ARUP

Dublin City Council

St Annes Court

Part 8 – Climate Action and Energy Statement

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1. Introduction

This document provides an overview of the energy strategy for the new residential development at St Annes Court to support the Part 8 circulation to DCC. The main aim is to meet or exceed the sustainability and energy targets and overheating risk assessment set by the Irish Building Regulations, Technical Guidance Document Part L 2022 – Conservation of Fuel and Energy - Dwellings.

This report looks at how the design team have reviewed the proposed development and identified opportunities to implement nearly Zero Energy Buildings (nZEB) solutions to reduce the energy demand from building services and meet the targets of Part L 2022 for Dwellings. To that end several passive and active strategies described in detail in Section 4 were implemented. Primary energy sources were also evaluated to identify the most suitable solution for the development.

As stipulated in the Part L 2022 for Dwellings, a DEAP (Dwelling Energy Assessment Procedure) assessment was conducted to evaluate the primary energy consumption and carbon emissions associated with the operation of the dwellings and verify they are in line with the current regulation. All the building services options presented in this report under Section 4 for each building type of the development have demonstrated compliance with Part L 2022 for Dwellings.

2. The Proposed Development

2.1 Site And Location

The diagram below illustrates the proposed development. Blocks 1-4 are all new buildings and linked on all levels. The development will have circa 102 properties, final figures to be determined.

Figure 1 Site Plan of Proposed Development

2.2 Building Description

The plan proposes building 4 residential blocks, each facing a distinct inner courtyard and having a different orientation. There are 102 apartments in total, spread across 4 stories in each block. One bedroom, an open kitchen and living area, a bathroom and an entryway make up a basic flat. The new buildings are designed to meet the current Irish Building Regulations, Part L – Conservation of Fuel and Energy 2021 and achieve a BER A2.

Figure 2 3D Model of the project

3. Design Targets

A key design driver is to achieve compliance with Part L 2022 for Dwellings (incorporating nZEB requirements) of the Building Regulations. Delivering buildings which will be cost effective and easy to own, occupy, control, and maintain is also fundamental to the design.

Low emissions energy supply is a key part of building a sustainable future and specifically tackling key environmental issues such as climate change, water pollution and air pollution. EU legislation for the built environment is designed to contribute to this by setting energy saving and low carbon energy generation targets for buildings.

The buildings will be designed to operate as low energy & low carbon buildings. This will be achieved through various energy efficiency measures that minimise heating, cooling, and mechanical ventilation loads. Controls, where appropriate, and metering can also help to reduce unnecessary energy consumption.

The current Building Regulation for Conservation of Fuel and Energy in dwellings is Part L 2022 for Dwellings. The current revision includes the recast Energy Performance of Buildings Directive and Energy Efficiency Directive S.I. 426 2014, which sets new targets for building energy performance including a move towards "Near Zero Energy Buildings" (nZEB). This requires a study of the technical, environmental, and economic feasibility of installing high efficiency alternative energy systems.

The directive states that the definition of a Nearly Zero Energy Building is:

"…a building that has a very high energy performance, as determined in accordance with Annex 1. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources provided onsite or nearby".

The permissible technologies allowed by SEAI include the following:

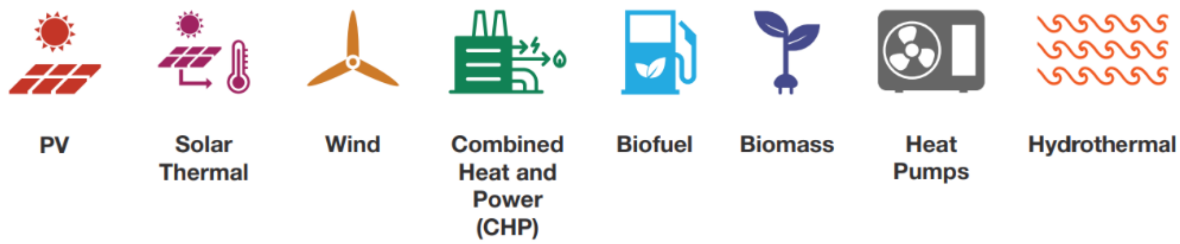

Figure 3 SEAI Part L Permissible Technologies

To satisfy that a building achieves Part L compliance, the following criteria must be met for new dwellings and existing dwellings undergoing major renovation.

