Shanganagh Castle Residential Scheme

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CONTENTS

1.0 INTRODUCTION

This report outlines the mechanical and electrical systems and building regulation compliance criteria at planning stage for the residential development at Shanganagh Castle, Shankill.

This report has been prepared as a compliance requirement for planning applications made in accordance with Dún Laoghaire-Rathdown County Council Guidelines.

The Residential units will achieve both PART F and PART L NZEB Compliance.

The report includes the following elements;

- Performance Details for the Mechanical and Electrical Services
- BER and TGD L and F Compliance
- Water Conservation Report

1.1. Key Energy Reduction and Sustainable Design Features include:

1. BER minimum of A3, with the majority of units achieving a BER of A2.

2. Reduction in Primary Energy compared to a Building Regulation Compliant Residential Building

3. Reduction in CO_2 Emissions compared to a Building Regulation Compliant Residential Building to Part L 2018 (public consultation)

Element	***Building Regulation (W/m²K)***	***Shanganagh Castle (W/m²K)***	***Comment***
Walls	0.18	0.18	*NZEB Backstop*
Floors	0.18	0.18	*NZEB Backstop*
Windows	1.40	0.90	*Triple Glazing*
Roofs *(Flat)*	0.20	0.20	*NZEB Backstop*
Roofs *(Insulated at Ceiling)*	0.16	0.16	*NZEB Backstop*

4. Air Tightness Test to achieve $0.6m^3/m^2/hr$ an 88% improvement on the Building Regulations advised upper limit figure.

5. Thermal Bridging factor 0.04 W/m^2K represents calculated thermal bridge details throughout.

6. Use of LED Lights. LED lights in the residences and in the Landlords areas.

2.0 ENERGY EFFICIENCY & SUSTAINABILITY

2.1 Reducing Energy Consumption – Building Fabric

In order to reduce the energy consumption of the heating and lighting systems integration between the architects, services engineer and structural engineer is required. This approach ensures the form of the building seeks to minimise heat gains in summer and heat loss in winter and also ensures that the choice of heating and ventilation systems will complement the building design and vice versa.

2.2 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.

It is the intention of the design team to meet the requirements of the relevant current/ near future building regulations (Part L 2018 (public consultation)). Target U-Values are identified below.

Element	***Building Regulation (W/m^2K)***	***Shanganagh Castle (W/m^2K)***	***Comment***
Walls	0.18	0.18	*NZEB Backstop*
Floors	0.18	0.18	*NZEB Backstop*
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Roofs *(Flat)*	0.20	0.20	*NZEB Backstop*
Roofs *(Insulated at Ceiling)*	0.16	0.16	*NZEB Backstop*

2.3 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 continue to improve in this area.

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.

In order to ensure that a sufficient level of air tightness is achieved, air permeability testing will be specified in tender documents, with the responsibility being placed on the main contractor to carry out testing and achieve the targets identified in the tender documents.

A design air permeability target of ***0.6m3/m^2/hr at 50 Pascals*** has been identified.
Air testing specification will require testing to be carried out in accordance with

- BS EN 13829:2001 'Determination of air permeability of buildings, fan pressurisation method'
- CIBSE TM23: 2000 'Testing buildings for air leakage"

2.4 Low Carbon & Renewable Energy Solutions

The building services design on any project is ultimately responsible for how a building will consume energy. The design of heating, ventilation and lighting systems will determine the energy consumption characteristics of the building.

The approach that has been adopted to delivering a development which is both highly efficient and sustainably designed has been to involve all members of the design team from the earliest possible stage in the design process. This integrated design approach will be continued throughout the design process.

This approach ensures that the knowledge and expertise of each member of the design team was available from the outset. The goals for sustainable design were identified at this early stage and each element of the design was progressed accordingly.

Several renewable and low carbon technologies were considered during the preliminary design process. Life cycle costing analysis and technical feasibility studies were conducted.

2.5 Combined Heat & Power

The inclusion of combined heat and power plant in any building scheme must be given very careful consideration due to the large capital costs involved and the potential risk of higher running costs than would be incurred if separate heating plant and grid electricity were used.

The most important consideration when designing CHP plant is to carefully assess both the heat load and the electrical load. A CHP installation will typically operate at approximately 80% combined efficiency. Approximately 60% of the useful output will be thermal energy with the remaining 40% being available as electric energy.

E.g. a CHP plant which consumes 100kWhrs of gas will produce approximately 80kWhrs of useful output. 50 kWhrs of this output will be available as thermal energy while the electric energy output will be 30kWhrs.

Given the proportion of thermal energy and electricity produced it is essential that the CHP plant is selected to meet the heat load of the building and not necessarily to meet base electrical loads.

CHP technology will not be included in this development. There is a concern regarding the Heat Losses associated with a large distribution network of LPHW Heating Pipework circulating constantly.

2.6 Heat Pump Technology

The general principal of heat pump technology is the use of electrical energy to drive a refrigerant cycle capable of extracting heat energy from one medium at one temperature and delivering this heat energy to a second medium at the desired temperature. The basic thermodynamic cycle involved is reversible which allows the heat pump to be used for heating or cooling.

The efficiency of any heat pump system is measured by its coefficient of performance (CoP). This is a comparison between the electrical energy required to run the heat pump and the useful heat output of the heat pump, e.g. a heat pump requiring 1kW of electrical power in order to deliver 3kW of heat energy has a CoP of 3.0.

This operating principle can be applied to different situations, making use of the most readily available heat source on any given site. The most common types are:

- Ground Source
- Water Source
- Air Source

Water source heat pumps generally offer the highest CoP however they can be expensive to install and maintain and must have a source of water from a well, lake or river.

An initial technical and financial analysis of the technology has shown that they will not be suitable for use within the building. There are also concerns regarding the potential practical difficulties and programming implications of incorporating vertical boreholes on such a tight site.

On a financial level, the significant increase in capital costs associated with the heat pumps and the associated boreholes is not considered to be justified by the potential savings that would be achieved.

Air source heat pump technology is a viable solution for this project. Locations for external condensers / central air to water heat pump have been located.

Heat Pump technology will be included in the development.

2.7 Bio-Mass Boilers

The use of bio-fuel in the form of wood chip or wood pellet can provide a realistic alternative to conventional fuels such as oil or gas. In terms of heat output, biomass boilers operate in exactly the same manner as conventional oil or gas fired boilers. There are, however, important differences to be considered.

The major drawback of a biomass heating system is the inconvenience associated with supply and storage of fuel, the increased maintenance of the boiler plant when compared to gas or oil-fired systems and the increased capital costs. The advantage of the system, however, is the practically zero net carbon emissions associated with the combustion of wood products and the marginal cost savings which can be achieved.

When natural gas is available as a potential fuel source it is always very difficult to make a sound financial argument for the inclusion of biomass heating systems. The unit cost of wood pellet or indeed wood chip (although slightly cheaper than pellet) is generally only marginally less than the unit of cost of natural gas (less than 10%).

This marginal saving is typically offset by the increase in maintenance costs and is never sufficient to offset the increase in capital costs associated with this installation of the biomass systems. Biomass technology will not be included in the development.

