rd Party DHS Network becomes available after 14 years.

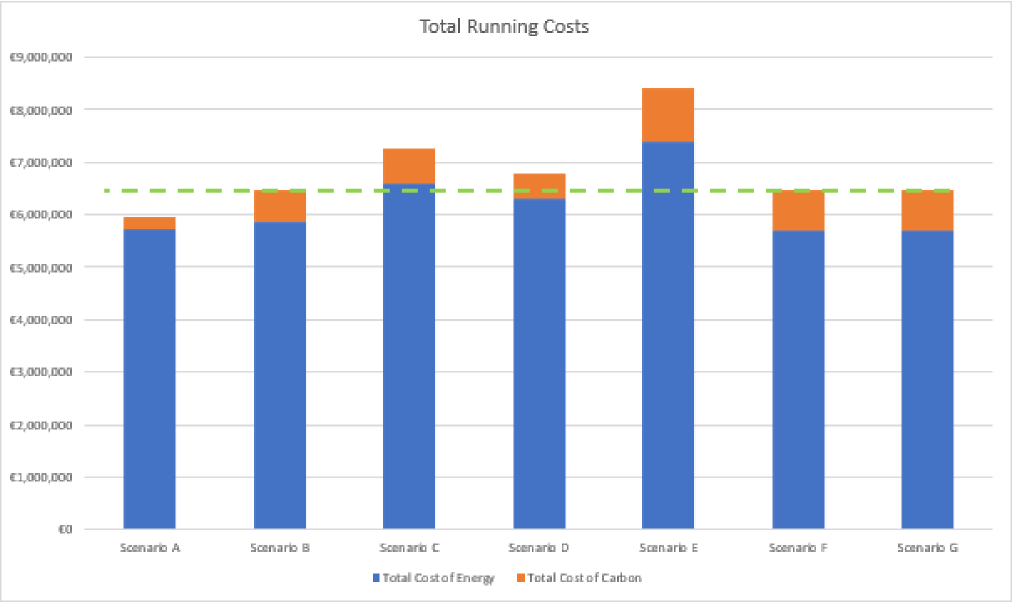

Figure 9.5 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***10 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

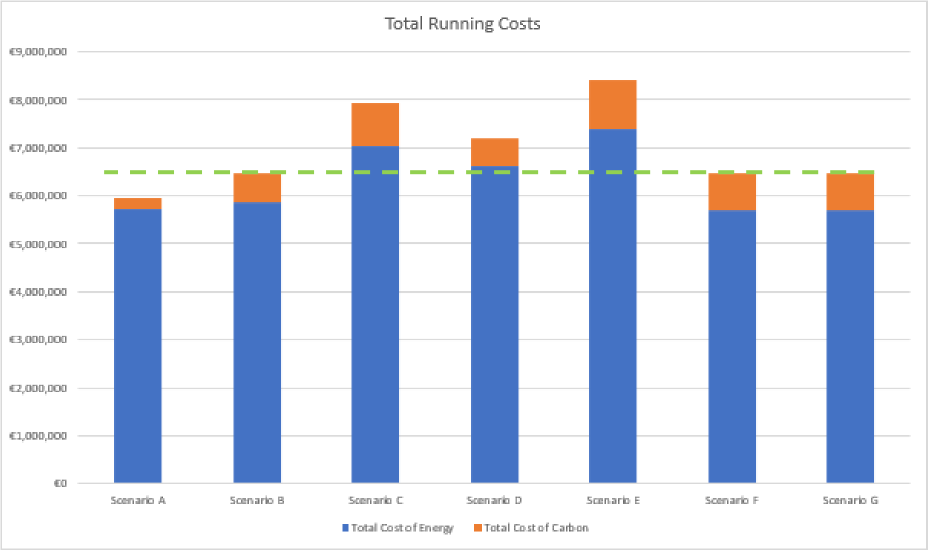

Figure 9.6 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after* ***15 years*** *; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