New dwellings: *New Apartment Blocks*

The calculated Carbon Performance Coefficient (CPC) should be no greater than the Maximum Permitted Carbon Performance Coefficient (MPCPC) of 0.35.

The calculated Energy Performance Coefficient (EPC) should be no greater than the Maximum Permitted Energy Performance Coefficient (MPEPC) of 0.30.

The calculated Renewable Energy Ratio (RER) should be greater than 0.2.

Per the Department of Housing Authority in Ireland a minimum BER of A2 for new dwellings should be achieved.

4. Energy Strategy Overview

This section introduces all the energy methods under consideration for the project, beginning with energy reduction techniques and progressing to energy supply strategies and renewable energy initiatives. While not all the solutions provided here have been implemented, they are all presented, along with their limits and project application concerns.

4.1 Energy Reduction Strategies

4.1.1 Passive Solar

Glazing is critical in terms of light and heat energy utilisation. In general, more glazing minimises the demand for artificial lighting, particularly in homes where natural light is frequently sufficient throughout the day. The amount of glazing used is also a major element in determining how much solar gain a building will receive. Because heat gain through windows contributes significantly to a building's space heating requirements and the lighting requirements of inhabited spaces, solar gain can be employed to minimise space heating loads and lighting loads.

However, it is also vital to note the impact that solar gain can play in overheating, as well as the amount of heat loss that occurs in places with a lot of glazing. It is therefore best practice to maximise the utilisation of natural daylight to improve visual comfort while maintaining thermal performance.

To prevent overheating, an adequate g-value, describing the quantity of solar energy transmittance through the glazing, will be provided. A suitable U-value is also provided to ensure that heat loss through the glazing is maintained to a minimum.

4.1.2 Building Fabric Performance Targets

The Part L underscores the importance of limiting heat loss via the fabric of the building. Heat loss through the building fabric is avoided by enhancing thermal insulation to an appropriate level. The criteria used to measure such heat loss are U-values, which are measurements of the conductivity of building fabric elements.

Table 1 shows the maximum permissible U-values for building fabric elements permitted by current rule Part L 2022 for new construction to achieve a BER rating of A2. The proposed values were derived from the DEAP assessment for this development. The findings of this assessment are reported later in this report.

Table 1:Fabric Element Apartment U-Values

Apartments		
Element	U-value W/m2K	Result
Flat roof	0.12	BER A2
Walls	0.15	
Ground Floor	0.12	
External Windows	0.85	
External Doors	1.2	

In order to achieve a BER rating of A2, the below U values in Table 2 are required to be achieved for the community centre. In addition to this, PV panels are required to meet the Part L compliance renewable energy targets. Hence 1 kW PV panels are proposed at the roof to serve the community centre.

Table 2: Fabric Element Community Centre U-Values

Community Centre		
Element	U-value W/m2K	Result
Flat roof	0.12	BER A2
Walls	0.15	
Ground Floor	0.12	
External Windows	0.85	
External Doors	1.2	

4.1.3 Thermal Bridging

A thermal bridge, also known as a cold bridge, is an area of a building construction which has a significantly higher heat transfer than the surrounding materials. This is typically where there is either a break in the insulation, less insulation or the insulation is penetrated by an element with a higher thermal conductivity (e.g. around windows, doors and other wall openings, at junctions between elements and other locations).

Acceptable construction details will be adopted for all key junctions where appropriate (i.e. typical/standard junctions). All bespoke key junction details which have been certified by a third-party certification body (such as Agrément or equivalent) will be used or calculated by an NSAI registered thermal modeller.

Heat loss due to thermal bridging is expressed as a multiplier of the total exposed surface area in DEAP calculations. The default value of this multiplier is 0.15 W/m2K in DEAP; and the proposed design target for this is 0.05 W/m2K.