2.8 Solar Water Heating

Solar thermal collection uses of the sun's energy and transfers the heat generated to the building's domestic hot water supply. Two distinct types of collection panel are available. The evacuated tube array and the flat panel collector. The evacuated tube array is the more effective of the two as it is capable of generating approximately twice as much hot water from the same surface area of flat panel.

Solar thermal collection can deliver up to 50% of the total annual hot water load of a Building.

Further to a review the optimum solution was deemed to be Heat Pumps + PV.
Therefore, Solar thermal technology will not be included in the development.

2.9 Photovoltaic (PV) Panels

PV Panels are capable of generating direct current electricity from the sun's energy, which can then be converted to alternating current and used within the building. They are generally a "maintenance free" technology as there are no moving parts. They also typically have a 20-year manufacturer's guarantee on electrical output and can be expected to operate effectively of 30 years or more. With the renewable energy requirement being achieved using heat pump technology additional renewables in the form of PVS will also be considered.

2.10 Wind Turbines

Due to the urban nature of the site wind energy has not been considered.

2.11 Conclusion

From the outset of the design process an integrated approach has been adopted which involved all members of the design team with focus and a holistic approach to sustainable design with a goal to provide a building that is designed in an environmentally sensitive manner while meeting the required comfort conditions of the project. It is the intention of the team that this approach will be continued through the detailed design process to ensure the targets identified are achieved. The proposed solution will incorporate heat pump technologies in the apartments and dwellings.

There is no specific BER rating that is required to comply with Part L, however, residential units compliant with NZEB usually achieve a BER of A2 / A3.

3.0. PART L and PART F for NZEB COMPLIANCE

OVERVIEW

This section sets out to review the method of NZEB compliance with Part L and Part F of the building regulations. It is important to note that the input data currently used is preliminary, and the design will develop as the project progresses.

Note:
There are a large number of variables to be taken into account, so any changes will need to be re-calculated to ensure that compliance is still achievable.

At this early stage of the project, a number of assumptions have been made regarding fabric performance and ventilation strategy required to meet Part L and Part F respectively.

Five residential unit types have been modelled IN DEAP 4.2 in the preparation of this report:

- North facing, top floor, 1-bedroom apartment;
- Northwest facing, top floor, 3-bedroom corner apartment;
- West facing, mid floor, 2-bedroom apartment;
- North facing, 2-bedroom duplex; and
- End of Terrace, 2-bedroom house.

The residential units have been analysed for compliance with the 2019 TGD for both Part L and Part F (NZEB).

There are seven main criteria that this report aims to demonstrate compliance with as listed below:

1. Building Energy Rating;
2. Energy Performance Coefficient (NZEB);
3. Carbon Performance Coefficient (NZEB);
4. Renewable energy contribution;
5. Maximum elemental U-Values;
6. Ventilation strategy (Part F); and
7. Overheating risk analysis.

A summary statement regarding compliance with each of the above seven criteria is provided below.

1. Building Energy Rating (BER)

Whilst there is no specific BER rating that is required to comply with Part L, residential units compliant with NZEB usually achieve a BER of A2 or A3. All of the residential units modelled for this project meet these BER ratings.

2. Energy Performance Coefficient (EPC)

The EPC and CPC are the two figures that are used to determine whether the dwelling complies with Part L on an overall basis.

The EPC is the calculated primary energy consumption of the proposed dwelling, divided by that of a 2005 reference building of the same size. To comply with Part L and NZEB requirements, the EPC must be better than the Maximum Permissible Energy Performance Coefficient (MPEPC) which is 0.30. All of the residential units modelled for this project meet the MPEPC requirement.

3. Carbon Performance Coefficient (CPC)

The CPC is the calculated carbon dioxide emissions of the proposed dwelling, divided by that of a 2005 reference building of the same size. To comply with Part L and NZEB requirements, the CPC must be better than the Maximum Permissible Carbon Performance Coefficient (MPCPC) which is 0.35. All of the residential units modelled for this project meet the MPCPC requirement.

4. Renewable Contribution

To satisfy part L, 20% of the building's regulated primary energy demand must be provided via renewable technologies. This is measured in the form of a renewable energy ratio (RER). All of the residential units modelled for this project meet the RER requirement, achieved through the use of heat pump technology for both space heating and domestic hot water. Details of the heat pump technology proposed is provide later in this report.

5. Maximum Elemental U-Values

Technical Guidance Document Part L 2019 sets out maximum U-Values which may not be exceeded for each construction type (see excerpt below). All of the U-values in the proposed project meet this requirement.

Table 1	Maximum elemental U-value (W/m²K)[1, 2]	
Column 1 Fabric Elements	**Column 2 Area-weighted Average Elemental U-value (Um)**	**Column 3 Average Elemental U-value – individual element or section of element**
Roofs Pitched roof - Insulation at ceiling - Insulation on slope Flat roof	 0.16 0.16 0.20	0.3
Walls	0.18	0.6
Ground floors[3]	0.18	0.6
Other exposed floors	0.18	0.6
External doors, windows and rooflights	1.4[4,5]	3.0

6. Ventilation Strategy

Ventilation requirements are specified in Part F of the Building Regulations. Where an air permeability of less than 3 m^3/hour.m^2 is achieved, it is required to provide continuous mechanical extract ventilation (CMEV). The target air permeability for Shanganagh is 0.6 m^3/hour.m^2 at 50 Pascal, requiring CMEV. The strategy for Shanganagh is to use mechanical ventilation with heat recovery (MVHR), meeting all of the supply and extract requirements. Part F will be fully complied with for the entire scheme, therefore.

7. Overheating Risk Analysis

An overheating risk analysis has been carried out on a number of apartment blocks using the PHPP software. Overheating is defined as exceeding 25˚C for more than 10% of the year. The strategy for this project is to achieve overheating for much lower proportion than 10%. A lower than normal g-value (also known as solar heat gain coefficient) has been proposed for glazing throughout the scheme to achieve this result.

INPUT DATA

It should be noted that this report and the accompanying calculations are based on preliminary information and a number of assumptions have had to be made at this stage. As the project progresses, the model will be refined when HOB is advised of changes to criteria set out in this report, and the results will be advised accordingly.

The backstop values for fabric performance in Part L 2019 were used for the purposes of this analysis. All 3 options were based on the same fabric design, so ensure a like-for-like comparison. The fabric input data and all three options are laid out in this section.

Fabric performance

U- Value thermal properties:

• External wall	**0.18 W/m²k** *(NZEB Backstop)*
• Roof (Insulated at Ceiling)	**0.16** W/m²k *(NZEB Backstop)*
• Roof (Flat)	**0.20** W/m²k *(NZEB Backstop)*
• Ground	**0.18** W/m²k *(NZEB Backstop)*
• Windows	**0.90** W/m²k (Triple glazing)
• Thermal Bridging	**0.04** W/m²k (All Junctions Thermally Modelled)

Air Tightness Test to achieve ***0.6m³/m²/hr at 50 Pascals***, an 88% improvement on the Building Regulations advised upper limit figure.

A thermal mass of Medium-high has been assumed for the preliminary DEAP calculations.