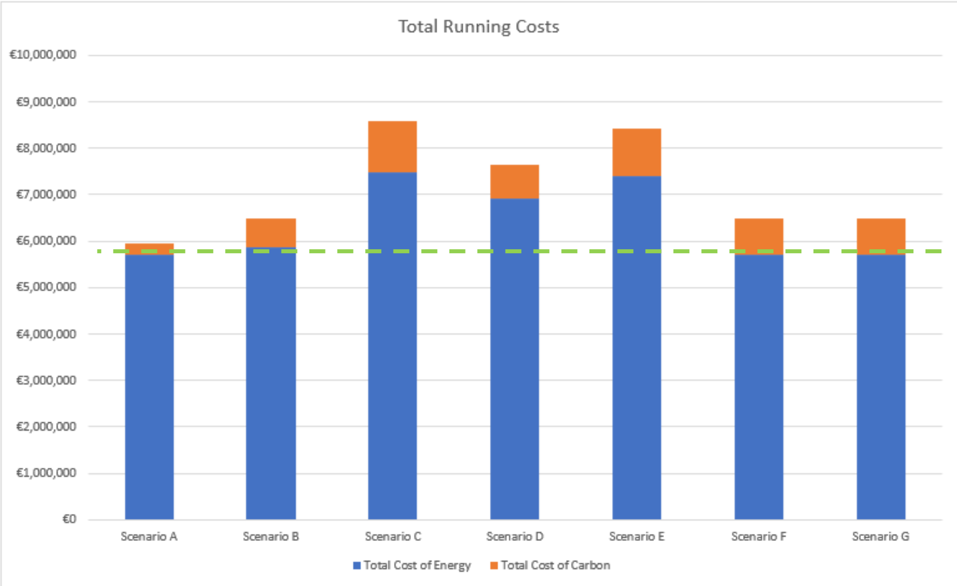

Figure 9.7 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after **20 years** ; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

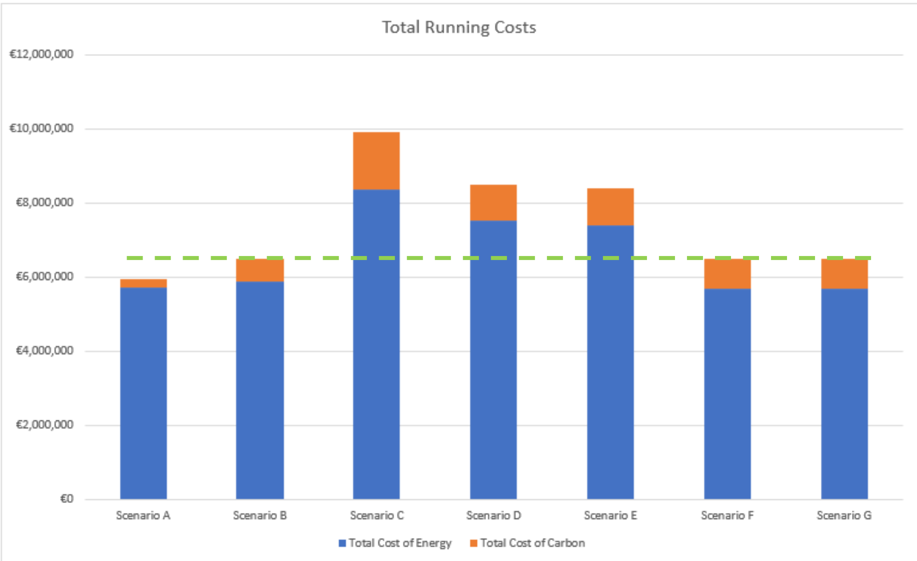

Figure 9.8 *Scenario A – 3rd Party DHN Available Day 1; Scenario B – 3rd Party DHN available after 5 years; Scenario C & 4 – 3rd Party DHN available after **30 years** ; Scenario E, F & G - 3rd Party DHN not available through full 35 year assessment period. Green dotted line represents counterfactual baseline.*

Based on an estimated energy consumption of 35kWHrs/m2/year and using an average of the inflated energy price over the 35 year assessment period, the cost of energy for each Scenario is as follows.

9.3 Analysis Excluding 3rd Party DHS Network

While the primary focus of this report is to analyse the viability of a 3rd Party DHS Network, it is also worth noting the findings of the analysis presented in Sections 9.1 and 9.2. This effectively involves a comparison of Scenario E (site based district heating with heat pumps for central plant) and Scenario G (individual heat pumps within each dwelling) using the data presented in Figure 9.1 and Figure 9.5.

In analysing this data, it can be seen that both the carbon emissions and the running costs of Scenario E are almost 30% higher than those in Scenario G. This confirms that Scenario G offers the optimum solution for the site in terms of running costs and carbon emissions.

10. Technical Constraints & Limitations

10.1 Scenario A (System 1)

It is known that the 3rd Party Off-site District Heating Network will not be available for Day 1 operation and therefore this scenario can be discounted

10.2 Scenario B (System 1 & System 2)

Since there are currently no plans to develop a 3rd Party Off-site District Heating Network within the vicinity of the Cherry Orchard site as such it is considered to be unlikely that a network will be available within 5 years of first occupancy and this scenario can be discounted.

