PROJECT TITLE:	C23024-LDA Wilton
CLIENT:	Reddy Architecture
DOCUMENT TITLE:	Energy & Heating Strategy Comparison
DOCUMENT NUMBER:	C23024-EDC-XX-XX-RP-Z-0001

Rev.	Status	Date	Originator	Checker	Approved By
1	For Information	30/07/2024	T. McDonnell	T. McDonnell	T. McDonnell
2	For Information	04/09/2024	T. McDonnell	T. McDonnell	T. McDonnell
3	For Information	18/11/2024	B.K.	R.O'F	M.O'S
4	For Information	16/12/2024	B.K.	R.O'F	M.O'S
5	For Information	06/02/2025	B.K.	R.O'F	M.O'S

TABLE OF CONTENTS

APPENDICES

APPENDIX A - CALCULATION ASSUMPTIONS

APPENDIX B – BLOCK COMPLIANCE CALCULATIONS

APPENDIX C – AVERAGE FUEL COST FOR IRELAND 2024

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The intention of this report is to provide technical guidance on the heating strategy for the LDA Wilton Sarsfield Road LRD, located in Wilton, Cork.

In line with Cork City Council policy objectives and regional policy objective RPO 7.38 set out in the Regional Spatial & Economic Strategy (RSES) 2019-2031, a feasibility study for district heating systems was carried out for the proposed development.

This study includes a comparison of three different heating strategies, including two standalone systems and centralised heating systems. For a fair comparison, early-stage Part L block compliance calculations were carried out on each heating strategy to determine the developments estimated primary energy, CO2 emissions, delivered energy, running costs and PV requirements. The study also determines if the heating strategy will achieve a 10% primary energy improvement and determines what is required for it to be achieved. Third party district heating and waste heat networks outside the development's curtilage have been excluded from this study, as it was found there is no current heat networks in the area and the development in not located in a SEAI district heating candidate area, as shown in Figure 2 below.

The following heating strategies have been included in this study.

- Exhaust Air to Water Heat Pump (EAHP)
- Hot Water Heat Pump + MVHR + Electric Radiators (HWHP)
- Central Heating with Air to Water Heat Pump+HIU (CH: AWHP+HIU)

The standalone systems (EAHP & HWHP) will provide space heating, water heating, and consider mechanical ventilation solely to the dwelling the system is located within. These systems will require a larger space for equipment compared to the district heating systems, however they will still fit comfortable into a utility cupboard. The Standalone system will not require any space outside of the dwellings.

The central heating system (CH: AWHP+HIU) will provide space heating, water heating from an energy centre located externally to each block. A standalone mechanical ventilation heat recovery system located within each dwelling will be required to provide adequate ventilation to the apartment. The district heating and central heating systems will be connected to a heat interface unit (HIU) located within each dwelling. HIUs do not require as much space for equipment compared to standalone systems. If the centralised system is intended to serve multiple blocks it may require additional buildings to locate the energy centre, multiple energy centres may be required to increase the system efficiency and reduce network distribution losses. However, adding any heat sub-stations will decrease the efficiency and would need to be avoided if possible. The central heating systems will require additional buildings to locate heat pump and heating plant.

The table that follows provides a comparison of the key system parameters defining delivered energy and running costs. It shows the EAHP has the best space heating efficiency. HWHPs have the best hot water heating efficiency. It shows the district and centralised heating systems have a network distribution loss of 5%, whereas the localised EAHP & HWHP system do not have network distribution losses. Current electricity costs are slightly more expensive for individual systems when compared to district and centralised (Commercial) heating systems, based on SEAI Fuel Cost Comparison for Domestic and Commercial October 2024. Note that the efficiencies come from the DEAP software and are based on the model of unit selected for the simulation.

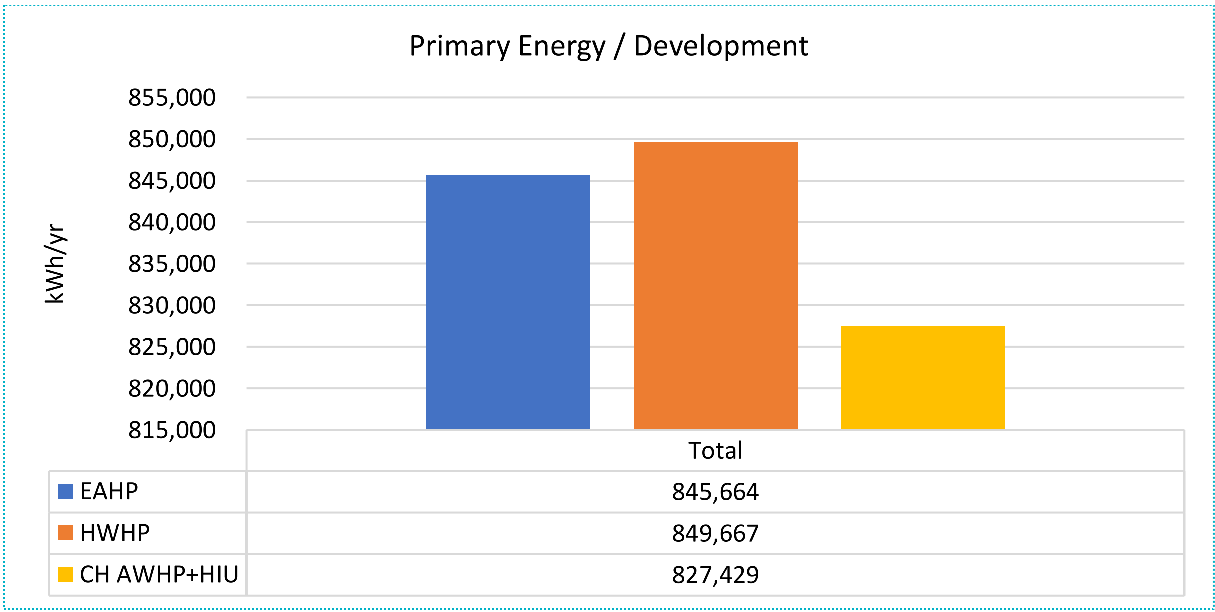
	EAHP	HWHP	CH: AWHP+HIU
Space heating efficiency (%)	507%	100%	310%
Water heating efficiency (%)	221%	308%	From Above
Network distribution losses	0.00	0.00	1.05
Electricity rate (€/kWh)	€0.35	€0.35	€0.278

The table below provides a ranking (1-4) of the best performing heating strategies (1 being the best performance). It presents the overall performance of each heating strategy in relation to primary energy, CO2 emissions, delivered energy and running costs.

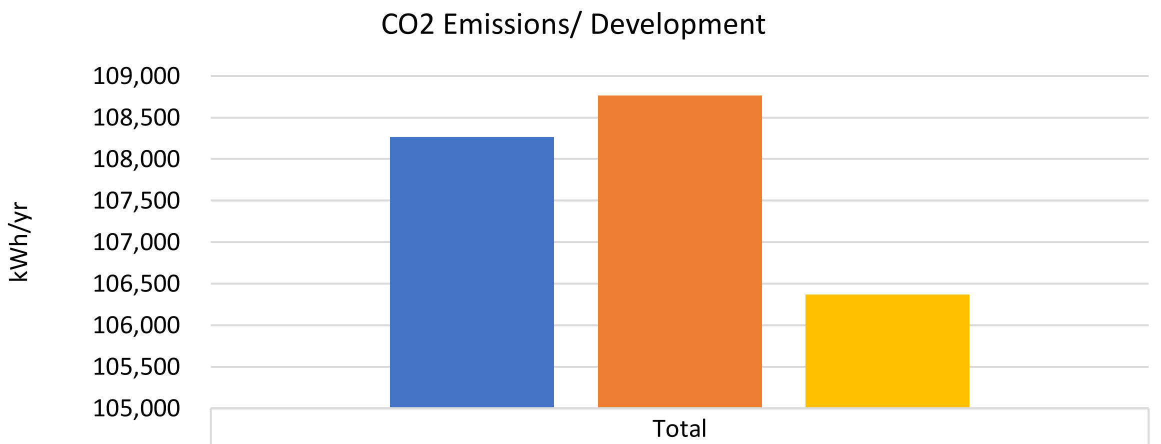
The table shows the "CH AWHP+HIU" heating strategy will consume the least amount energy and produce the lowest CO2 emissions, followed by DH AWHP+HIU, EAHP and then DH CHP+HIU.

	EAHP	HWHP	CH AWHP+HIU
Primary Energy	**2**	**3**	**1**
CO2 Emissions	**2**	**3**	**1**
Delivered Energy	**1**	**2**	**3**
Running Costs	1	**2**	**3**
Landlord Heating	**2**		**1**

The chart below represents the developments **Primary Energy Consumption** for each heating strategy. It shows the CH AWHP+HIU is estimated to consume the least amount of primary energy.

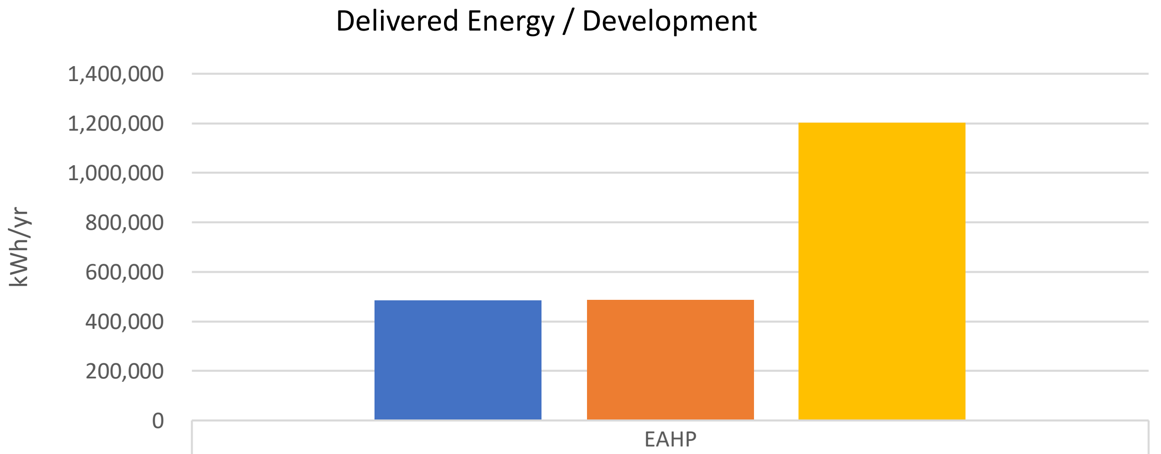


The chart below represents the developments **CO2 Emissions** for each heating strategy. It shows the CH AWHP+HIU is estimated to produce the least amount of CO2 emissions.