4.1.4 Building Envelope Air Permeability

New buildings should have less air leakage to cut down on uncontrollable ventilation and the heat loss that comes with it. This can be made easier by using standard details to make the right air barrier parts (such as plaster, a vapour control layer, and a breather membrane). During building, the air barrier will need to be checked regularly to make sure it stays in place.

Part L (2022) says that a new dwelling must have an air permeability level of no more than 5m3/m2/hr @ 50Pa. The planned dwellings will have an air permeability target of 3m3/m2/hr @ 50Pa.

The air permeability test will be done by a third party, such as the National Standards Authority of Ireland or an organisation with the same name.

4.1.5 Light Fittings

It is proposed that all light fittings are to be specified as being low-energy lights, reducing the energy requirement of artificial lighting. LED are the proposed fitting type throughout the apartments to achieve energy performance and to achieve alignment with CIBSE lighting guidance.

4.1.6 Insulation Of Pipes, Ducts & Vessels

All hot water storage vessels and pipes will be fully insulated. Hot water storage vessels shall have a minimum of 50mm factory installed insulation. All water pipes shall be insulated throughout the building. This will improve energy performance and help protect against legionella and freezing.

4.1.7 Heating Controls

Heating systems should be effectively controlled to ensure the efficient use of energy. It is intended that the system will minimise energy requirements by meeting user requirements closely while not exceeding them.

Heating and hot water level of controls will comply with the minimum control requirements stated in Part L 2022. A summary of this level of control is as follows:

1. Automatic control of space heating based on room temperature:
2. Automatic control of heat input to stored hot water based on stored water temperature.
3. Separate and independent automatic time control of space heating and hot water
4. Shut down of heat pump or boiler when there is no demand for either space or water heating from that source.
5. Additional thermostat included in living room space which can over-ride the heat pump integrated thermostat to offer more user control.

4.2 Technical, environmental, and economic feasibility of on-site renewable energy generation

Various energy source technologies are evaluated for the proposed development. The feasibility and acceptability of each alternative is assessed based on the site's location, the type of the development, economic parameters, functionality, efficiency, and the system's sustainability.

There is a requirement for development that a portion of the energy sources employed be renewable. Part L (2022) specifies that the minimum Renewable Energy Ratio (RER) be equal to or greater than 0.2.

A RER of 0.2 indicates that renewable energy technologies serve 20% of the building's primary energy compared to the overall primary energy of the building, as defined and measured in DEAP.

Potential energy sources were evaluated in light of the Part L requirements and their suitability for this development. Among the systems evaluated are:

- Small Scale Wind Power
- Photovoltaics
- Solar Water Heating
- District Heating
- Combined Heat and Power (CHP)
- Air Source Heat Pumps

4.2.1 Wind Power

Wind power could be generated by either micro wind turbines attached to the roof of each building, or standalone mast-mounted wind turbines. Based on an assessment of the site, we contend that the site will be exposed to annual average wind speeds greater than 6 to 8 m/s.

Due to the nature and location of the site, neither of these wind power options would be feasible.

Figure 4 Wind Turbine Example

4.2.2 Photo-Voltaic

Photo-voltaic (PV) panels convert the sun’s energy to electricity using semiconductor technology. PV panels are a renewable energy option which could operate alongside a boiler system for instance. However, the surface of PV panels required for each apartment to comply with Part L 2022 is around 5 to 6 m2 per apartment. Achieving the space requirement for PV panels makes such a solution less desirable in comparison to utilising a heat pump system. The heat pump option does not require PV Panels to cover the renewable supply minimum requirement required by Part L 2022. It is proposed to allow space on the roof area where possible for the future addition of PV panels should the decision be taken in future to implement and enhance the scheme.

Figure 5 Photovoltaic panels example

4.2.3 Solar Water Heating

Solar panels may be used to provide the domestic hot water for the buildings. A potential for high maintenance frequency is a factor in not considering solar water heating a viable option. In the context of utilising combined heat and power plant or heat pumps, solar water heating is counter-productive and not considered a viable technology.

Figure 6 Solar Water Heating Panels example

4.2.4 District Heating

As part of the development and analysis of the available energy solutions for the project District Heating was assessed as a potential strategy. There are no available or planned district heating networks in the area, and the site is not located within an SDRA.