3.1. OUTLINE OF HEATING TECHNOLOGIES REVIEWED

Two options were analysed for heating as follows:

- **Option 1 - Centralised**

- **Option 2 - Decentralised or Individual**

    - **Manufacturer 1 – option a**
    - **Manufacturer 2 – option b**

3.2. OPTION 1 – CENTRALISED GENERATION

3.2.1. Description:

This option consists of a single Energy centre positioned in the development serving multiple apartment units. The energy centre will have a combination of Air Source Heat Pumps and Gas Boilers for heat generation and will distribute heat to the apartment units using a pumped LTHW distribution network.

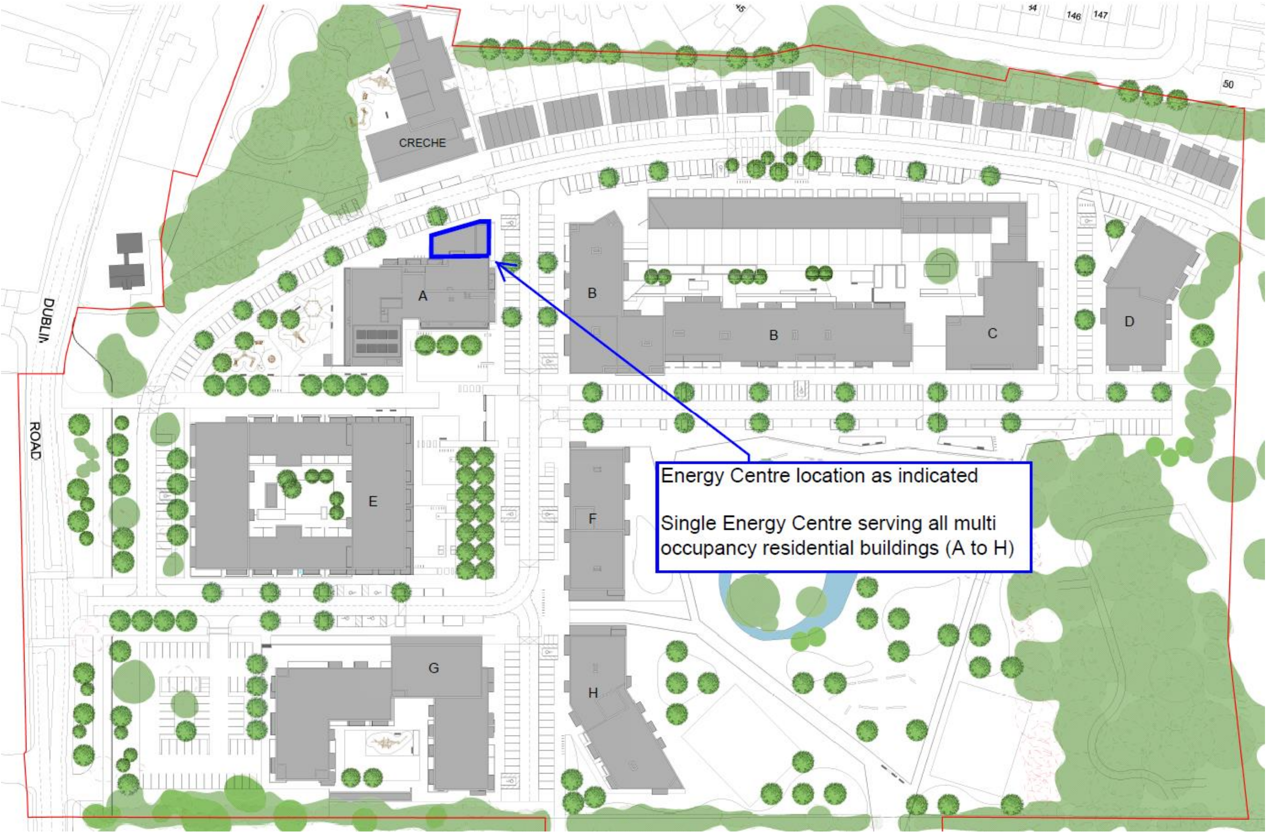
There is a balance to be struck between efficient distribution of energy and economy of scale for district heating systems. At one end of the scale is a single energy centre which is cost effective and space efficient but will have reduced energy efficiency due to distribution losses (heat and pump energy) on the distribution pipework. The other end of the scale is a small centre per building which will be more expensive and consume more gross space but will be more energy efficient due to minimal distribution losses (particularly horizontal distribution in external locations).

The CIBSE code of practice on Heat Networks (CP1:2015) advises that peak energy demand be calculated with diversity of load included. The recommended diversity curve is based on Danish standard DS 439:2009 and its associated formulas and guidance. Under DS 439:2009 useful or beneficial diversity starts to apply from 50 dwelling units and greater and the largest and most diverse component of the total peak energy demand is the instantaneous hot water generation at each dwelling unit.

Using this guidance, the site plan and schedule of accommodation was reviewed and analysed, this analysis plus the analysis of the distribution network losses and the spatial impact of the energy centre/s showed that a single energy centre was the most advantageous. The additional distribution losses were more than offset by the increased central plant efficiency due to the increased diversity of load and the ability to introduce the latest in large scale heat pump technology due to the overall plant load.

See image 1 below with the energy centre location shown.

Image 1


CRECHE
A
B
B
C
D
E
F
G
H
DUBLIN
ROAD
Energy Centre location as indicated
Single Energy Centre serving all multi occupancy residential buildings (A to H)

3.2.2. Energy Centre plant and Equipment

To ascertain the ratio of energy required from Heat Pumps versus Gas Boilers two aspects had to be considered.

Firstly, Heat Pump efficiency generating relatively high temperature water for a LTHW heat network. Air Source Heat pump efficiency or co-efficient of performance (COP) reduces as the outgoing water temperature increases. The highest flow temperature achieved by all single stage refrigerant cycle heat pumps on the market is approx. 60 to 65°C and the efficiency is reduced to achieve this temperature. To enable heat pump integration into district system the system temperature needs to be reduced to suitable level.

The flow and return temperatures being considered for this project heat networks is 70°C flow and 30°C return. The benefits of this are:

- Low return water temperature down to point that is suitable for integration of air source heat pumps

- Gas boilers integrated as second stage will still avail of condensing efficiency

- The temperatures are suitable for use with most Heat Interface Units for space heating and instantaneous hot water generation e.g. Danfoss flat station

- The low mean water temperature helps reduce distribution pipework energy losses

- The 40°C temperature differential keeps pipes sizes small and pumping power low.

A configuration of Air Source Heat Pumps acting as a first stage and receiving return water at 30°C and heating it to 50°C, the gas boilers acting as a second stage and heating the water from 50°C to 70°C has been achieved. This has the effect of splitting the heating load 50/50 between the heat pumps and the gas boilers.

Secondly the ratio of input energy had to be verified in DEAP for Part L 2019 building regulation compliance.

A typical 2 bed apartment based on the preliminary architects sketch layouts was inputted into DEAP 4.2.0 workbook v1.2 (see note on DEAP version in appendices) it was found that the above system configuration with a 50/50 combination of ASHPs and Boilers achieved compliance with results as per the below extract.