	Total
EAHP	108,269
HWHP	108,767
CH AWHP+HIU	106,374

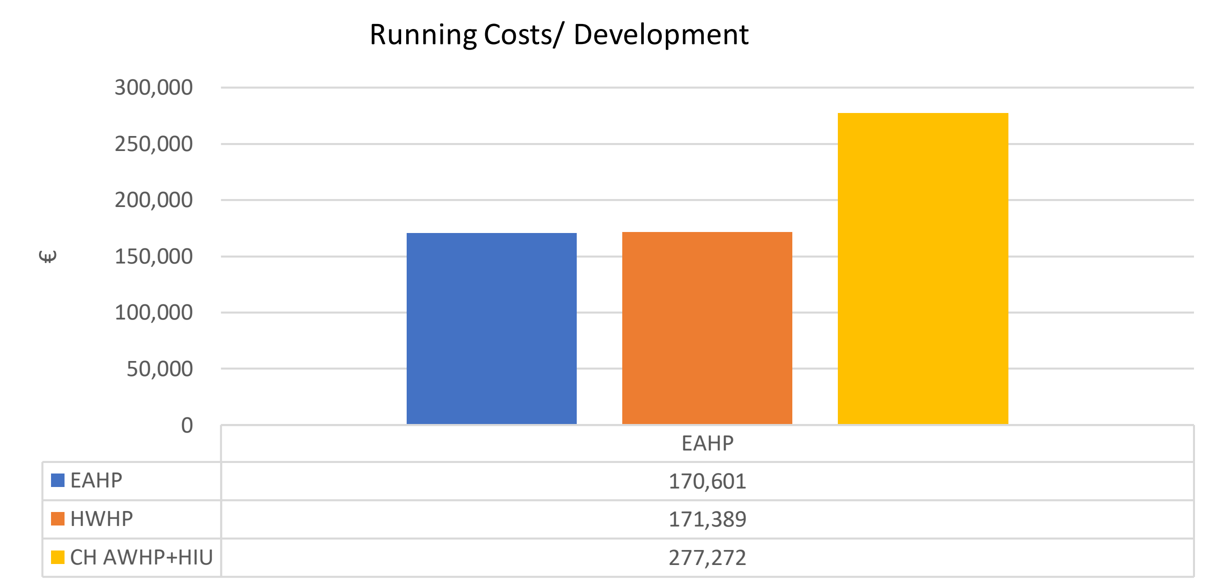
The chart below represents the developments **Delivered Energy Consumption** for each heating strategy.



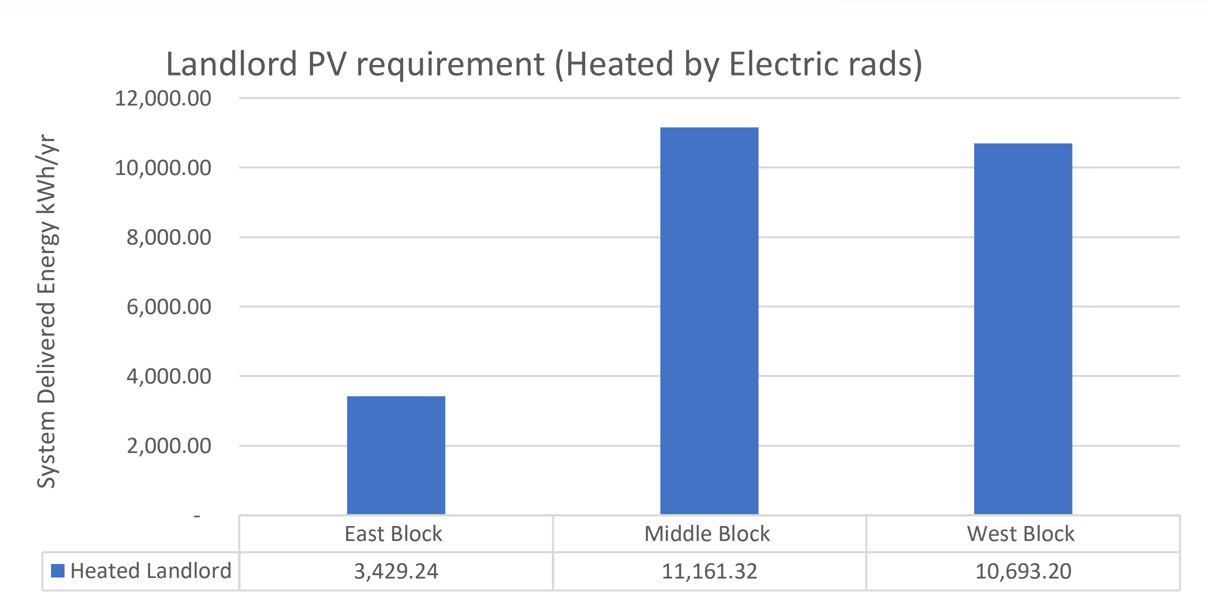
	EAHP
EAHP	483,288
HWHP	485,521
CH AWHP+HIU	1,200,313

The chart below represents the developments **Annual Running Costs** for each heating strategy. These running costs are based on the latest SEAI kWHr costs as per table 1. EDC have compared the heating strategies in the DEAP software as per the DEAP methodology. It reflected the difference in heat generation seasonal efficiency, SFPs for ventilation systems and additional distribution losses for CH & DH systems to produce the comparison below.

It is worth noting that the CH system will present opportunities for the management company to maximise usage during the night to benefit from night rates they can negotiate with the energy supplier and maximise the benefit of thermal storage. This could reduce the operating cost by typically 15-30%. To this extend we have used a blended kWHr rate to account for the reduced night rate gain. This rate is 0.231c per kWhr.



The chart below shows the PV requirements for each block to satisfy the landlord areas. No additional PV is anticipated for the residential units to achieve 10% primary energy improvement.



Proposed Strategy:
A centralised heating system with ASHP is proposed for the Apartment blocks.
It is proposed to install individual monoblock heat pumps to service each townhouse individually.

1. INTRODUCTION

The intention of this report is to provide technical guidance on the heating strategy for the LDA Wilton Sarsfield Road LRD, located in Wilton, Cork.

In line with Cork City Council policy objectives and regional policy objectives RPO 7.38 set out in the Regional Spatial & Economic Strategy (RSES) 2019-2031, a feasibility study for district heating systems was carried out for the proposed development.

This study includes a comparison of three different heating strategies, including two standalone systems and a centralised heating system. For a fair comparison, early-stage Part L block compliance calculations were carried out on each heating strategy to determine the developments estimated primary energy, CO2 emissions, delivered energy, running costs and PV requirements. The study also determines if the heating strategy will achieve a 10% primary energy improvement and determines what is required for it to be achieved. Third party district heating and waste heat networks outside the development's curtilage have been excluded from this study, as it was found there is no current heat networks in the area and the development is not located in a SEAI district heating candidate area, as shown in Figure 2 below.

The following heating strategies have been included in this study.

- Exhaust Air to Water Heat Pump (EAHP)
- Hot Water Heat Pump + MVHR + Electric Radiators (HWHP)
- Centralised Heating: Air to Water Heat Pump + HIU (CH: AWHP+HIU)

The four heating strategies were compared on the apartment West, East and Middle blocks. The proposed development includes 332 apartments in total, made up of 152 one-bedroom apartments, 168 two-bedroom apartments and 12 no. three-bedroom apartments. Figure 1 below shows a site plan of the proposed development.

Figure 1 - Proposed Development

It is worth noting that the townhouses will have an **Air Source Heat Pump (ASHP)** solution, designed to provide efficient heating solutions. These units are not considered in the calculations. By treating each unit as an individual solution, the design ensures:

- Customized Efficiency: Each townhouse has a system tailored to its specific heating and demands, optimizing energy performance.
- Independent Operation: Individual systems provide autonomy for occupants in managing their energy use and preferences.
- Simplified Maintenance: Maintenance is localized, reducing complexity compared to centralized systems.
- Simpler construction phasing where these units can go live independently of the apartment blocks.

2. CORK CITY DEVELOPMENT PLAN 2022-2028

This study addresses the policy objectives outlined in the *"Cork City Development Plan 2022-2028 – written statement".* The development plan sets out the following policies in relation to energy in use and the use of district heating networks.

Policy Objective 5.20: Cork City District Energy Action Plan - To lead on the preparation of the Cork City District Energy Action Plan in partnership with Energy Cork and in consultation with the SEAI, SRA and CARO.

Policy Objective 5.21: District Heating – To support the delivery of district heating and be guided by the proposed Policy Framework for the Development of District Heating in Ireland and in time, the Cork City District Energy Action Plan. All future planning applications for development schemes of 50 or more homes or 1,000sqm of commercial floorspace at the following strategic locations will be required to be supported by an assessment of district heating opportunities and how these will be taken forward as part of the development unless it is demonstrated to be technically unfeasible or unviable:

- City Docklands
- Tivoli
- The Cork Science and Innovation

In line with Cork City Councils policy objective and regional policy objective RPO 7.38 set out in the Regional Spatial & Economic Strategy (RSES) 2019-2031, a feasibility study for district heating systems was carried out for the proposed development (this document). This feasibility study includes a heating strategy comparison for individual and communal district heating networks. **Third party district heating and waste heat networks outside the development's curtilage have been excluded from this study, as it was found there is no current heat networks in the area and the development in not located in a SEAI district heating candidate area, as shown in Figure 2 below.**

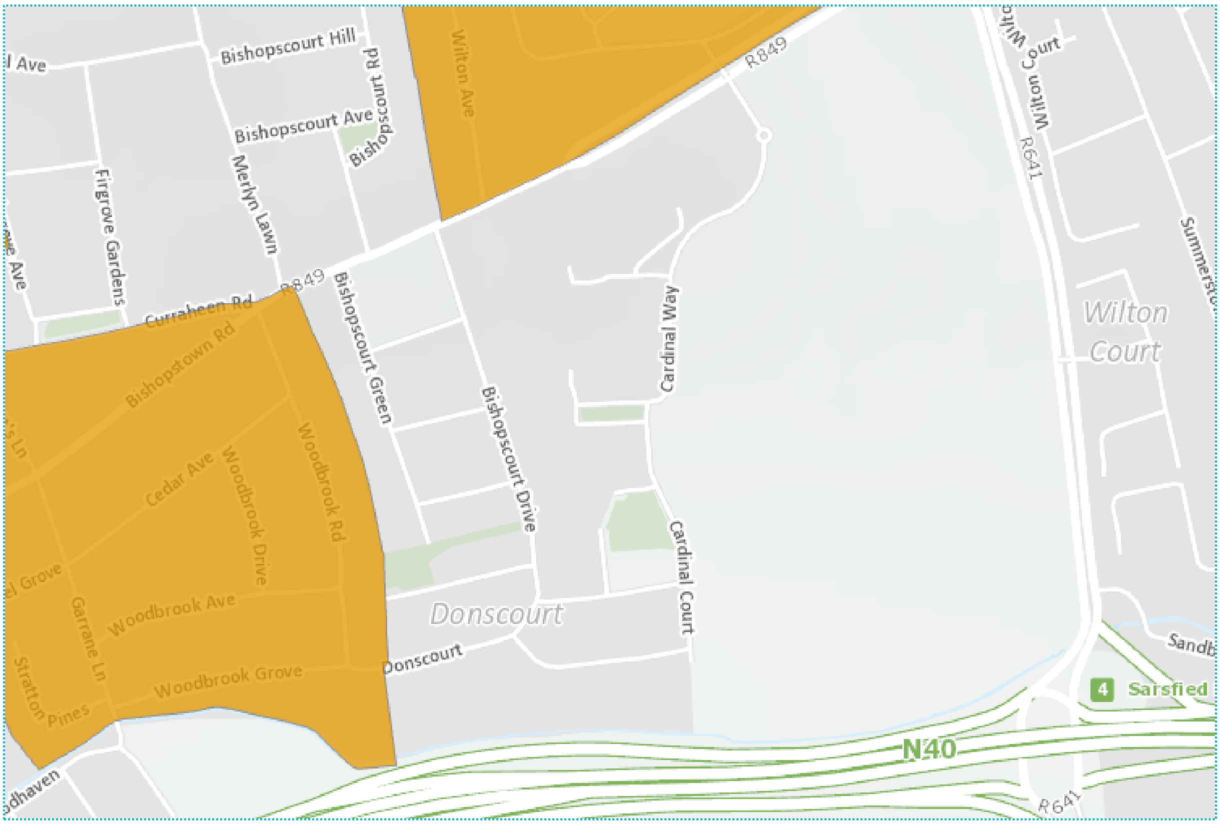


Figure 2 - SEAI District Heating Map

3. OVERVIEW OF SYSTEMS

The following section provides a description of each heating strategy included in this study.