District Heating enablement for the scheme was reviewed with a view of the potential of enabling future connections to any district heating schemes. This is detailed further in the Life Cycle Cost Assessment in Appendix A2. The most viable means of providing district heating enablement to the scheme was by utilising a centralised heating network fed by central Air Source Heat Pump plant, with Heat Interface Units at each apartment interface. As can be seen from the LCCA analysis, this solution does not provide an economically feasible solution for the development as there is a poor economy of scale when implementing a centralised system for this quantum of units. Given the het density of the area and also proximity to any heat sources, it is unlikely that in the lifetime of the energy systems that a district energy connection will be available in the area.

As such District Heating enablement has not been proposed for this development.

4.2.5 Combined Heat & Power (CHP)

Combined Heat & Power (CHP) is a technology that utilises the heat produced in electricity generation rather than releasing it wastefully into the atmosphere.

For a CHP system to be viable, the year-round base heat load on the plant would need to be roughly 1.6 times that of the electrical load delivered by the CHP plant. In this development, the limiting factor will be to find a use for the heat output, especially in the summer months (this may limit performance of solar water heating systems if installed).

The following illustration shows a typical gas-fired CHP system, supplemented by a gas boiler. Note that outputs are only illustrative and do not represent the would-be installed system.

As this is a residential scheme with multiple electrical meters the electrical energy produced by the CHP cannot be sold back to individual tenants. This means that electrical usage will have to be charged to the tenants via a service charge.

The advantage of the heat interface unit is that it allows for metering of heat energy used by the tenants and then tenants can be billed on this basis. Another advantage of heat interface unit is that it allows for the instant production DHW in the dwelling and negates the need for individual water cylinders.

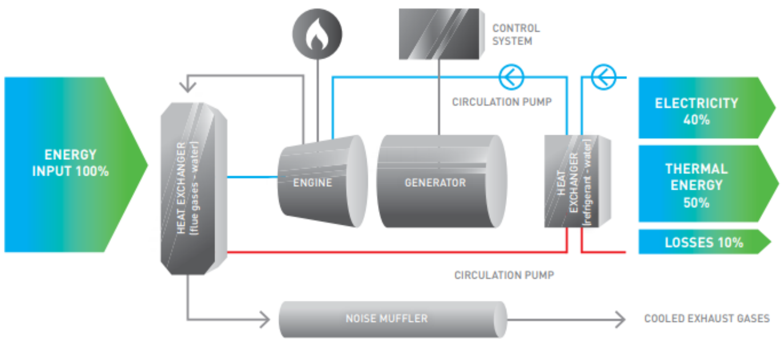

Figure 7 Diagrammatic example of a typical CHP System

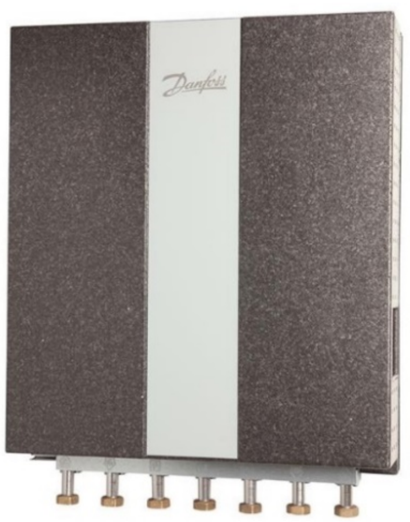

Figure 8 Heat Interface Unit

Available plant space for a CHP, accompanying boilers, associated pumps and other ancillary equipment would be required. Each CHP and boiler have an associated flue which must clear the highest point of the development by 2 metres. Due to the increased cost, complexity, and space limitations on the site, this option is considered less preferable than the alternatives and has not been included in the options considered in detail.

4.2.6 Air Source Heat Pumps

An 'Air Source Heat Pump' is a system which utilises a refrigeration cycle to transfer heat from the outside air (or other air source) to the inside of a building, or vice-versa. This has been deemed to be the most suitable technology for each of the building following an LCCA assessment.