10.3 Scenario C (System 1 & System 3)

The constraints and limitations of Scenario C are as follows:

- Fossil Fuel Consumption on site
- Plant Space Requirements
- Impact on low density portion of the site

10.4 Scenario D (System 1 & System 4)

The constraints and limitations of Scenario D are as follows:

- Availability of heat pumps capable of meeting demand and which are certified to meet SEAI efficiency standards for domestic hot water.
- Capital cost and technical / certification issues related to use of large scale heat pumps not certified to the correct domestic standard.
- Codema diversity of demand advice suggests a total site wide heat demand of 1.5MW to 2.0MW
- Plant Space Requirements (internal & external)
- Impact on low density portion of the site

10.5 Scenario E (System 4 & System 6)

The constraints and limitations of Scenario E are as follows:

- Availability of heat pumps capable of meeting demand and which are certified to meet SEAI efficiency standards for domestic hot water.
- Capital cost (meeting full demand with heat pumps will be expensive)
- Plant Space Requirements (internal & external)
- Capital costs and embodied carbon due to measure required to be "DHS Enabled"

10.6 Scenario F (System 5 & System 6)

The constraints and limitations of Scenario F are as follows:

- Counter Factual Case
- Capital costs and embodied carbon due to measure required to be "DHS Enabled"

10.7 Scenario G (System 5 & System 6)

The constraints and limitations of Scenario G are as follows:

- Counter Factual Case
- Not "DHS Enabled"

11. Conclusions & Recommendations

Following a comprehensive analysis of the technical, financial and energy/carbon-in-use aspects of the potential use of a waste heat network and the alternatives systems that could be implemented within the Cherry Orchard development, the following conclusions can be made.

11.1 Technical & Practical Implications

Scenarios A – E all include district heating systems in various forms and as such all will require central plant space, heat distribution networks throughout the site and within the buildings, heat interface units in each building and within each apartment and the use of a water based heating system within each apartment.

The biggest impact on spatial planning on the site would be provision of DHS pipework to serve the low density portions of the site. Based on the site master-planning and on urban design principles, the space available for below ground services is limited when co-ordination with other services, landscaping and parking are assessed. It is likely that the installation of a DHS network to the low density portion of the site would impact on the overall housing densities that could be achieved.

If the difficulties in serving the low density portion of the site were discounted, or could be addressed in a satisfactory manner, the flowing assessment of each scenario can be made

- Scenario G is based on exhaust air heat pumps in apartments and air source heat pumps in houses and as such has no central plant requirements.
- Scenario F is based on the same systems as Scenario G but is District Heating Enabled and will require space for future installation of plant and distribution pipework.
- Of the assessed options, Scenario G has the lowest overall impact on the site.
- The next lowest impact on the site would be Scenarios A & B as the central plant requirements are the smaller than that other DHS options.
- Scenario D & E would be most impactful as they are based on a DHS network on the site using only air source heat pumps which will require more plant space than DHS networks that contain elements of gas fired plant.

11.2 Energy and Carbon in Use

The energy and carbon in use assessment of each of the scenarios (based on a 35 year assessment window) revealed the following trends

- Scenario F & G are deemed to be the baseline / counterfactual carbon performance. Both offer carbon performances that exceed Building Regulations Part L & NZEB performance levels.
- Scenario A would result in the lowest carbon emissions of all options assessed.
- Scenario B yields the next best results as this assumes that the 3rd Party heat network would be available within 5 years.
- Scenarios C, D & E are assessments based on the initial use of on-site DHS networks and the eventual connection to the 3rd party network. Assuming that this connection can be secured within

the first 12 years of occupancy, Scenario D will generally have the next best carbon in use performance.

- Scenario E has one of the highest carbon emissions of each of the systems proposed, with the exception of Scenario C where a 3rd Party DHS Network becomes available after 14 years
- Scenario A offers a 10% reduction in running costs when assessed against the counter factual scenario, assuming the 3rd Party DHS network is available at Year 0. This is based on theoretical / target energy costs proposed by Dublin City Council / Codema which define the unit cost of heat from the 3rd party network as being 10% less than the counterfactual.
- Scenario B offers approximately comparable running costs to the counterfactual Scenario. This is based on similar assumptions to those for Scenario A and on the assumption that the 3rd Party DHS network is available at Year 5.
- Scenario C, D & E all show an increase in running costs compared to the counterfactual scenario, even if the 3rd Party DHS Network becomes available after 10 years. This increase ranges from 5% to 30% depending on when the 3rd Party DHS network becomes available.
- Scenario E has one of the highest carbon emissions of each of the systems proposed, with the exception of Scenario C where a 3rd Party DHS Network becomes available after 14 years.