All heating strategies will provide 100% of the apartments space heating, water heating and considers mechanical ventilation demands.

The table below provides a comparison of the key system parameters defining delivered energy and running costs. It shows the EAHP has the best space heating efficiency. HWHPs have the best hot water heating efficiency. It shows the district and centralised heating systems have a network distribution loss of 5%, whereas the localised EAHP & HWHP system do not have network distribution losses. Current electricity costs are slightly more expensive for individual systems when compared to district and centralised (Commercial) heating systems, based on SEAI Fuel Cost Comparison for Domestic and Commercial October 2024.

Table 1 - Comparison of System Parameters

	EAHP	HWHP	DH: AWHP+HIU	CH: AWHP+HIU
Space heating efficiency (%)	507%	100%	300%	310%
Water heating efficiency (%)	221%	308%	From Above	From Above
Network distribution losses	0.00	0.00	1.05	1.05
Electricity rate (€/kWh)	€0.35	€0.35	€0.278	€0.278

It is worth noting that the CH system will present opportunities for the management company to maximise usage during the night to benefit from night rates they can negotiate with the energy supplier and maximise the benefit of thermal storage. This could reduce the operating cost by typically 15-30%. To this extend we have used a blended kWHr rate to account for the reduced night rate gain. This rate is 0.231c per kWHr.

3.1 Exhaust Air Heat Pump (EAHP) system

The Joule ModulAir All-E 180ltr EAHP was used in this study. This EAHP can provide over 100% of the space, water heating and ventilation demand for each apartment (the Joule Victorum was not considered as it has been replaced with the ModulAir unit).

EAHP’s provide continuous mechanical extract ventilation for the dwelling even if there is no space heating or domestic hot water demand.

EAHP’s can provide a space heating seasonal efficiency of up to 550% and domestic hot water seasonal efficiency of up to 250%, reducing energy consumption and CO_2 emissions.

Figure 3 below shows a typical flow diagram for an EAHP system.

Figure 3 - Exhaust air heat pump flow diagram

3.1.1 How it works

- Warm air is extracted from wet rooms through selected ducting and back to the heat pump.
- If there is a space heating or domestic hot water demand, the air will pass through the heat pumps evaporator, which transfers the heat into the heat pump's refrigerant circuit.
- The cooled air is then discharged from the unit and exhausted outside.
- Meanwhile, the vapour compression cycle of the heat pump raises the temperature of the refrigerant and transfers the extracted heat into a water-based system that can either heat the domestic hot water via a coil in an indirect cylinder or heat the building via underfloor heating or radiators.
- If there is no heat or hot water demand the heat pump acts as a typical Mechanical Extract Ventilation (MEV) system.
- Connected to each individual unit's electrical supply.

3.1.2 Advantages

- All billing is between tenant and traditional utility supplier.
- Maintenance is generally by house owner/tenant unless Cost Rental.
- For Cost Rental units some access will be require for light maintenance, such as cleaning or replacing air filters every 3-6 months, depending on manufactures recommendations.
- Less energy consumption than DH CHP+HIU systems, energy is recycled from apartment.
- Produces less CO2 Emissions than a DH CHP+HIU system.
- Lower capital cost than a DH system.
- Can meet Part L compliance and Renewable energy targets.
- Mechanical ventilation is built into the EAHP, no additional cost for ventilation.
- Reduces the risk of overheating in corridors and units.
- No heating risers
- No Energy Centre required.
- Annual end-user energy consumption is much less than DH systems.

3.1.3 Disadvantages

- Can take up more floor space within the apartment than DH systems, as it is floor mounted.
- Common corridors and stairs will require individual heating solutions.

- Common corridors and stair will require a renewable contribution to meet TGD Part L, heat pumps should be considered here to reduce the need for multiple services. Alternatively, if heat pumps are not used, additional PV systems could be installed to meet the renewable energy requirements.

3.1.4 Spatial Requirements

Figures 4 and 5 below show a typical dwelling service cupboard housing an EAHP. Additional Space can be left to either side of the EAHP to accommodate for washing machines, clothes dryers etc.

Typical service cupboard area for the below arrangement is 0.9m x 1.7m, providing the doors open out to provide 1.2m clear space in front of the EAHP for maintenance. The space over washing machine is generally left available for storage or electrical panel.

Figure 4 - Exhaust air heat pump typical service cupboards

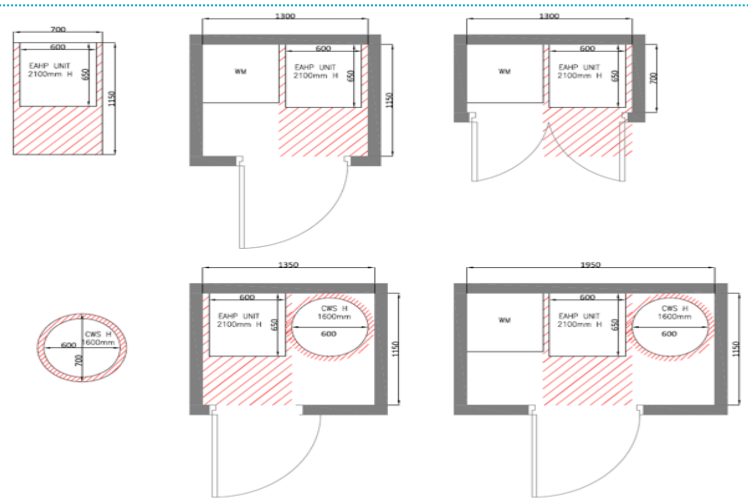


Figure 5 - Exhaust air heat pump typical service cupboard arrangements

3.2 Hot Water Heat Pump (HWHP) & Electric Radiators

3.2.1 How it works

- The Dimplex Edel HWHP is used to provide water heating. Uses an integrated high-performance compressor to extract energy for hot water production from the external air using insulated duct work.
- Electric radiators provide space heating. It is a smart electric heater. It knows precisely how long it takes to get to the desired temperature and when to turn off as it approaches that target temperature. This minimises the energy that it uses, while maximising comfort.
- Xpelair ventilation system is used to provide mechanical ventilation heat recovery. It is designed to combat condensation, mould and pollutants to ensure the air you're breathing is clean, fresh and healthy, while recovering up to 90% of the heat from the stale air leaving the building. This ensures a continuous fresh air supply while maintaining the maximum efficiency for the building and its occupants.

Figure 6 shows a system overview in image below.

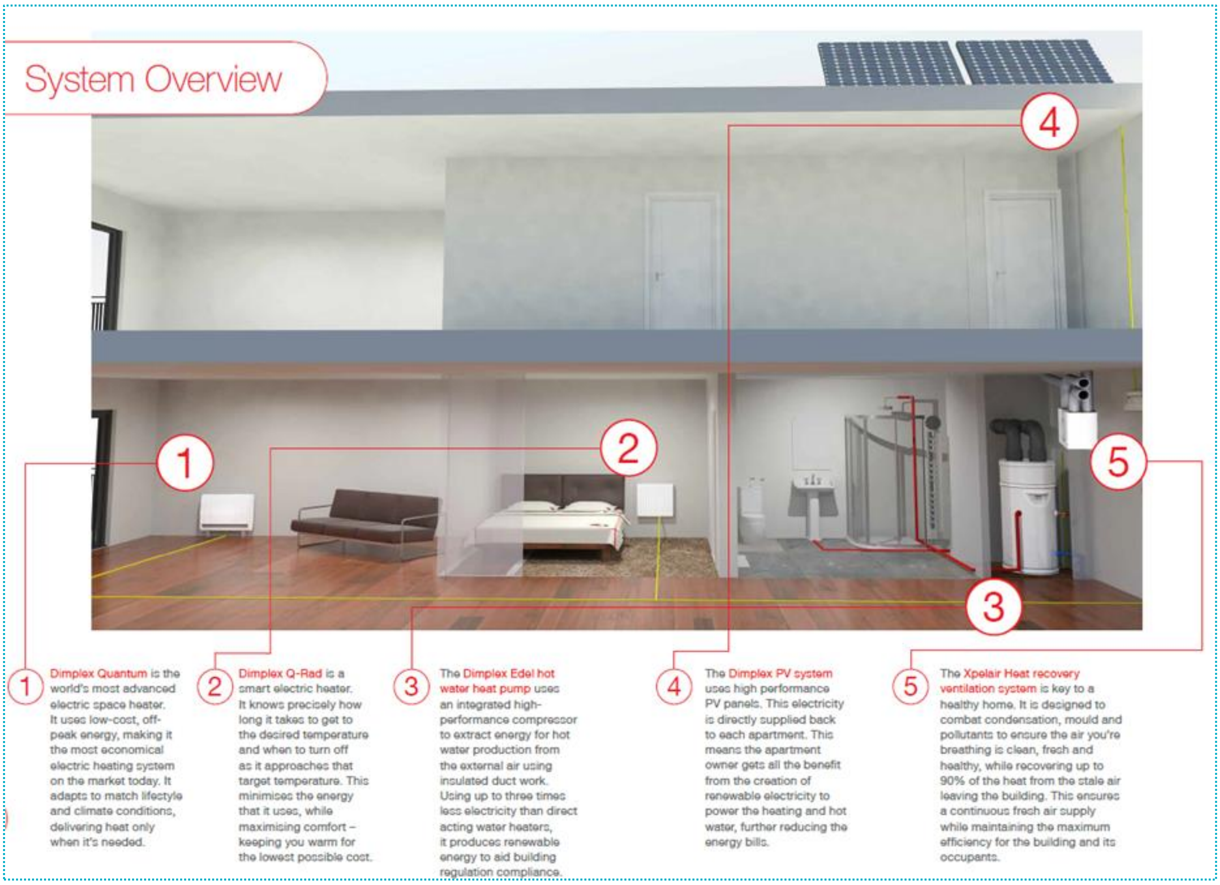


Figure 6 – HWHP & Electric Radiators Overview

3.2.2 Advantages

- The system allows for individual apartment/townhouse heating solution.
- The system comprises of smart electric radiators providing space heating.
- Fully remote access for landlord controls
- Can meet Part L compliance and renewable energy targets.
- Potential capital cost saving.