The LCCA study period was taken for 30 years, with the proposed options including two centralised options and one decentralised option for the apartment unit. Table 3 below summarise the life cycle cost values (i.e., 2023 currency values) which have been calculated using the discount rate assumption presented above.

Table 3: LCCA Results Summary

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's) at each apartment	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's) at each apartment Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
LCCA (30 Years)	€5,328,784	€6,291,682	€2,955,403

4.2.6.1 New Apartments

In this development exhaust air heat pumps (EAHPs) will be provided for each apartment. Exhaust air heat pump is a form of air source heat pump technology which recovers heat energy from the wet rooms of the apartment, kitchens, and bathrooms, then use this energy in a refrigeration cycle to heat water for domestic hot water and space heating requirements.

This option offers the following advantages:

1. EAHPs offers a highly efficient, low carbon heating solution to the development which satisfies the Part L Renewable Energy Requirements
2. This solution minimises the requirement for central plant and distribution infrastructure, thus minimising materials use and embodied carbon.
3. This option is advantageous if the apartments were to be sold individually in the future. The de-centralisation of plant equipment means that the complex management company can hand over the maintenance of the equipment if desired.
4. Due to the high heating efficiency of the heat pumps this option does not require additional PV panels to achieve compliance with the minimum renewable's requirement (RER) of Part L.
5. As defined by the function of the system, the ventilation provided to heat the space via the heat pump also provides the fresh-air requirements.

4.2.6.2 Community Centre Space

A Variable Refrigerant Flow (VRF) system in combination with a Mechanical Ventilation Heat Recovery (MVHR) system is proposed for the community centre space. Heating and cooling shall be via VRF heat pumps. The system consists of outdoor and indoor units connected by refrigerant pipework. The ventilation will be provided separately through an MVHR system. Point of use electric water heaters will provide hot water for the DHW system. A small PV array is also required for the Community Centre Space to achieve the RER requirement of Part L DEAP.

5. Energy Analysis

5.1 Proposed Strategy

The St Anne's Court Development will primarily use air source heat pump technology to provide space heating and generate hot water to all dwellings. The apartments will be served by a Double Ducted Exhaust Air Heat Pump (DDEAHP) system in each apartment.

DDEAHP's do not require any central or external plant. The DDEAHP, located in the utility cupboard of each apartment, will utilise energy recovered from extracted air from bathrooms, kitchens, and wet rooms, to generate heat for space heating and hot water to a suitable temperature for Domestic Hot Water (DWH) which is stored within an integral storage tank.

Space heating is provided via a warm air supply to each space, delivered via a network of ductwork above the ceiling, connected to ceiling mounted supply diffusers. There is no wet heating system associated with this option, the system is provided with an integrated electric panel heater which can be utilised to provide a backup 'boost' functionality to the living space if required.

This system provides ventilation to the apartment by default and as such a separate Mechanical Ventilation Heat Recovery Unit (MVHR) is not required.

5.2 DEAP Analysis

The conditions outlined above have been used to carry out a preliminary DEAP assessments to ensure that all apartments comply with EPC and CPC limitations and ultimately Part L (2022).

The preliminary DEAP calculations have been carried out for different typical apartments, which were deemed to be worst case scenarios, using SEAI DEAP version 4.2.0 software to demonstrate compliance. Whilst the project must meet the requirements of Part L (2022) the most recent version of DEAP (DEAP v4.2.0) does not reflect Part L (2022). The most recent version of the building regulations addressed in the current version of DEAP is Part L (2021). The typical apartment layouts selected and analysed for compliance are included in Appendix A1. The community centre and common area DEAP calculations are also present in Appendix A1.

5.2.1 DEAP Inputs

The DEAP assessment was carried out based on the proposed values, which are detailed in Table 4 for the sample apartments.