Results

	Delivered energy [kWh/y]	Primary energy [kWh/y]	CO_2 emissions [kg/y]
Space heating - main	-26	-25	-5
Space heating - secondary	0	0	0
Water heating - main	2,220	2,126	402
Water heating - supplementary	0	0	0
Pumps, fans, etc.	209	435	86
Energy for lighting	199	414	81
CHP input (individual heating systems only)	0	0	0
CHP electrical output (individual heating sys	0	0	0
Photovoltaic/ Wind Turbine	0	0	0
Type 1 -	0	0	0
Type 2 -	0	0	0
Type 3 -	0	0	0
Total	2,602	2,950	564
per m^2 floor area	34.7	39.33	7.52
		[kWh/m^2 y]	
Building Energy Rating		39	A2

Check conformity with MPEPC, MPCPC and RER requirements in TGD L
Relevant for new-build.

	Primary energy [kWh/y]	CO2 emissions [kg/y]	Renewable Energy Ratio
Totals for reference dwelling	10,438	2,085	
	EPC	CPC	RER
Performance coefficients	0.283	0.271	0.20
Maximum permitted	0.300	0.350	0.20
	Complies	Complies	Complies

Image 4 – DEAP Results for Typical 2-bed apartment

An additional benefit of Centralised Plant is the ability in the future to replace the Gas Boilers with newer technologies as they come on stream. This maybe more efficient, heat pumps operating at higher temperature or heating plant operating using hydrogen to generate heat.

One or two items of plant can be swapped out centrally rather than replacing 597 individual apartment systems. Image 6 indicates a Hydrogen Boiler being tested in the Netherlands.

The inclusion of gas boilers in the system have the benefit of being able to respond to peak loads without reducing overall system efficiency which would happen where heat pumps matched 100% of the load. Gas Boilers are a space and cost-efficient method of providing emergency redundancy or back up to the system with no impact on system efficiency when in standby/ reserve. Image 5 below indicates this typical array.

The other plant required to complete the energy centre are 2 no. thermal buffer tanks sized accordingly to the system and generation plant capacity and Circulation pumps located on piping headers to feed the Heat pumps and boilers and circulate the water in the Distribution Pipe Network.

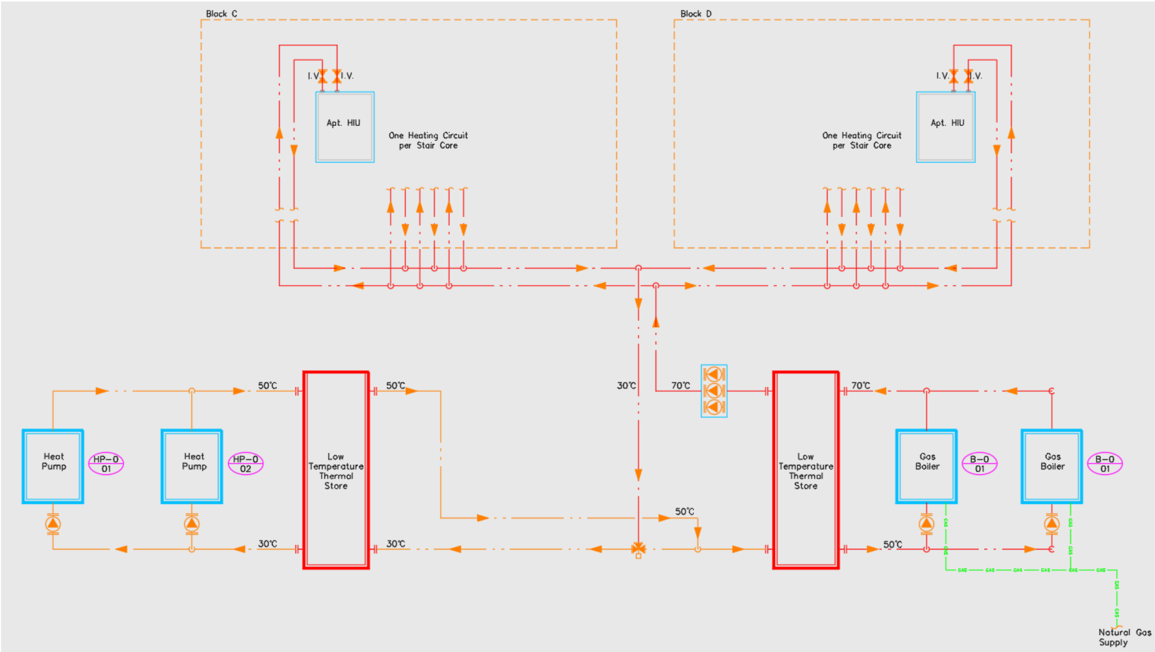


Image 5 - Option 1 System Schematic:

Image 6

3.2.3. Apartment Plant and Equipment

With a Centralised System, the apartments will be fitted with a Heat Interface Unit (HIU) sometimes called a “flat station” or “consumer unit”. The type being proposed for the Shanganagh Caste residential project contains two heat exchangers, the smaller for space heating and the larger exchanger for instantaneous hot water. The HIU has typical dimensions of H 765 x W 530 x D 375. It can be located in the kitchen, store or utility room. Image 7 below indicates this unit.

3.2.4. Energy Capacity

The typical capacities of the HIU for space heating and hot water generation are in the following ranges:

- Space Heating 3.5 – 10 kW
- Hot Water Generation 30 – 60 kW

The proposed capacities for the HIUs for the Shanganagh castle development are at the lower end of the scale to correlate with the low energy consumption of the passive house standard

- Space Heating 3.5 kW
- Hot Water Generation 30 kW

A space heating capacity of 3.5 kW relative to the calculated steady state heat loss and will ensure quick response times from occupant’s inputs and will cater for a variety of preferred space temperatures.

The HIU provides the space heating through radiators or underfloor heating and instantaneous hot water through a domestic hot water pipework connecting the HIU to the outlets. Radiators will be controlled with 2 zones namely one for bedrooms and one for living areas as per Building Regulations requirements. In addition, each radiator will be independently controlled through Pressure Independent Thermostatic Radiator Valves allowing efficient temperature control for every room. The ventilation would be provided through a Mechanical Ventilation Heat Recovery unit, providing fresh air to normally occupied rooms and extract stale air for “wet” rooms.

Image 7 – Typical “cupboard” with HIU top left MVHR top right with washer and dryer beneath

3.2.5. Billing

There are many ownership and billing configurations available for the running and management of district heating systems.

One of the common arrangements used in Ireland is for the management company to own and maintain the central plant and network and to subcontract the billing function to a third party. The management company will maintain a sinking fund for maintenance and replacement of system components as required.

The consumers are billed on their actual energy consumption with the energy monitored and recorded using calibrated energy meters.

It is also possible to offer consumers the option of prepaid energy supply using web or phone-based applications.

CIBSE offer further guidance in its code of practice on how to provide fair and transparent billing structures and agreements to ensure best practice operation of billing in Heat Networks

3.2.6. CENTRALISED PLANT – *ADVANTAGES*

- Provides the full requirement of onsite renewable energy generation required for NZEB compliance.
- Low operational costs
- Good efficiency with large 3-phase Electrical Plant
- Low carbon emissions
- Good Plant resilience with two fuel sources
- No water source bore hole drilling required
- New technologies using other fuel such as Hydrogen as a fuel source can be added to the centralised system.
- More efficient Heat Pumps operating at higher temperatures could be added to replace gas fired boilers.
- Plant Maintenance concentrated in central boilers and not affecting Tenants.