3.2.3 Disadvantages

- Can take up more floor space within the apartment than DH systems with the Edel hot water heat pump.
- Ventilation ductwork is larger and requires larger air terminals.
- The primary energy is higher compared to the EAHP & the DH AWHP+HIU
- The CO2 emissions & delivered energy are higher compared to the EAHP & the DH AWHP+HIU
- It is likely that PV is required to meet energy targets.
- The annual running cost are also higher compared to the EAHP & the DH AWHP+HIU
- Potential risk of additional sprinkler to the bathroom area.

3.2.4 Spatial Requirements

Hot Water Heat Pump & Electrical rads spatial requirements as per Figure 7 below

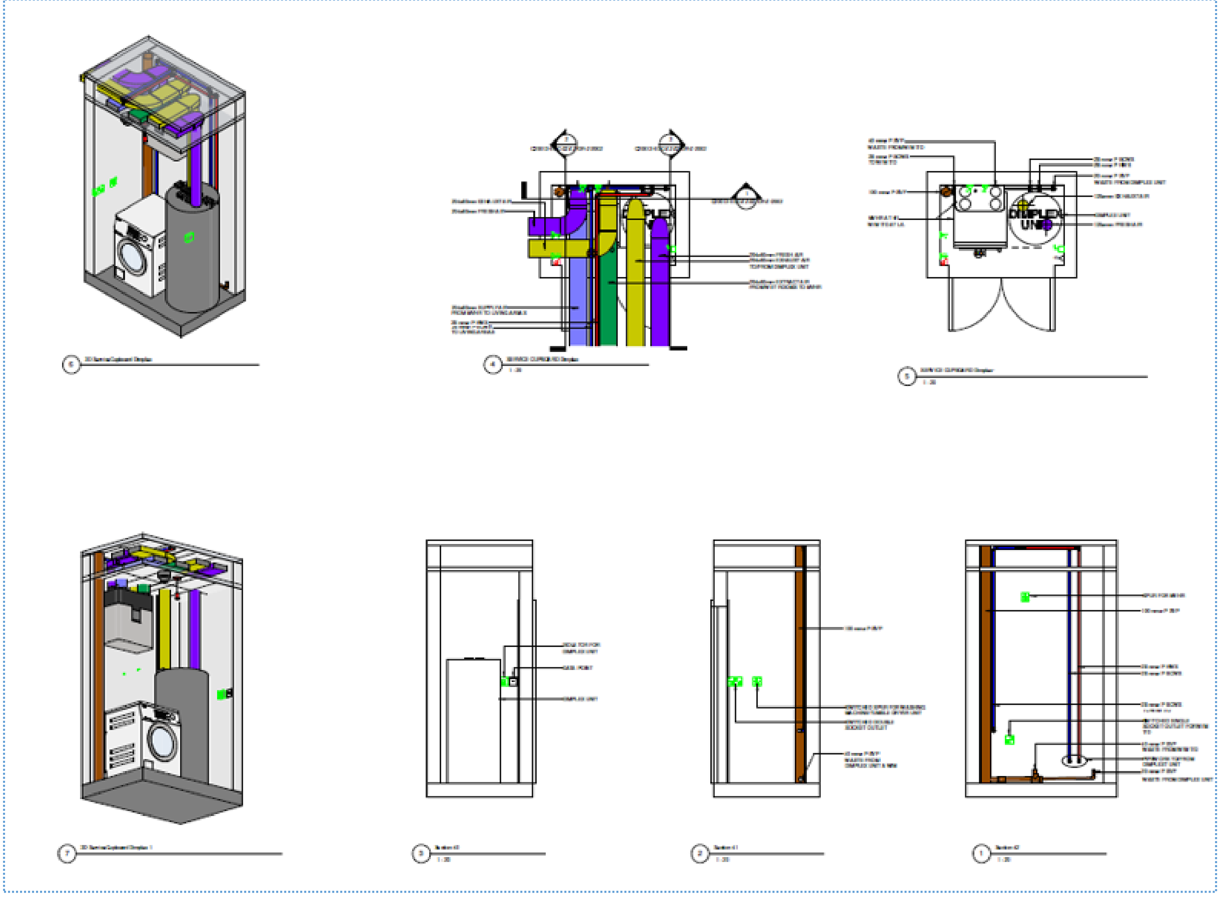


Figure 7 – HWHP & Electric Radiators Spatial Requirements

3.3 Heating Networks

Centralised heating, also known as a heat network, is a system that uses a singular central heat source to distribute hot water through a network of insulated pipes to multiple individual apartment blocks or dwellings. Centralised heating network is normally used to fulfil space heating and water heating requirements in apartment complexes.

The CH scheme energy centre would be installed in each apartment block – the external units generally mounted on the roof. Each apartment building will also require a common internal plant room, and each apartment will require a heat interface unit to transfer heat from the district heating network to the apartments space and water heating. The detailed design for this would be carried out in detailed design phase.

Figure 8 below shows a typical flow diagram of a DH system in a multi-building development. Figure 9 below shows a typical flow diagram for a multi dwelling building.

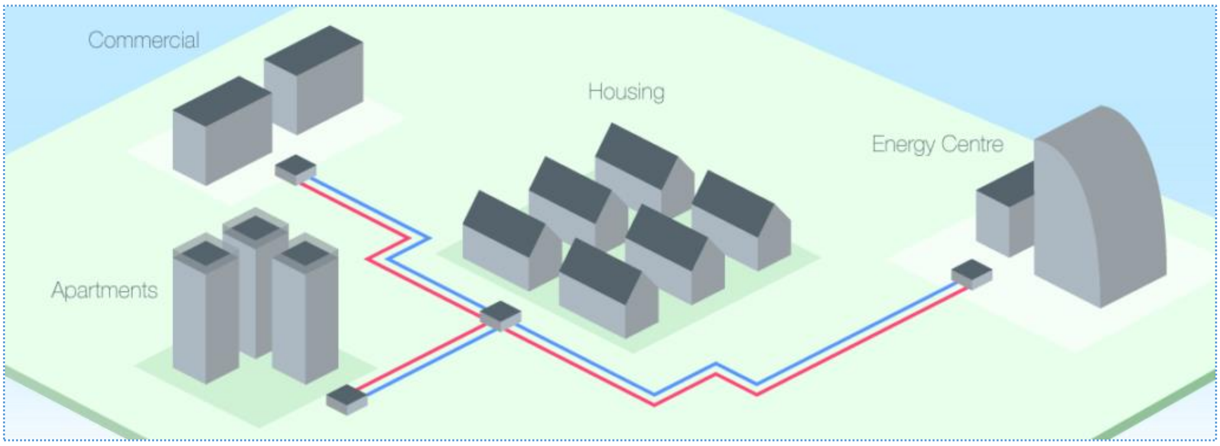


Figure 8- Typical district heating flow diagram

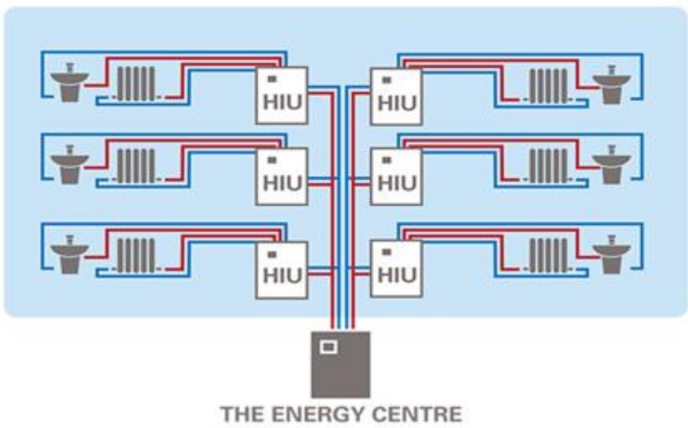


Figure 9 - Typical District heating flow diagram for multi-dwelling building

3.4 Centralised Heating (CH)

The Centralised heating system is intended to provide 100% of the space and water heating using **Air Source Heat Pumps.** The Air-water heat pumps will be in a located in an external location in each apartment block, often the roof or ground mounted. The renewable energy requirements set out in TGD Part L 2022, are expected to be met in all unit types with this type of system. Fossil fuels have been excluded in this study.

Centralised heating systems are very similar to the DH systems discussed in Section 3.3. The main difference is the energy centres will be in a centralised location in each apartment block. Dwellings will also have HIU's located in a services cupboard as shown in Figure 9 and 10 above in section 3.3.

3.4.1 How it works

- The Centralised heating system is heated by the Air-Water Heat Pumps, located in a centralised location in each apartment block, most commonly the roof.
- Hot water is distributed through a heat network, providing heat for the complete development.
- A heat interface unit (HIU) is located within each dwelling, where a plate heat exchanger transfers heat from the CH system to the dwelling internal space heating and domestic hot water system.
- A management company or a third-party ESCO company will bill each unit individually for heat consumed.

3.4.2 Advantages

- Can provide Part L compliance and meet renewable target from a centralised location.
- Most system maintenance can be conducted without access to apartments.
- Reduces space requirements for plant within the units when compared to EAHP.
- Common corridors and stairs do not require additional mechanical systems and can be run from the CH system.
- Primary plant can be easily upgraded with modern technologies in future years, providing the potential to further reduce energy consumption, CO2 emissions and operational costs.
- Combined PV system could be installed and sent to landlord panel to offset generation costs.
- The system has less distribution losses compared to DH schemes.

3.4.3 Disadvantages

- Can involve high installation costs, due to the amount of pipework and builders' infrastructure works required.
- Requires large plant space and potentially additional buildings.
- The system is constantly circulating hot water which is costly and inefficient.
- Overheating can become an issue in units and corridors because of circulation heat losses. An overheating risk assessment can be carried out in early design to mitigate this risk early in the design phase
- Access to apartments will be required for some maintenance of the HIU.
- Additional mechanical ventilation will be required for each unit when compared to EAHP.
- Third party ESCO management company will be required to manage billing.
- ESCO management companies generally provide a fixed price for 12months, this is reviewed every 12 months.
- Can require additional plant areas when compared to DH systems.

3.4.4 Spatial Requirements

The spatial requirements for the central heating plant can vary from block to block. Space for external central heat pumps and an additional heating plantroom will also be required. Sizes for each block is noted in the strategy option spreadsheet in appendix C.

Figure 10 below shows a typical dwelling service cupboard housing a Heat Interface Unit (part of DH system) and a Mechanical Ventilation Heat Recovery (MVHR) unit. The service cupboard at low level can accommodate washing machines, clothes dryers etc. A typical DH scheme and MVHR unit spatial requirement for a district heating system heat interface unit is 0.9m x 1.5m.