11.3 Capital Costs

The capital cost analysis completed was broken down into costs within the apartment, costs required within common areas of apartment buildings and costs related to site distribution. Included with the building common area costs is an allowance for future works where required to connect to the 3rd party network in the future.

The analysis revealed the following trends

- Scenario A, B & G offer the lowest capital cost solution for the site with only 4% variance in the 3 scenarios.
- Each of the alternative scenarios (A to F) would result in a variance in capital costs against the counterfactual scenario (G) as follows
    - Scenario A -3%
    - Scenario B 1.2%
    - Scenario C 18%
    - Scenario D & E 17%
    - Scenario F 35%
- In monetary terms, the uplift in costs range from €1.5M for Scenario A to € 4.2M for Scenario F. The uplift cost per dwelling unit over the counter-factual case is as follows:
    - Scenario A - € 603
    - Scenario B € 218
    - Scenario C € 3,351

- Scenario D & E €3,128
- Scenario F €6,381

11.4 Recommendations

Scenario A

There are no known 3rd party off-site district heating networks available for connection to the site. **Therefore, Scenario A can be discounted.**

Scenario B

Similarly, Scenario B can be discounted as there are no known 3rd party off-site district heating networks available for connection to the site. While the 5 year window does bring about the possibility that a district heating network would become available, the assessment of Scenario B assumes a temporary derogation on compliance with Part L would be available, thereby allowing temporary gas fired heating plant to be used for the first 5 years. Without any known plans for a 3rd party network in the vicinity of the site, it will not be possible to enter into detailed design and construction phases of the project with a strategy based on temporary plant or the possibility of a derogation on Part L compliance. **Therefore, Scenario B can be discounted.**

Scenario C

Scenario C is the only proposed solution that involves the use of fossil fuels on site. This would be contrary to the Land Development Agencies brief for the site. The analysis shows that Scenario C will have a higher running costs than the counterfactual system and will have higher carbon emissions than the counterfactual system unless the 3rd party network is available within 12 years of occupancy. The capital costs for Scenario C are also 18% higher than those for the counterfactual system. **Therefore, based on a combination of factors, Scenario C can be discounted.**

Scenario D

Scenario D involves the use of an on site district hearting system utilising air source heat pumps. At the time of writing this report, it is unclear if large commercial heat pumps can be correctly accounted for within the DEAP assessment procedure. This would present a Part L compliance risk. The analysis shows that Scenario D will have a higher running costs than the counterfactual system and will have higher carbon emissions than the counterfactual system unless the 3rd party network is available within 21 years of occupancy. The capital costs for Scenario C are also 17% higher than those for the counterfactual system. **Therefore, based on a combination of factors, Scenario D can be discounted.**

Scenario E

Scenario E is effectively the same as Scenario D but without any suggestion that a 3rd party DHS network would be available during the assessment period. Carbon emissions, running costs and capital costs are all higher than the counterfactual system. **Therefore, based on a combination of factors, Scenario E can be discounted.**

Scenario F

Scenario F is involves the use of individual heat pumps within each residential unit and includes measures to ensure the site is “district heating enabled”. As the systems proposed in Scenario F are the exact same as those in the counterfactual case (Scenario G) the performance in terms of running costs and carbon emissions are identical. The capital costs of the **active systems** installed on Day 1 are also identical however there are significant additional costs associated with the provision of additional plant space, below ground heating pipework, space within each building for DHS sub-stations and the installation of pipework within the common areas of each apartment block. The costs associated with this additional installation is significant and make Scenario F the most costly of all Scenarios assessed, with an estimated cost uplift of 35% over the counterfactual scenario. **Therefore, based on capital costs, Scenario F can be discounted.**

Scenario G

Scenario G is involves the use of individual heat pumps within each residential unit and does not include allowances to make the site “district heating enabled”

With Scenario A & B discounted due to the fact that there is no known or planned district heating network in the vicinity of the site and Scenario C discounted primarily due to the on-site use of fossil fuels, the only other Scenario to consider is Scenario D, E and F.

Scenario D offers a potential of carbon savings, but only if a 3rd party DHS network becomes available within 21 years. However, the running costs from day 1 will be higher than Scenario G and initial capital costs are also higher

Scenario E would involve higher running costs, higher carbon emissions and higher capital costs

Scenario F offers identical performance to Scenario G but the addition of a provision for district heating adds substantial capital costs to the project.

It is therefore recommended that Scenario G be adopted as the approach for the project.

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