3.2.7. CENTRALISED PLANT – *DISADVANTAGES*

- External Air Source Heat Pump evaporators required local to energy centre(s).
- Infrastructure of heating pipework with associated heat losses.
- Heating water needs to be constantly circulated.
- Space for centralised plantroom (s) is required.
- Careful consideration required with respect to noise generation in a residential environment. Plant considered can be supplied with low noise kit to achieve noise requirements.

3.3. OPTION 2 - INDIVIDUAL HEAT PUMP SYSTEMS

3.3.1. Option A (Nilan type Unit) – Description

This unit located within the apartment is multipurpose in that it provides the Mechanical Ventilation Space heating and hot water heating to the individual apartment utilising air ducted in from and out to outside. The unit supplies air to habitable rooms and extracts from bathroom, utility and kitchen areas. It is to be noted the supply air is used as the medium for space heating. During times of extreme outdoor temperatures or as required the warm air system is supplemented by wall mounted electric heaters typically in the living room and bathroom.

3.3.1.1 Hot Water Generation

The heat pump unit has an integrated hot water cylinder incorporated into the frame and casing. The cylinder has a nominal tank volume of 180 litres. The cylinder is heated by the Heat Pump similar to the space heating operation. The unit through a set of algorithms prioritises either space heating or hot water generation. The cylinder is also fitted with an electrical immersion heater that is used to carry out timed high temperature purges to stop possible legionella growth in the cylinder.

3.3.1.2. Ventilation

The heat pump unit has an integrated mechanical ventilation heat recovery unit. The ventilation is run on a continual basis with the flow rate modulating in response to environmental conditions such as humidity or respond to ancillary optional CO^2 sensors. In addition, the fans are regulated by the algorithm-based controls to assist with space heating or hot water generation when additional airflow across the refrigerant coils is required.

The unit can also two additional options for summer periods;

- 100% bypass on the heat exchanger, so fresh air goes directly to the space and doesn't gain any additional heat
- Cooling mode were the refrigerant cycle is reversed. This generates hot water at the same time as cooling down the supply air to the space.

3.3.1.3. Plant and Equipment

Due to the nature of the system the plant is integrated in one unit. It can be located in the kitchen, store or utility room.

The Heat Recovery Heat Pump has dimensions of H 2065 x W 900 x D 610.

Image 8

3.3.2 INDIVIDUAL HEAT PUMP - OPTION B (NIBE type Unit)

This unit located within the apartment is multipurpose in that it provides the mechanical ventilation, space heating and hot water heating to the individual apartment utilising air ducted in from and out to outside. This air is supplied to habitable rooms and extracted from bathroom, utility and kitchen areas. The air is supplied at a neutral temperature and is not used as the medium to heat the apartment. During times of extreme outdoor temperatures or as required a direct electric immersion heater will be used to top up the heat generated by the heat pump.

Image 9

3.3.2.1. Hot Water Generation

The heat pump unit also has an integrated hot water cylinder incorporated in the frame and casing.

The cylinder is heated by the Heat Pump similar to the space heating operation. The unit through a set of algorithms prioritises either space heating or hot water generation. The cylinder is also fitted with an electrical immersion heater that is used to carry out timed high temperature purges to stop possible legionella growth in the cylinder. The stated storage capacity is 240l.

3.3.2.2. Ventilation

The heat pump has an integrated mechanical heat recovery unit. Heat is extracted from the exhaust air and used to heat the integrated hot water cylinder and heat water for use with the apartments LPHW radiator installation.

The compressor in the heat pump has invertor driven control which improves efficiency of operation.

The ventilation system operates at a constant volume in a similar way to an apartment heat recovery ventilation system.

3.3.2.4. Plant and Equipment

Dimensions: H2025 x W600 x D610

3.4. DECENTRALISED SYSTEMS ADVANTAGES / DISADVANTAGES

3.4.1. Advantages

- All apartments will individually power the heat pump unit contained therein and pay directly for energy consumed.

3.4.2. Disadvantages

- Individual heat pumps take up floor space within each apartment.

- Maintenance staff will have to enter the apartment to service the heat pumps.

3.5. COMPARISON TABLE FOR ALL SYSTEMS REVIEWED

SYSTEM TYPE	OPTION 1 Centralised Generation	OPTION 2 Decentralised Generation	
	Applicable to 1, 2 & 3 plantrooms	Option (a)	Option (b)
System Description	Central Plant with Large Heat Pumps and Gas Fired Boilers supplying distribution network, Heat Interface Unit at each apartment	Individual Heat pump in Dwelling	Individual Heat pump in Dwelling
Trade or Brand Name	Danfoss (Apt. HIU / flat station) Hidros (Heat Pumps)	NILAN compact P	NIBE 730
Supplementary Heat Source	NA	Electric radiator	
Hot Water	Instantaneous	Integrated storage	Integrated storage
Ventilation	Separate Standalone MVHR required	Integrated Supply & Extract ventilation	Integrated Supply & Extract ventilation
Max Capacity in kW (at dwelling)	Typical capacities of HIU: 3.5kW heating 30kW hot water (instantaneous)	2.2kW with heat recovery included 500W without heat recovery	2.43kW with heat recovery included Heat recovery through refrigerant cycle
Supplementary Heat kW (at dwelling)		1.6kW through electric radiators	Up to 10kW immersion heater
Method of Space	LPHW with Rads or UFH	Supply Air - ducted	LPHW with Rads or

Heating			UFH
Temperature Control	Rad Valve or UFH wall stat per room with additional bedroom and living zones	Temperature set centrally for whole dwelling	Rad Valve or UFH wall stat per room
Noise in dwelling	NA	46dBA (casing) 66dBA (supply conn. At unit)	40-55dBA
Billing	Third Party billing required through heat meters or building wide flat fee	All electrical energy through dwellings electrical consumer board	All electrical energy through dwellings electrical consumer board

3.6 CONCLUSION

Having outlined the option for Apartment Space and Hot Water Heating, we believe the overall more economically advantageous option is to provide heat centrally.

In this regard our recommendation would be to proceed with 1 Centralised Plantroom for all of the apartments. If this cannot be achieved our next preferred option would be for 2 Centralised Plantrooms.

It is to be noted that the house units will be provided with individual air to water heat pumps.

4.0 WATER CONSERVATION PLAN

Water consumption and the conservation of water has become increasingly important in recent times. There are a number of potential advantages from the conservation of water both environmentally and financially. The reductions in usage of water result in reductions in energy, wastewater and in turn associated costs.

The water supply for the site will be taken from the Local Authority mains network.

There are a number of features which will be included in the design of the water services installation which will reduce the consumption of potable water.