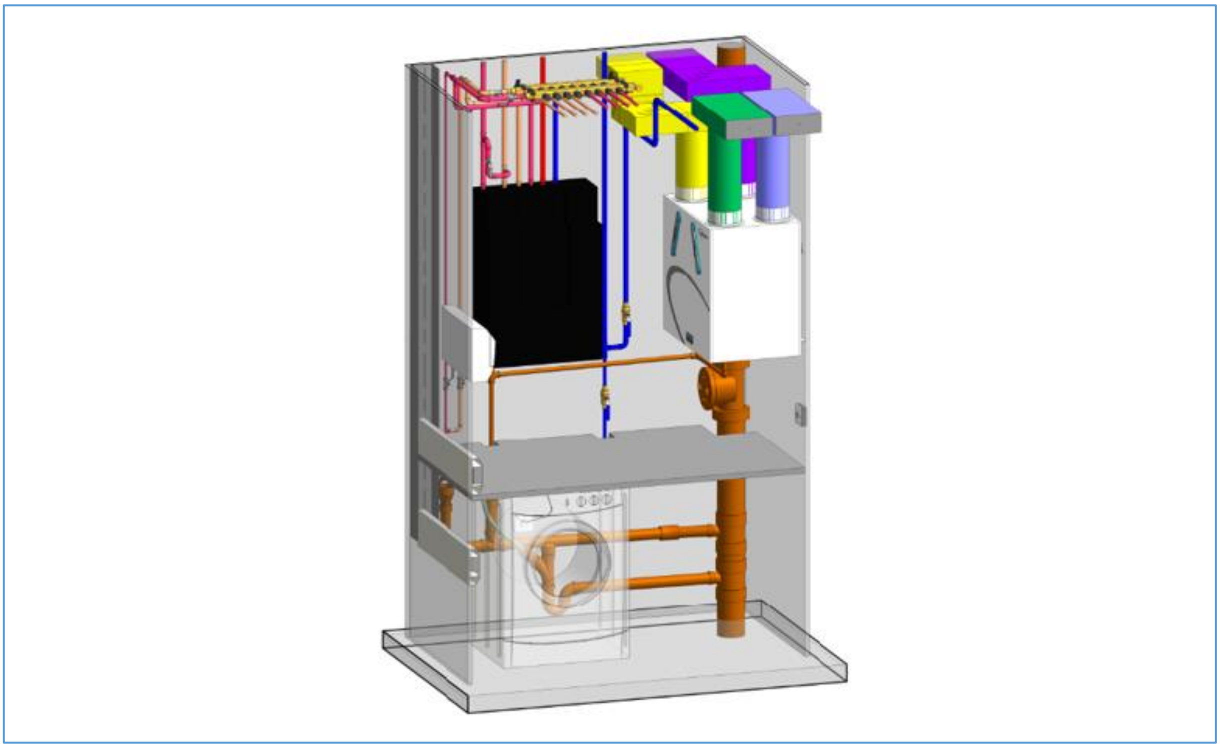


Figure 10 - Typical Dwelling Service Cupboard Housing for Central Heating

4. ENERGY, CO2 EMISSIONS & RUNNING COSTS

To compare each system (like for like), The early-stage Part L block compliance calculations were carried out on each apartment block. The DEAP calculation methodology was used to conducted building energy rating calculations on a typical 1 and 2 bed apartments located on mid-floors and top/ground floor. The calculations were conducted for each heating strategy. The space heating, water heating and ventilation systems were changed for each heating strategy, all other parameters were not changed, such as building fabric, lighting, number of showers etc.

The calculations were conducted at apartment level, block level and across the whole development to determine the following.

- **Primary energy consumption:** Measures the total energy demand of the dwelling. It includes energy consumption from the raw fuels used for electricity generation, energy consumed by the energy sector itself, network transmission losses and final delivered energy consumed by the dwelling.

- **CO2 emissions:** Measures the total Carbon Dioxide Emissions generated to provide the total primary energy to the dwelling.

- **Delivered Energy:** Measures the actual energy delivered to the dwelling or consumed by the end user. This value corresponds to the energy consumption that would normally appear on the dwelling's energy bill.

- **Estimated Annual Running Costs** were calculated to using the most recent Fuel Cost Comparisons for commercial and domestic buildings published by SEAI. The commercial rate for electricity used in calculating the district heating system running costs was €0.2122/kWh, a 15% markup has been assumed for third party/ ESCO management fees. The domestic rate of for electricity used in calculating the stand-alone heating systems running costs was €0.30/kWh.

Table 2 below shows the type and number of apartments that were calculated for each block and the development.

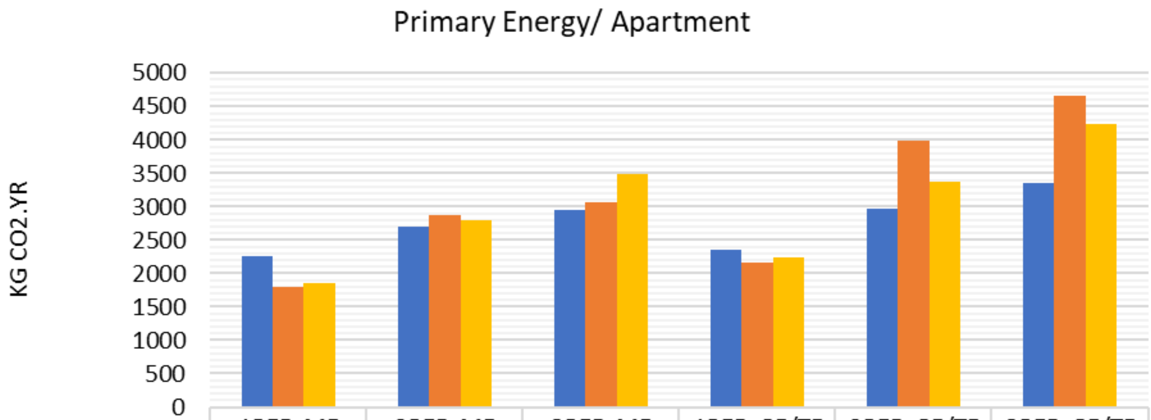
Table 2: Typical Apartment Details

Apartment types	Apartment Block		
	West	East	Middle
1B2P (MF)	48	24	48
2B4P (MF)	52	16	52
3B5P (MF)	0	8	0
1B2P (GF/TF)	11	13	16
2B4P (GF/TF)	15	7	18
3B5P (GF/TF)	0	4	0
Sub-total	126	72	134
Total	332		

4.1 Primary Energy Consumption

A comparison of the primary energy consumption of each apartment type can be seen in Figure 11 below. The results have determined the following.

- **EAHPs** are expected to have the lowest primary energy consumption two and three bed apartments.
- **HWHP** are expected to consume least amount of primary energy in one bed apartments
- **CH AWHP+HIU** are expected to have a lower primary energy consumption in two and three bed apartments compared to HWHPs and more than EAHPs.

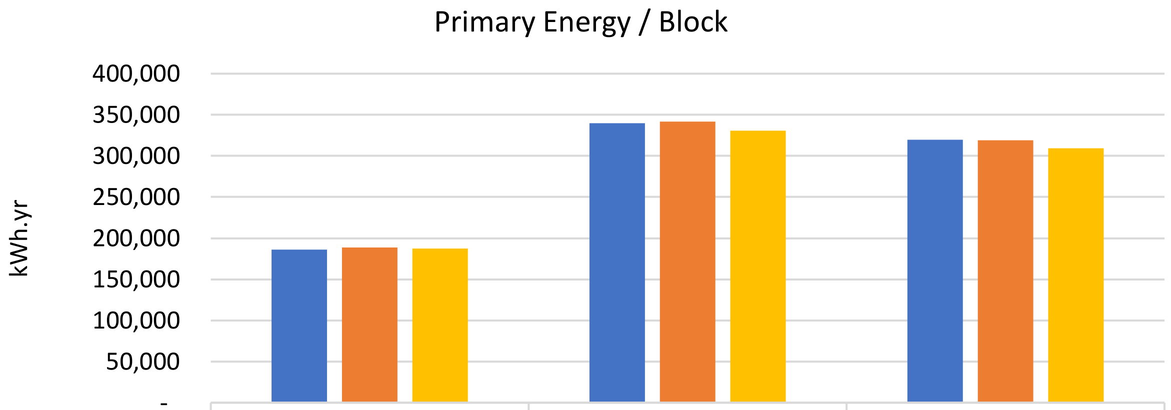


	1BED-MF	2BED-MF	3BED-MF	1BED-GF/TF	2BED-GF/TF	3BED-GF/TF
EAHP	2257	2705	2950	2352	2965	3347
HWHP	1789	2877	3057	2155	3995	4658
CH AWHP+HIU	1851	2796	3479	2235	3374	4238

Figure 11 - Primary Energy Consumption / Apartment

A comparison of the primary energy consumption of each apartment block can be seen in Figure 12 below. The results have determined the following.

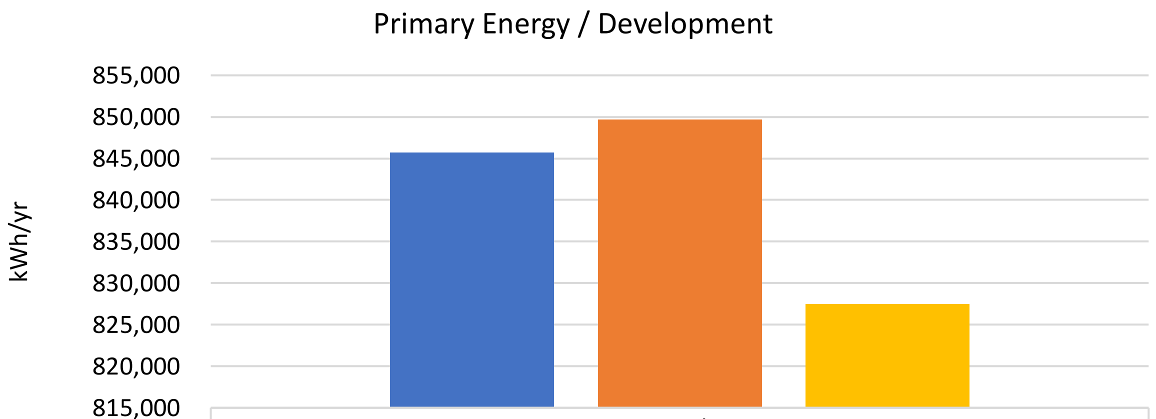
- CH AWHP+HIU is expected to consume least amount of primary energy consumption across all blocks.



	East Block	Middle Block	West Block
EAHP	186,315	340,003	319,347
HWHP	188,672	341,878	319,117
CH AWHP+HIU	187,269	330,728	309,432

Figure 12 - Primary Energy Consumption / Block

Figure 13 below represent the primary energy consumption of each heating strategy across the development. It shows the CH AWHP+HIU is estimated to consume the least amount of primary energy.



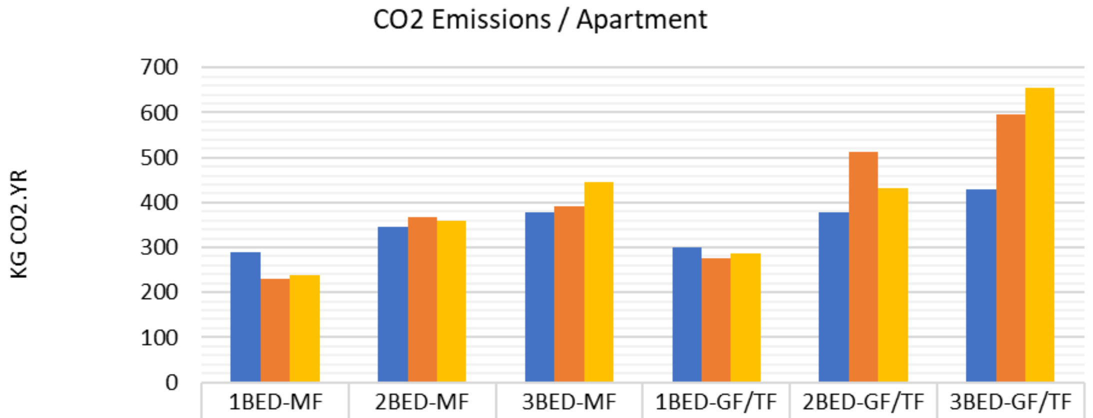
	Total
EAHP	845,664
HWHP	849,667
CH AWHP+HIU	827,429

Figure 13 - Primary Energy Consumption / Development

4.2 CO2 Emissions

A comparison of the CO2 emissions of each apartment type can be seen in Figure 14 below. The results have determined the following.