Table 4: DEAP Assessment Input Values Apartments

Input Parameter	Input Value
Structural Air Permeability	$3m^3/m^2/hr$ at 50Pa
Ventilation Method	Depends on services option
External Glazing g-value	0.57
Roof U-Value	0.12 W/m^2K
Walls U-Value	0.15 W/m^2K
Ground / Exposed Floors U-Value	0.12 W/m^2K
External Doors U-Value	1.2 W/m^2K

Input Parameter	Input Value
External Glazing U-Value	0.85 W/m^{2}K
Thermal Bridging	0.05 W/m^{2}K
Lighting	LED (eff = 66.9 lm/W)
Thermal Massing Category	Medium-high

5.2.2 DEAP Outputs Summary

- The preliminary results of the DEAP assessment are provided in Appendix A1 for different blocks.
- The results outlined in Appendix A1 have been extracted from DEAP Part L reports.
- The report confirms that the energy performance of the St. Anne's Court Development will meet or exceed all statutory requirements and deliver on targets set out in the analysis brief.

6. Embodied Carbon Impact

For the embodied carbon assessment, Stages A1-A3 are considered for typical heat pump solutions.

Accordingly, the embodied carbon impact of the following strategies are considered in this case:

- Centralised heat pump solutions
- Decentralised heat pump solutions

There is an intrinsic level of approximation to be considered when assessing the embodied carbon which is related to future replacements. Therefore, we have only included stages A1 to A3 to assess upfront carbon only. Centralised heat pump strategies involve a greater amount of distribution pipework and equipment from the central plant, including central pumps, pressurisation equipment, distribution pipework, heat interface units, and wet pipework and heat emitters within the units. The decentralised solution involves a heat pump unit in each apartment, with no centralised distribution or plant, and heat delivered within the apartment by short runs of plastic ductwork.

For typical decentralised residential systems, the upfront carbon can be higher compared to centralised systems. This can however be greatly influenced by the refrigerant used which can be natural or artificial. The refrigerant type has a significant impact on the embodied carbon of heating and cooling solutions, as the greenhouse gas emissions associated with different refrigerants vary greatly and outweigh in some cases the materials installed.

Our assessment of the options considered for this project, align with the assessment of typical systems described above. For this project, at the early stage of design the A1 to A3 embodied carbon of the centralised system is lower compared to the decentralised system. A detailed assessment will be conducted in later stages of the project to reassess the above.

7. Recommendations and Conclusion

The report confirms that the energy performance of the St Annes Court Development will meet or exceed all statutory requirements and deliver on targets set out in the analysis brief.

As demonstrated in this report, the operational and embodied carbon of the centralised system are less than that of the decentralised systems option considered. However, the life cycle costs of the centralised are significantly greater than that of the decentralised system and are prohibitive.

As result, the recommendation is to continue with the decentralised system option despite the increased carbon impacts.

Appendix A

A.1 DEAP Assessments

Table 5: DEAP Assessment Output Values– Apartment L3-WB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.219	0.143	0.378	52.7	✓

Table 6: DEAP Assessment Output Values– Apartment L3-WB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.22	0.144	0.372	52.7	✓

Table 7: DEAP Assessment Output Values– Apartment L3-NEB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.218	0.143	0.371	52.7	✓

Table 8: DEAP Assessment Output Values– Apartment L3-WNB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.219	0.144	0.371	52.7	✓

Table 9: DEAP Assessment Output Values– Apartment L3-EB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.218	0.143	0.371		✓

Table 10: DEAP Assessment Output Values– Apartment L1-WB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.216	0.141	0.381	52.7	✓

Table 11: DEAP Assessment Output Values– Apartment L1-WB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.219	0.146	0.357	52.7	✓

Table 12: DEAP Assessment Output Values– Apartment L1-NWB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.217	0.145	0.355		✓

Table 13: DEAP Assessment Output Values– Apartment L1-EB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.217	0.144	0.355	52.7	✓

Table 14: DEAP Assessment Output Values– Apartment L0-WB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.211	0.137	0.378		✓

Table 15: DEAP Assessment Output Values– Apartment L0-NWB-E

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.198	0.129	0.36	52.7	✓

Table 16: DEAP Assessment Output Values– Apartment L0-EB-I

EPC	CPC	RER	Size (m^2)	Compliance
< 0.300	< 0.350	>0.2	--	--
0.214	0.14	0.374	52.7	✓