4.1. Low Water Use Sanitary Ware

The sanitary ware selected within the buildings can have a significant effect on the water consumption. Low use appliances such as aerated taps, dual flush WC's and low water use showers will be installed throughout the development

The following is a table detailing maximum water consumption for various appliances:

Appliance	Minimum Standard
Dual Flush Cistern	6/4 Litres or better
Showers	<9 litres/min
Taps	Aerating Taps (approx 0.5l/use)

4.2 WATER STORAGE 24 HOURS

Apartment	Storage
1 Bed	227 L
2 Bed, (1bath+ en-suite)	317 L

5.0 BUILDING LIFE CYCLE

The new Apartment Guidelines are as outlined in the Introduction in this Document. Under Section 6.0 Operation and Management of Apartment Developments states the following:

"*Certainty regarding the long-term management and maintenance structures that are put in place for an apartment scheme is a critical aspect of this form of residential development. It is essential that robust legal and financial arrangements are provided to ensure that an apartment development is properly managed, with effective and appropriately resourced maintenance and operational regimes.*

In this regard, consideration of the long-term running costs and the eventual manner of compliance of the proposal with the Multi-Unit Developments Act, 2011 are matters which should be considered as part of any assessment of a proposed apartment development.

Accordingly, planning applications for apartment development shall include a building lifecycle report which in turn includes an assessment of long term running and maintenance costs as they would apply on a per residential unit basis at the time of application, as well as demonstrating what measures have been specifically considered by the proposer to effectively manage and reduce costs for the benefit of residents".

5.1. Design Measures to ensure Low Maintenance and Low Running Costs

The following measures will be incorporated into the Design to achieve Low Maintenance and Running Costs.

These measures will include but not limited to;

- Efficient Heating System using Centralised Heat Pump Technology
- Efficient Hot Water Generation also using Centralised Heat Pump Technology
- Low Air Infiltration & Thermally modelled junctions reducing heat losses
- User friendly Heating and Hot Water Controls to enhance occupant comfort and reduce over heating
- LED Low Energy Lighting throughout

5.2. Estimated Annual Heating, Hot Water and Lighting Running Costs.

All of the apartment units have been scheduled together with their calculated energy consumption and energy consumption costings.
It is intended this information will be used to feed into an overall building Life Cycle Report which will also have input from the Client, Property Managers and Consultants.

APPENDIX 1

NO.	ITEM
1.0.	**MECHANICAL**
1.1	**Design Criteria**
	The Mechanical Services shall be designed to comply with the Irish Building Regulations and the Chartered Institution of Building Services Engineers (CIBSE) Guidelines and all other relevant International and Local Authority Standards. **Indoor Climate:** Operative temperature: Winter mode: min. *21 °C* **Outside Design Conditions – Dublin:** ▪ Winter: Temperature -5°C 100% RH ▪ Summer: Temperature 26°C (dry bulb) Humidity 19.5°Cwb (wet bulb) **Air Quality:** Rooms such as toilets, shall be put in under negative pressure towards surrounding room spaces. Exhaust air discharge points shall be placed in compliance with CIBSE Guidelines. Air velocity within the occupation zones 0.15/ms **Background Noise Levels:** **Area** **NR** Bedrooms (Night Time) ≤NR25 Stairwells and Corridors ≤NR40 Entrance Lobby, ≤NR40 Kitchen ≤NR45 Toilets ≤NR45 External Plant: In accordance with acoustic consultant criteria and design report.
1.2.	**Mechanical Site Services**

	Site services associated with the Mechanical Services comprises of piped natural gas, district heating pipework and water mains pipework. An external isolation valve point shall be provided local to each block for mains water and district heating pipework adjacent to the main entrance. A check meter will be provided on each water supply. There is a mains water network in the area provided by the Local Authority which will be extended to the site. Gas will be extended from the Local Gas Infrastructure to serve the Central Energy Centre. The mains water network will run underground to each Block mains water break tank and cold-water storage tank serving each Block.
1.3.	**Heating System:**
	A Centralised Heating system will be provided to serve all of the apartment blocks. Individual heating systems will be provided to serve house units. ***Apartments;*** A Central Energy Centre is located within Block A. This Centralised Heating System will be a combination of Air to Water Heat Pumps and Gas Fired Boiler Plant. Heating Flow and Return Pipework will be distributed below ground to each Block from this location. Within the Central Plantroom variable speed heating circulation pumps will be provided supplemented with a small jockey pump. The proposed designed Heating Flow and Return Temperatures are 70ºC / 30ºC giving a mean water temperature of 50ºC. This compares favourably within the mean water temperature of a conventional 80ºC / 70ºC system of 75ºC. The Variable Speed Pumps typically will cycle to 30%, however, during the night they will switch off with the small jockey pump operating to maintain pipeline temperatures. Within each Apartment, a Heat Interface Unit (HIU) will be provided. Served from this HIU each Apartment will be provided with a radiator heating circuit via a Heat Exchanger within the HIU. Also within the HIU a dedicated Heat Exchanger will be provided for hot water heating for the apartment. Heat Meters will be provided in each HIU. All meters will be linked via BMS to a front end PC within the Facility Managers Office for bill logging (which can also be done remotely off site if required). In additional to straight forward billing, the software/application will be capable of comparing actual usage with pre-programmed acceptable usage levels for all metered consumption. 7 day, 24 hour acceptable consumption profiles will be accommodated by the software. A dedicated HIU will provide heating via LPHW radiators to Landlord Spaces within each Apartment Block. The heating installations will be designed in accordance with the Chartered Institution of Building Services

	Engineers (C.I.B.S.E.) Guidelines and Part J of the Building Regulations Technical Guidance documents and amendments where applicable. ***Houses;*** Each individual House Unit will be provided with an Air to Water Heat Pump Heating System. This heating system will comprise of a floor mounted indoor unit and outdoor wall mounted condenser unit. The indoor unit will incorporate a hot water cylinder and circulation pump. The outdoor unit will comprise of a compressor and condenser with interlinking refrigerant pipework to the indoor unit. In addition to heating the hot water, the heat pump will be the heat source for the house radiator heating system.
1.4.	**Ventilation**
	Apartments and Houses: Each apartment and house will be provided with a dedicated Mechanical Ventilation Heat Recovery (MVHR) system. The MVHR unit will have a ducted fresh air intake and discharge to outside. Air will be supplied from the MVHR unit to habitable rooms and extracted from bathroom(s), the kitchen and store room. The MVHR unit will be located within the apartment and adjacent to the party wall with the Landlord area corridor. The intention is to have an access door to enable maintenance staff to clean / replace the two filter units contained within the MVHR unit as required. Kitchen extract air will be filtered and recirculated. The apartment internal corridors at each level will be mechanically ventilated by a roof mounted large MVHR unit. Fresh air will be vertically ducted to each corridor at one end and extracted at the opposite end.
1.5.	**Water Services:**
	Apartments; Mains water will be supplied to the residential blocks and will enter beneath the ground and into the water storage room and rise to a check meter. Mains water will serve the sinks located in each apartment via a dedicated booster pump and break-tank. Sectional GRP cold water storage tanks to Format 30 Specification will be installed. Separate dedicated cold water storage tanks will be provided typically with a storage allowance of 227 litres per dwelling. A pump set will serve a dedicated CWS piped service to each dwelling. The tanks will be located so that it is possible to repair or replace any sections of the tank without any fabric / structural changes. All tanks will be supplied with lightweight covers and fitted with drip trays. Provision will be made in the tanks cover for access to the ball cock. Overflow and warning pipes to the tanks and drip trays will be incorporated discharging at a point of visibility.