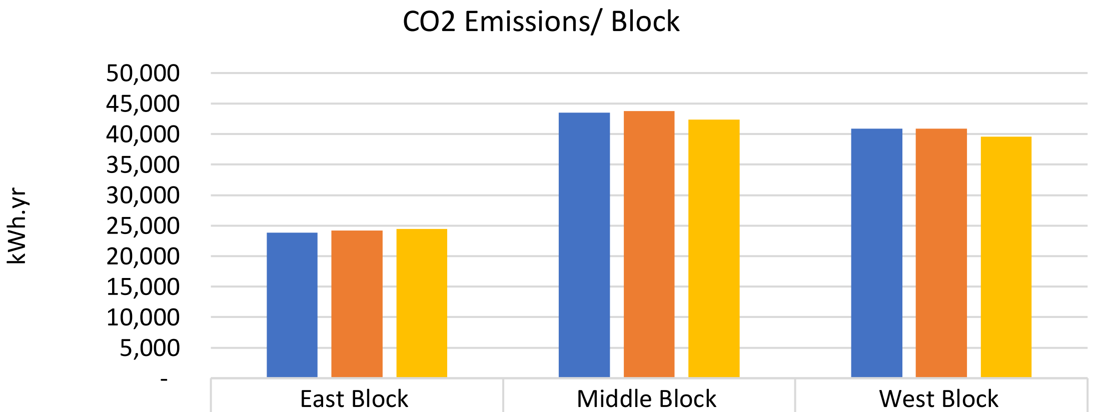
- **EAHPs** are expected to produce the least amount of CO2 emissions in two and three bed apartments.
- **HWHP** are expected to produce the least amount of CO2 emissions in one bed apartments
- **CH AWHP+HIU** are expected to produce the least amount of CO2 emissions in two and three bed apartments compared to HWHPs and more than EAHPs.



	1BED-MF	2BED-MF	3BED-MF	1BED-GF/TF	2BED-GF/TF	3BED-GF/TF
EAHP	289	346	378	301	379	428
HWHP	229	368	391	276	511	596
DH AWHP+HIU	237	358	446	286	432	655

Figure 14 - CO2 Emission / Apartment

A comparison of the estimated CO2 emission produced by each heating strategy for each apartment block can be seen in Figure 15 below. The results have determined the following that CH AWHP+HIU is expected to produce the least amount of CO2 emissions across all blocks.



	East Block	Middle Block	West Block
EAHP	23,849	43,531	40,889
HWHP	24,149	43,766	40,852
DH AWHP+HIU	24,428	42,335	39,611

Figure 15 - CO2 Emission/ Block

Figure 16 below represents the developments CO2 Emissions for each heating strategy across all apartments in the development. It shows the CH AWHP+HIU is estimated to produce the least amount of CO2 emissions.

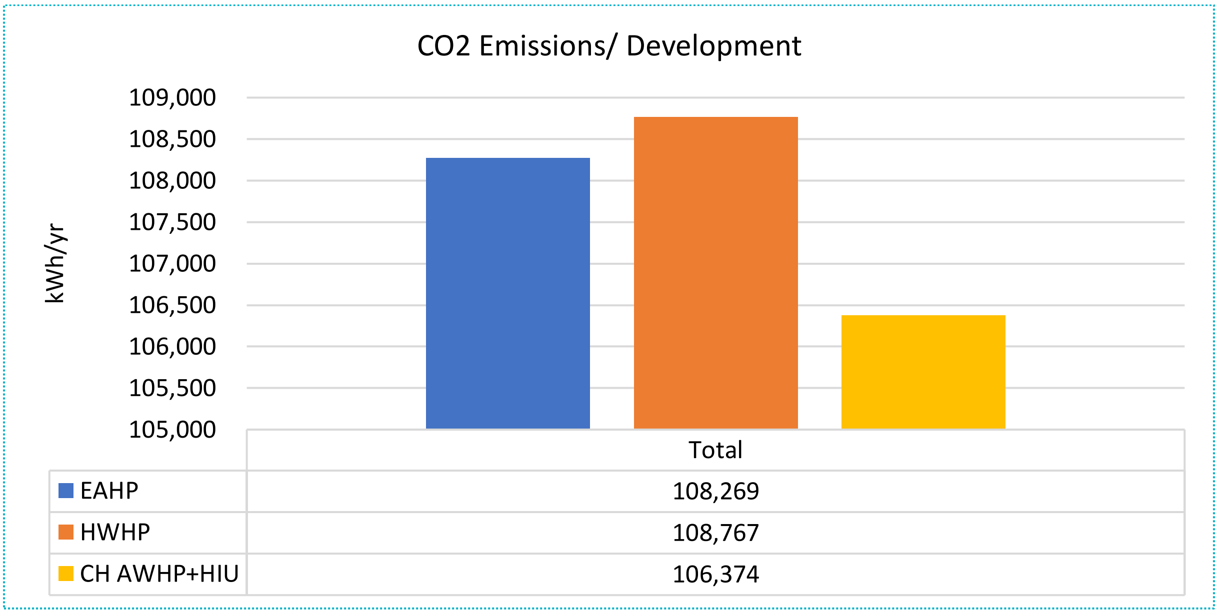
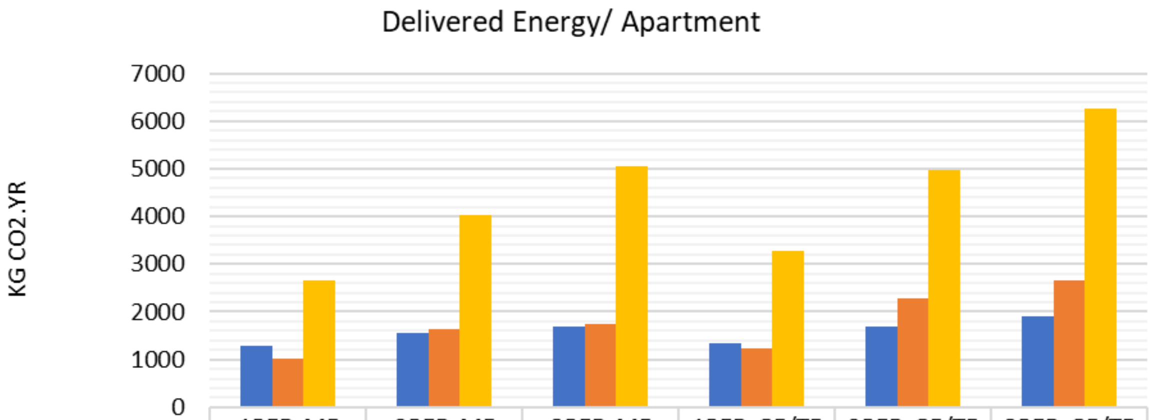


Figure 16 - CO2 Emission / Development

4.3 Delivered Energy

A comparison of the delivered energy consumption of each apartment type can be seen in Figure 17 below. The results have determined the following.

- **EAHPs** are expected to consume the least amount delivered energy consumption two and three bedroom apartments.
- **HWHPs** are expected to consume the least amount of delivered energy in one bedroom apartments.
- **CH AWHP+HIU** is expected to consume the most energy in each apartment type.

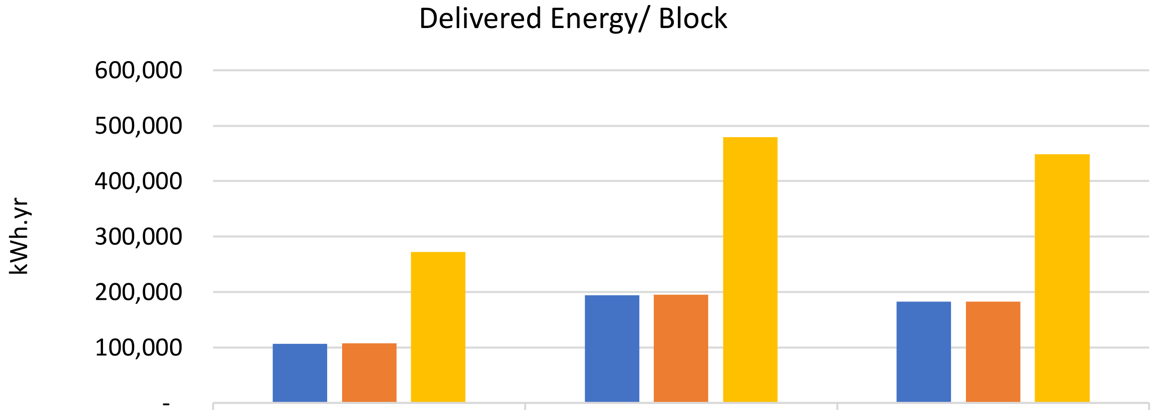


	1BED-MF	2BED-MF	3BED-MF	1BED-GF/TF	2BED-GF/TF	3BED-GF/TF
EAHP	1290	1546	1686	1344	1694	1913
HWHP	1022	1644	1747	1231	2283	2662
CH AWHP+HIU	2658	4043	5047	3274	4969	6266

Figure 17 - Delivered Energy Consumption / Apartment

A comparison of the delivered energy consumption of each apartment block can be seen in Figure 18 below. The results have determined the following.

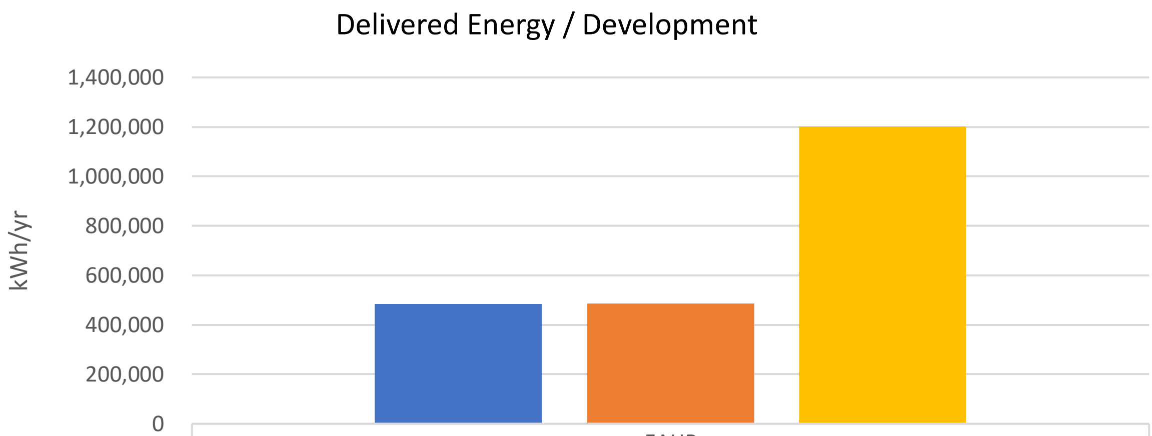
- **EAHP** are expected to consume the least amount to delivered energy in East and West apartment blocks.
- **HWHP** are expected to consume the least amount to delivered energy in Middle apartment blocks.
- **CH AWHP+HIU** is expected to consume the most energy across all blocks.