Table 17: DEAP Assessment Output Values – Common areas

Services Option	EPC	CPC	RER	Size (m^2)	Compliance
	< 1	< 1.15	>0.1	--	--
EB Stairwell	0.49	0.51	0.34	150.22	✓
NEB Stairwell	0.47	0.49	0.33	150.22	✓
NWB Stairwell	0.44	0.46	0.33	150.22	✓
WB Stairwell	0.44	0.46	0.34	150.22	✓

Table 18: DEAP Assessment Output Values– Community Centre

EPC	CPC	RER	Size (m^2)	Compliance
< 1	< 1.15	>0.1	--	--
0.73	0.76	0.12	187.5	✓

A.2 LCCA Assessment

7.1 LCCA Analysis

A Life Cycle Cost Assessment (LCCA) has been conducted for each of the services options presented in this section. Below is a summary of the assumptions, inputs, and results of the assessment. Each assessment includes a detailed build-up of the first cost, replacement cost, maintenance cost, and annual energy cost as described below.

7.1.1 LCCA Assumptions

The LCCA study period for this analysis is taken as 30 years. The analysis presented here is a constant currency analysis, meaning it is excluding the rate of general inflation in all currency amounts, discount rates, and price escalation rates.

An LCCA calculation requires the use of certain assumptions regarding the time value of money as well as the future costs of energy, in this case electricity only. Below is a summary of the relevant parameters and values used in this analysis. References are provided where relevant.

LCCA Assumptions Summary

Parameter	Value	Reference
Discount Rate	4.0%	https://www.gov.ie/en/policy-information/1a0dcb-project-discount-inflation-rates/
Electricity Price Escalation Rate	2.5%	Assumed value

7.1.2 LCCA First Cost

The first cost for each services option is summarized below. The total first cost for all apartments for the central system components and distribution system are presented separately from the same for the in-unit systems.

LCCA First Cost per Option

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's)	Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
Total First Cost	€2,577,920	€2,517,255	€942,786

7.1.3 LCCA Replacement Cost & Equipment Lifetime

- The replacement costs have been estimated using input from the manufacturers of the relevant systems components and their local vendors. The replacement costs reflect typical costs of sub-component replacements (e.g., the compressor of the in-unit heat pump) and not for the full replacement of the relevant system component (e.g., the full in-unit heat pump).
- The equipment lifetimes utilised are taken from CIBSE Guide M which presents typical lifetimes for various services systems components and sub-components.
- All cost values are listed in present value terms (i.e., cost as of 2023 with no time value of money included).

LCCA Replacement Cost & Equipment Lifetime

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's)	Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
Equipment lifetime	20	20	15
Replacement Cost	€424,200	€888,800	€703,800.00

7.1.4 LCCA Annual Maintenance Cost

The annual maintenance cost has been estimated per major system component using input from the vendors and engineering judgement for preventative maintenance costs. Below is a summary of the total annual maintenance cost for the central system elements, the in-unit system elements for all apartments and the total for the site.

LCCA Annual Maintenance Cost

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's)	Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
Maintenance Cost	€20,700	€68,000	€10,200

7.1.5 LCCA Annual Energy Cost

The annual energy costs have been estimated using the DEAP analysis results and the Home Performance Index (HPI) Domestic Energy and Water Cost Calculator v1.1 published by the Irish Green Building Council (IGBC). Below is a summary of the energy inputs and electricity cost results for each option.

LCCA Annual Energy Costs

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's)	Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
Annual Electricity Consumption per apartment (kWh/yr)	4,124	4,083	3925
Annual Electricity Consumption per m2(kWh/m2/yr)	62	62	59
Annual Electricity Consumption per block(kWh/yr)	365,309	349,932	357,785
Annual Electricity Cost	€89,077	€87,483	€84,394.3

7.1.6 LCCA Results

The life cycle costs presented here are present values (i.e. 2023 currency values) which have been calculated using the discount rate assumption presented above.

LCCA Results Summary

	Option 1	Option 2	Option 3
Services Description	Central Air Source Heat Pump (ASHP) with Heat interface units (HIU's)	Plant arrangement is centralised on a block-by-block basis	Decentralised Double ducted Air to Air Heat Pump per apartment
LCCA (30 Years)	€5,328,784	€6,291,682	€2,955,403