	Hot water will be generated instantaneously via the HIUs. All water services distribution pipework shall be appropriately insulated. The insulation shall be of preformed sections of rigid mineral wool incorporating aluminium foil laminate cover and fitted in accordance with the manufacturers' instructions. The insulation shall also be applied to all connections, bends, tees and valves. Proprietary jackets with Velcro fixings shall be used on all valves over 32mm. Additional taping shall be provided at 2m intervals on the insulation within the heating centre plant room. Thermostatic shower mixers will be provided to all showers. The water systems will be designed and installed to ensure water hammer and air locking does not occur, and will be provided with an adequate number of isolating valves for the purpose of isolation and maintenance. The dead leg distribution pipe to all outlets will be kept to a minimum in accordance with current industry standards. ***Houses;*** A metered incoming mains water supply will be routed to the Kitchen Sink and then to the Attic Cold Water Storage Tank. Individual Cold Water Storage Tanks will be provided within the attic of each house. Cold Water Storage capacities will be in compliance with the Irish Water "Code of Practice for Water Infrastructure". Each Water Storage Tank will be Format 30 compliant. From this tank a Booster Pump will serve the hot and cold water services outlets within the house. Thermostatic Mixing Valves will be provided to showers. Hot Water will be stored and generated within the Air to Water Heat Pump indoor unit.
1.6.	**Fire Fighting:**
	First aid fire fighting will be provided in accordance with building regulation requirements.
1.7.	**Sprinkler System**
	Apartments; A Domestic Sprinkler System is proposed for all the Apartment Blocks. The sprinkler system will be designed in accordance with BS 9251 2014 "Sprinkler systems for residential and domestic occupancies – Code of Practice." This Standard gives recommendations for the design, installation, components, water supplies, commissioning and maintenance of fire sprinkler systems for use specifically in residential and domestic occupancies. , not exceeding 45 m in height, include apartments, residential homes, houses of multiple occupancy (HMOs), blocks of flats, boarding houses, aged persons homes, nursing homes, residential rehabilitation accommodation and dormitories. Fire sprinkler systems for domestic and residential application are designed to provide an additional degree of protection of life and property, above that already achieved by the installation of smoke and/or fire detectors and systems. Residential and domestic fire sprinkler systems are systems that consist of a water supply, backflow prevention valve (check valve), stop valve, priority demand valve (where required), automatic alarm system (both internal and external) and pipework to quick response sprinklers. The sprinklers are fitted at specified locations, the appropriate sprinkler type being used for each location. Sprinklers operate at a pre-determined temperature to discharge water over a known area below. The flow of water thus initiated causes the sounding of an alarm. Only those sprinklers operate which are individually heated above their operating temperature by the heat from the fire. The design of the sprinkler system will take cognisance of the following principle issues stipulated in BS

	9251 ; 2015 when being designed; **Category of System:** The BS identifies 3 category types of sprinkler installation. The Category of the sprinkler system is determined by the type of building as indicated in Table 1 of the standard. It is envisaged most of the Blocks will fall under Category 2 as their size will exceed 2400m². The chosen category determines the design density and duration of supply under Table 2 of the standard the minimum discharge density is 2.80 mm/min, number of design sprinklers 1 or 2 and minimum duration of supply 30 minutes. **System Type:** A residential sprinkler system should be a wet pipe system, i.e. one that is permanently charged with water. **Extent of Sprinkler Protection:** Sprinkler protection will be provided throughout with the permitted exception of; - bathrooms with a floor area of less than 5 m2 - cupboards and pantries with a floor area of less than 2 m2 or where the least dimension does not exceed 1 m; - attached buildings such as garages and boiler houses without direct access from within the protected building; - crawl spaces; - ceiling voids; - external balconies permanently open to the outside and uninhabited loft/roof voids. **Water supply:** Subject to meeting the minimum performance criteria of the BS and where applicable local authority approval the following water supply options will be considered during the design stage; Sprinkler systems should be connected to a reliable and sustainable supply, for example; • Mains water supply: • Mains pressure only; • Mains water supply boosted by a pump; • Stored water supply: • Pump supplied from a water tank; • Regulated pressurized vessel; • Gravity-fed stored water system

	Fire Pump & Storage: Where a pump is used, the recommendations of 5.3.3 of the BS will be met and the pump should be: a) Located such that it is unlikely to be affected by a fire; b) Located where the temperature will be maintained above freezing; c) Protected electrically by suitable fusing; d) Protected against the effects of fire; e) Of sufficient capacity to ensure the recommendations of 5.3.3 of the BS are met; f) Suitably designed and manufactured such that testing is needed at not more than annual intervals; g) Operated automatically on demand and require manual shut down. A combined sprinkler and domestic supply pump can be provided subject to meeting the stated minimum criteria in 5.3.3. of the BS. Category 2 systems typically have a water storage requirement of 3 – 4.5 m^3. **Sprinklers:** Only sprinkler heads in accordance with BS 9252 or as agreed with the local authority with quick-response temperature-sensing elements should be used in the inhabited parts of the building. Sprinkler heads should be of pendent, upright or sidewall spray pattern types suitable for flush, recessed or concealed installation. The sprinkler head type to be proposed to the Local Authority will be either a Viking Freedom Residential Pendant Sprinkler type VK 466 (K 5.2) or Tyco rapid response Series LFII Residential 4.9 K- Factor Pendant Sprinkler. Only new sprinkler heads should be used. Any sprinkler head removed from a system should be discarded. Fusible link sprinklers should be colour coded on the frame or sprinkler body; glass bulb sprinklers should be colour coded by the bulb liquid in accordance with BS 9252 or EN 12259-l. The temperature rating of the sprinklers should be: a) The closest to but at least 20°C greater than the highest anticipated ambient temperature of the location b) Within the range of 79°C to 100°C when installed under glazed roofs. For normal conditions the sprinkler temperature ratings will be 57°C to 77°C. **Power supply:** The electrical supply to the fire pumps should be installed in such a way as to minimize the risk of electric supply fai ***Apartments;*** lure by having a separately fused connection taken after the meter and from the supply side of the fuse box, using fire-resisting cable. In all other instances the electrically operated devices should be capable of carrying out their function the event of a complete failure of the mains electrical power supply.
1.8.	**Sanitary:**

	Apartment and Houses: Above ground soils and wastes form part of the Building Services scope of the project. Generally, the above ground soils and wastes shall be run in PVC piping to BS 5572, and shall include vents, anti-siphons and traps to all fittings as appropriate. The design of wet areas in a stacked configuration facilitates this simple and low maintenance approach. All soils and wastes pipework will include sufficient blank caps and cleaning door for access of cleaning rods. On the ground floor there are two connections to builder up stands to accommodate the soils vent pipe and the WC. (Refer to Civil Engineers drawings indicating below ground drainage). Drainage will be accessible through the service space at the rear of each pod in residential buildings. SMU cast iron pipework shall be used for slung drainage routed in the fulcrum building at level 2 over the medical centre and where waste services pass through all retail tenancies.
1.9.	Renewables
	To achieve the renewables requirement stipulated in TGD Part L, Centralised Air to Water Heat Pumps will be provided.
1.10.	Sustainability Target
	BER Target is NZEB Part L 2019 Compliance.