	East Block	Middle Block	West Block
EAHP	106,472	194,310	182,506
HWHP	107,813	195,357	182,351
DH AWHP+HIU	272,234	479,678	448,401

Figure 18 - Delivered Energy Consumption / Block

Figure 19 below represent the delivered energy consumption of each heating strategy across the development. The **EAHP** is estimated to consume less energy than the HWHP and less energy than the CH AWHP+HIU.



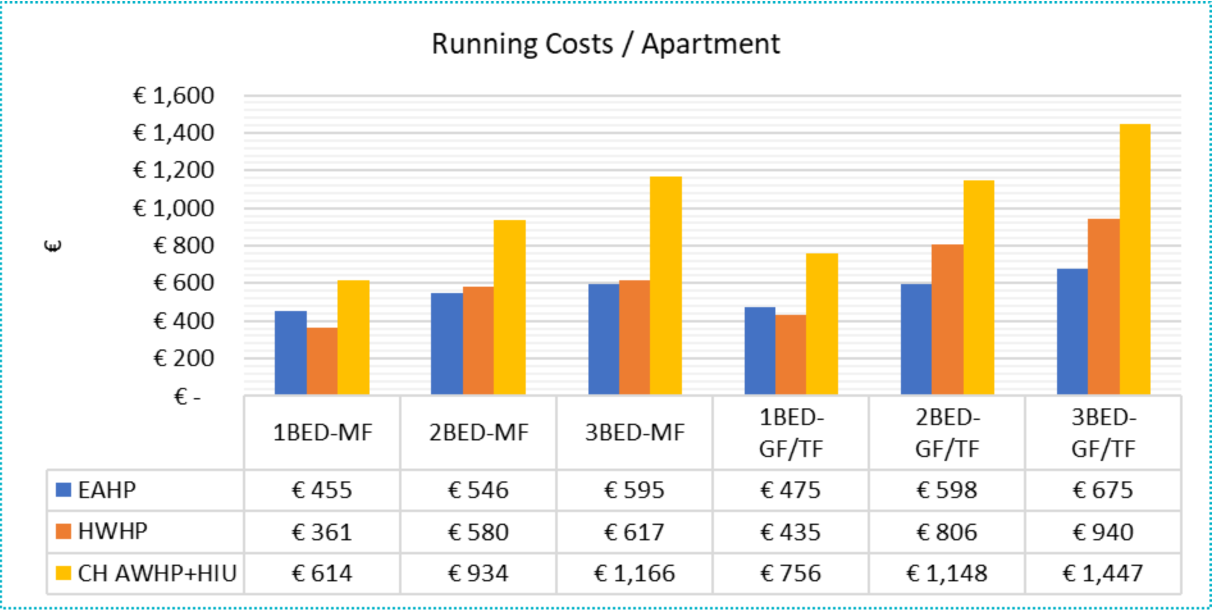
	EAHP
EAHP	483,288
HWHP	485,521
CH AWHP+HIU	1,200,313

Figure 19 - Delivered Energy Consumption / Development

4.4 Annual Runnings Costs (Estimate)

A comparison of the delivered energy consumption of each apartment type can be seen in Figure 20 below. The results have determined the following.

- **EAHPs** are expected to have the lowest annual running costs in two- and three-bedroom apartments.
- **HWHPs** are expected to have the lowest annual running costs in one-bedroom apartments.
- **CH AWHP+HIU** is expected have the highest annual running costs each apartment type.

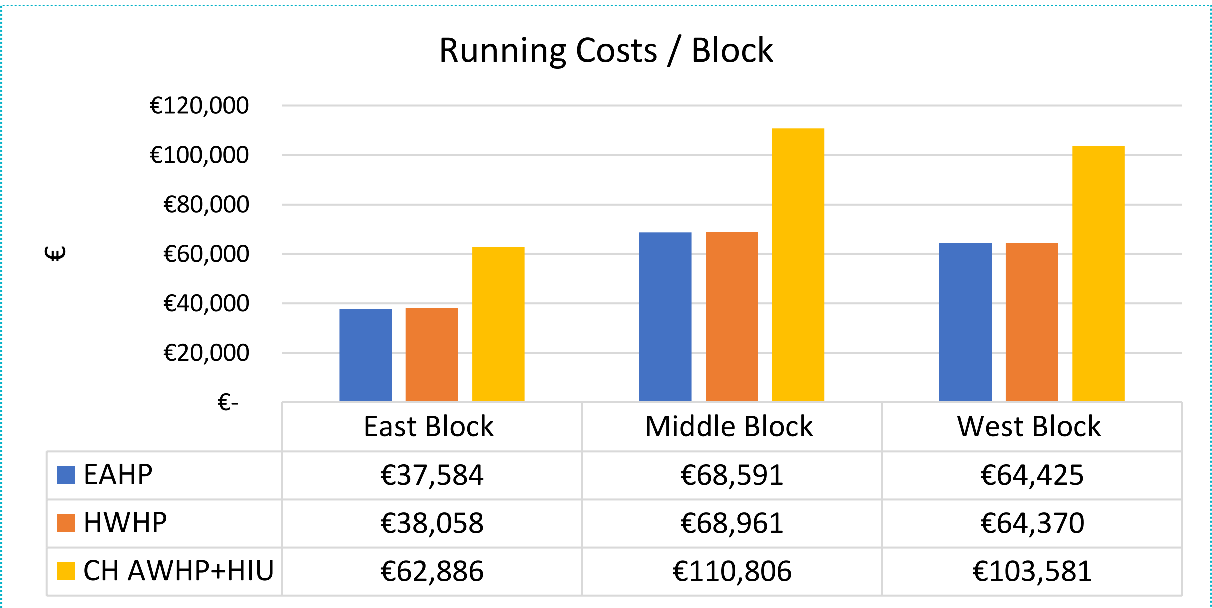


	1BED-MF	2BED-MF	3BED-MF	1BED-GF/TF	2BED-GF/TF	3BED-GF/TF
EAHP	€ 455	€ 546	€ 595	€ 475	€ 598	€ 675
HWHP	€ 361	€ 580	€ 617	€ 435	€ 806	€ 940
CH AWHP+HIU	€ 614	€ 934	€ 1,166	€ 756	€ 1,148	€ 1,447

Figure 20 - Annual Running Costs / Apartment

A comparison of the annual running costs of each apartment block can be seen in Figure 21 below. The results have determined the following.

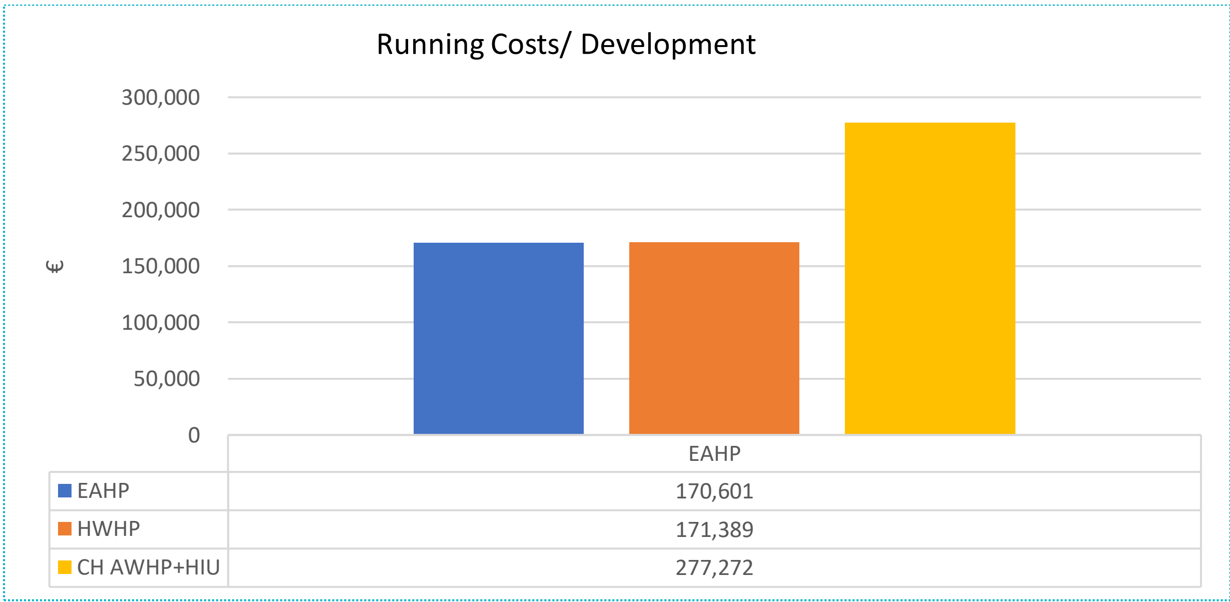
- **EAHP & HWHP** are expected to have similar annual running costs.
- **CH AWHP+HIU** is expected to have the highest annual running costs across all blocks.



	East Block	Middle Block	West Block
EAHP	€37,584	€68,591	€64,425
HWHP	€38,058	€68,961	€64,370
CH AWHP+HIU	€62,886	€110,806	€103,581

Figure 21 - Annual Running Costs / Block

Figure 22 below represent the annual running costs of each heating strategy across the development. It shows the EAHP is estimated to cost 2.06% less than the HWHP, 183% less than the CH AWHP+HIU and DH AWHP+HIU.



	EAHP
EAHP	170,601
HWHP	171,389
CH AWHP+HIU	277,272

Figure 22 - Annual Running Costs / Development

4.5 PV Requirements (Residential)

It is not expected additional renewable energy from photovoltaic systems will be required to meet Part L compliance or 10% primary energy improvement for the apartments.

4.6 PV Requirements (Landlord areas)

Figure 23 below provides the expected PV requirement to meet Part L's renewable energy requirement for the Landlord areas in each block.