2.0	**ELECTRICAL**
2.1	**Design Criteria**
	The Electrical Services shall be designed to comply with the Irish Building Regulations, The Electro Technical Council of Ireland (ETCI) Guidelines and the latest IEE Regulations. The general services provision shall be in accordance with DCC social and affordable housing guide, requirements, where required.
2.2	**Incoming Power Supply**
	5 dedicated ESB sub-stations will be sited in the development to serve the entire site. The supply to all buildings, landlord and tenant services will be at LV. The LT switch room for each building will be designed to accommodate a main distribution board suitable for multi tenancy metering, provision for power factor and surge protection equipment and have spare space of 20%. Switchgear shall be located in areas protected from flooding or water ingress. Main power supply cables will have a spare capacity of 20%. External site services will be supplied via dedicated ESB meters & DBs located in each building. Electric car chargers will be supplied via dedicated ESB meters & DBs located in each building.
2.3	**Switchgear and Distribution Boards**
	ESB metering for each dwelling and landlord services will be provided for each building with a landlord distribution board. All main distribution boards (MDB) will be Form 4 type 2 and local Sub Main Boards will be Form 3b. Individual meters will be attached to each house unit.
2.4	**Standby Power Supply**
	Standby generator or battery back-up supply will be provided by the Landlord to support all firefighting and life safety systems in the development.
2.5	**Power Factor Correction**
	Power Factor Correction equipment will be provided by the Landlord to ensure a minimum corrected value of 0.95 exists on all phases.
2.6	**Voltage Equalising Equipment**
	The building will be equipped with lightning arresters in the form of roof leads, down-leads, ring leads and foundation earth points. The buildings will be equipped with a leading-in protector to eliminate transient over voltages that may enter the building through the external cable network.
2.7	**Cable Distribution (Duct Systems)**
	The duct system in common areas will include for four separate cable runways. ▪ One for LV sub mains distribution. ▪ One for LV outgoing final sub circuits.

	▪ One for the data network and ELV functions ▪ One for Fire Alarm In common areas vertical risers will connect all floors and horizontally distribution will be in accessible ceiling void.
2.8	**General Services**
	The general services installation will be designed according to the current The Electro Technical Council of Ireland (ETCI) Guidelines and the latest IEE Regulations. General services outlets and small power requirement shall be provided to all areas of the development as required. Circuit management will be considered in the design and each general services socket circuit shall be provided with a 30mA trip residual current device (RCD) at the local distribution board/ Consumer unit.
2.9	**General and Emergency Lighting**
	The general lighting installation in all areas shall incorporate energy efficient lamps within selected luminaires, to provide suitable and adequate levels of illumination in accordance with required standard and in compliance with the current EU Directive on interior lighting and the C.I.B.S.E. / SLL Code for Lighting 2016. Lights in landlord core areas will be energy efficient LED recessed downlighters generally designed to an average of 100 lux with a uniformity of 0.7 with light switching control facilities to provide efficient use of the lighting system. Lighting in plant areas will be provided by surface IP rated LED fittings with vapour resistant polycarbonate diffusers. External lighting will be provided on roadways, car parks, utility and amenity areas in compliance with design standards. In addition, external lighting will be provided on path, outside of site boundary, to new LUES station. A lighting control system will be included in the design as agreed with DLR requirements. Emergency Lighting will be provided within the Apartment Blocks. The emergency lighting installation will comply with IS3217. Emergency lighting shall be independent LED and provided via independent battery packs. In the event of power failure these battery packs will power the fittings for 3 hours and will provide adequate light for safe escape. An emergency lighting central test unit shall be installed.
2.10	**Fire Alarm Installation**
	The fire alarm system will comply with IS3218. 2013+A1 2019 and the specific requirements of the Fire Certificate. The system will be designed for L3 for common areas & LD2 for the dwellings coverage as defined in IS3218 2013+A1 2019. The fire alarm system will be fully addressable and capable of interfacing with other systems. The control panel should be capable of providing status outputs to the Building Management System (BMS). Individual Fire Alarm Systems will be provided in each house unit.
2.11	**Earthing & Bonding**

	Earthing system shall be installed in accordance with ET101:2008 and as indicated on schematics provided. Equipment such as window frames, bathroom fixtures, all incoming services pipework and lightning protection installation shall all be bonded. Bonding shall be carried out across non-metallic apparatus.
2.12	**Security and Cableway Provision**
	Each building will come complete with landlord-controlled access control, CCTV and intruder alarm systems installed at main entrance and exit points to the building. These systems will be IP type adaptable to an open network. The site will be covered with CCTV system which will be two separate systems. One system will be a landlord system which will be monitored and controlled by the landlord with the building systems. The other will be monitored and controlled by DLR. These systems will be IP type adaptable to an open network. Internal cameras shall be 3.0-megapixel day, 1.5-megapixel night, PTZ colour type with auto-iris lens. External cameras shall be 3.0-megapixel day, 1.5-megapixel night, PTZ colour type with auto-iris lens all contained within a vandal proof IP65 housing combined with heater and thermostat. A suitable sized multiplex unit shall be provided to cater for all cameras. Each house unit will be wired for an individual security alarm system.
3.0	**LIFTS**
3.1	**Passenger Lifts** All lifts to fully comply with EN 81. The passenger lifts will provide a level of service which meets or exceeds the following: - Internal lift car dimensions - 13-person capacity. Lift door clear height 2100mm All lifts serve all floors Quality durable internal car finish Display in car
3.2	**Fire Fighting Lift**
	To be provided in accordance with BS 9999:2008, if and where required.
4.0.	**Satellite TV**
	Space for 1 no. 1.2m (nominal diameter) satellite dish is allowed for each roof. The dish will be able to see an arc of the sky from southeast to southwest, above an angle of 20 degrees elevation.
5.0	**PUBLIC UTILITIES**

5.1	<u>Telecoms</u> All Telecom Providers are available in the area. A dedicated telecom system provider's communications room is provided centrally within each block of the development. Telecoms Termination Boxes will be provided externally on each unit unit.
6.0.	**BUILDING CONTROL SYSTEM**
	A complete Building Management Control System including all necessary motor control centres and front end PC will be provided. The Building Management Control System will operate on an open network to allow interface with the following:- Lighting Controls Fire Alarm Access Control Security Systems The Building Management Control System will provide the following:- Status of all plant Record energy consumed Monitor and adjust temperature set points Monitor and adjust time schedules and sequence of operation of all plant. Be compatible for remote connections
7.0.	**TESTING AND COMMISSIONING**
	All systems shall be commissioned in accordance with CIBSE and BSRIA codes. All systems will be demonstrated to the tenants Engineers prior to acceptance of PC. The O&M Manuals and Record Drawings should be available in Draft form at PC with the final documents submitted within 4 weeks of PC.