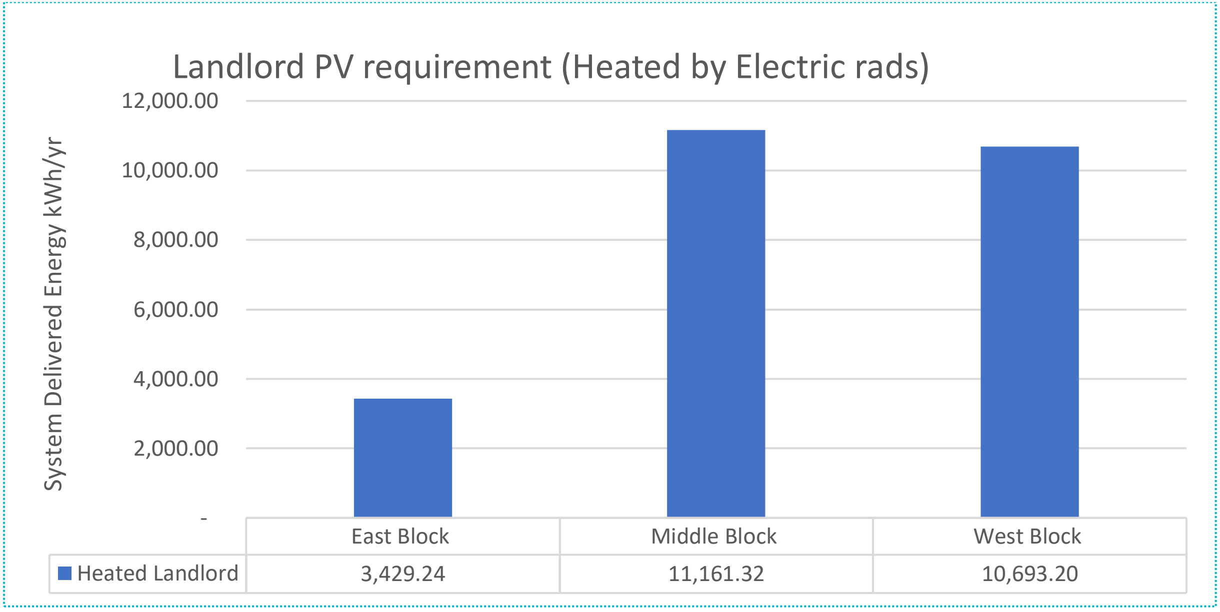


Figure 23- PV requirements (landlord)

5. CONCLUSION

In line with Cork City Council policy objectives and regional policy objective RPO 7.38 set out in the Regional Spatial & Economic Strategy (RSES) 2019-2031, a feasibility study for district heating systems was carried out for the proposed development.

This study includes a comparison of three different heating strategies, including two standalone systems and one centralised heating systems. For a fair comparison, early-stage Part L block compliance calculations were carried out on each heating strategy to determine the developments estimated primary energy, CO2 emissions, delivered energy, running costs and PV requirements. The study also determines if the heating strategy will achieve a 10% primary energy improvement and determines what is required for it to be achieved. Third party district heating and waste heat networks outside the development's curtilage have been excluded from this study, as it was found there is no current heat networks in the area and the development in not located in a SEAI district heating candidate area, as shown in Figure 2 above.

The following heating strategies have been included in this study.

- Exhaust Air to Water Heat Pump (EAHP)
- Hot Water Heat Pump + MVHR + Electric Radiators (HWHP)
- Centralised Heating with Air to Water Heat Pump + HIU (CH: AWHP+HIU)

The table below summarises how each heating strategy has performed in comparison to each other. EAHP heating strategy has performed the best in terms of delivered energy and running costs followed by HWHP. CH AWHP+HIU have performed the best in terms of primary energy and CO2 Emissions followed by the DH AWHP+HIU heating strategy.

	EAHP	HWHP	CH AWHP+HIU
Primary Energy	**2**	**3**	**1**
CO2 Emissions	**2**	**3**	**1**
Delivered Energy	**1**	**2**	**3**
Running Costs	1	**2**	**3**
Landlord Heating	**2**		**1**

It is proposed to install CH AWHP solution to each block for the apartments as it performs best in the overall assessment criteria and also simple upgrade of technology in the future to facilitate future technologies and future carbon reduction.

The townhouses will have individual systems of monoblock heatpumps as to pipe to each townhouse will incur more heat losses than gain.

APPENDIX A

CALCULATION ASSUMPTIONS

1. SEAI Fuel cost comparisons 01 Oct 24 - Domestic (Band DB).   Electricity: € 0.353
2. SEAI Fuel cost comparisons 01 Oct 24 - Commercial (Band IB).   Electricity: €0.278
3. System distribution losses allowed for in DEAP calculation for District Heating system (distribution loss factor = 1.05)

APPENDIX B

BLOCK COMPLIANCE CALCULATIONS

Project Name:	C23024-Reddy Architecture-LDA ESB Site
Date:	16/12/2024
Revision:	4
Document	**Estimated PV requirements - East Block Apartments - TB as per ACDs**

Accomodation Schedule

Apartment type	Qty	Area	Total floor area
1B2P (MF)	24	51.7	1240.8
2B4P (MF)	16	78.04	1248.64
3B5P (MF)	8	104.4	835.2
1B2P (GF/TF)	13	51.7	672.1
2B4P (GF/TF)	7	78.04	546.28
3B5P (GF/TF)	4	104.4	417.6
	72		4960.62

Joule ModulAir All E

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L RER met	Part L Compliant	10% EPC Improvement	Achieved A2 BER or Better
1B2P (MF)	A2	43.66	5.59	24.95	0.288	0.196	0.268	357.35	0.259	243.20	0.174	Yes	Yes	Yes	Yes
2B4P (MF)	A2	34.66	4.44	19.81	0.251	0.168	0.257	313.41		209.77					
3B5P (MF)	A2	28.67	3.67	16.38	0.251	0.169	0.242	209.64		141.15					
1B2P (GF/TF)	A2	45.5	5.82	26	0.26	0.174	0.276	174.75		116.95					
2B4P (GF/TF)	A2	37.99	4.86	21.71	0.238	0.156	0.281	130.01		85.22					
3B5P (GF/TF)	A2	32.53	4.16	18.59	0.24	0.158	0.274	100.22		65.98					

	Part L Individual Compliance		10% EPC Improvement	
Apartment type	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
1B2P (MF)	45.48	-1289.84	40.93	1934.76
2B4P (MF)	41.43	-4827.81	37.28	-1872.01
3B5P (MF)	34.27	-2671.18	30.84	-1035.76
1B2P (GF/TF)	52.50	-2688.40	47.25	-672.10
2B4P (GF/TF)	47.89	-3089.31	43.10	-1594.48
3B5P (GF/TF)	40.66	-1940.65	36.60	-970.32
Estimated PV Required:		0		0
No of PV Required:		0		0

Dimplex Edel

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L RER met	Part L Compliant	10% EPC Improvement	Achieved A2 BER or Better
1B2P (MF)	A2	34.6	4.43	19.77	0.228	0.155	0.416	282.90	0.264	192.32	0.176	Yes	Yes	Yes	Yes
2B4P (MF)	A2	36.87	4.72	21.07	0.267	0.179	0.344	333.39		223.51					
3B5P (MF)	A2	29.71	3.8	16.98	0.26	0.175	0.358	217.15		146.16					
1B2P (GF/TF)	A2	41.69	5.34	23.82	0.239	0.159	0.381	160.63		106.86					
2B4P (GF/TF)	A3	51.19	6.55	29.25	0.32	0.21	0.275	174.81		114.72					
3B5P (GF/TF)	A2	45.27	5.79	25.87	0.334	0.219	0.268	139.48		91.45					

	Part L Individual Compliance		10% EPC Improvement	
Apartment type	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
1B2P (MF)	45.53	-7747.07	40.97	-4519.12
2B4P (MF)	41.43	-3251.43	37.28	-295.58
3B5P (MF)	34.28	-2181.43	30.85	-545.36
1B2P (GF/TF)	52.33	-4086.58	47.10	-2076.78
2B4P (GF/TF)	47.99	998.72	43.19	2496.79
3B5P (GF/TF)	40.66	1099.68	36.60	2069.98
Estimated PV Required:		0		0
No of PV Required:		0		0

Centralised Heating (100% Elec AHWP + HIU)

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L RER met	Part L Compliant	10% EPC Improvement	Achieved A2 BER or Better
1B2P (MF)	A2	35.8	4.58	51.42	0.234	0.159	0.47	290.35	0.262	197.29	0.176	No	Yes	Yes	Yes
2B4P (MF)	A2	35.83	4.59	51.81	0.259	0.174	0.473	323.40		217.26					
3B5P (MF)	A2	33.81	4.33	49.05	0.295	0.198	0.474	246.38		165.37					
1B2P (GF/TF)	A2	43.23	5.53	63.33	0.247	0.165	0.478	166.01		110.90					
2B4P (GF/TF)	A2	43.23	5.53	63.67	0.27	0.178	0.48	147.50		97.24					
3B5P (GF/TF)	A2	41.19	6.37	60.89	0.303	0.199	0.482	126.53		83.10					

	Part L Individual Compliance		10% EPC Improvement	
Apartment type	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
1B2P (MF)	45.90	-7159.37	41.31	-3905.11
2B4P (MF)	41.50	-4046.97	37.35	-1085.77
3B5P (MF)	34.38	-273.49	30.94	1367.46
1B2P (GF/TF)	52.51	-3562.54	47.26	-1546.01
2B4P (GF/TF)	48.03	-1499.41	43.23	0.00
3B5P (GF/TF)	40.78	97.32	36.70	1070.50
Estimated PV Required:		0		0
No of PV Required:		0		0

Assumptions All landlord areas are heated

Project Name:	C23024-Reddy Architecture-LDA ESB Site
Date:	16/12/2024
Revision:	4
Document	**Estimated PV requirements - West Block Apartments - TB as per ACDs**

Accomodation Schedule

Apartment type	Qty	Area	Total floor area
1B2P (MF)	48	51.7	2481.6
2B4P (MF)	52	78.04	4058.08
3B5P (MF)	0	104.4	0
1B2P (GF/TF)	11	51.7	568.7
2B4P (GF/TF)	15	78.04	1170.6
3B5P (GF/TF)	0	104.4	0
	126		8278.98

Joule ModulAir All E

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L Compliant	10% EPC Improvement
1B2P (MF)	A2	43.66	5.59	24.95	0.288	0.196	0.268	714.70	0.261	486.39	0.175	Yes	Yes
2B4P (MF)	A2	34.66	4.44	19.81	0.251	0.168	0.257	1018.58		681.76			
3B5P (MF)	A2	28.67	3.67	16.38	0.251	0.169	0.242	0.00		0.00			
1B2P (GF/TF)	A2	45.5	5.82	26	0.26	0.174	0.276	147.86		98.95			
2B4P (GF/TF)	A2	37.99	4.86	21.71	0.238	0.156	0.281	278.60		182.61			
3B5P (GF/TF)	A2	32.53	4.16	18.59	0.24	0.158	0.274	0.00		0.00			

	Part L Individual Compliance: Ref Building Primary Energy (kWh/m2/yr)	Part L Individual Compliance: Required PV (kWh/yr)	10% EPC Improvement: Ref Building Primary Energy (kWh/m2/yr)	10% EPC Improvement: Required PV (kWh/yr)
1B2P (MF)	45.48	-2579.68	40.93	3869.52
2B4P (MF)	41.43	-15690.38	37.28	-6084.03
3B5P (MF)	34.27	0.00	30.84	0.00
1B2P (GF/TF)	52.50	-2274.80	47.25	-568.70
2B4P (GF/TF)	47.89	-6619.95	43.10	-3416.75
3B5P (GF/TF)	40.66	0.00	36.60	0.00
Estimated PV Required:		0		0
No of PV Required:		0		0

Dimplex Edel

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L Compliant	10% EPC Improvement
1B2P (MF)	A2	34.6	4.43	19.77	0.228	0.155	0.416	565.80	0.261	384.65	0.175	Yes	Yes
2B4P (MF)	A2	36.87	4.72	21.07	0.267	0.179	0.344	1083.51		726.40			
3B5P (MF)	A2	29.71	3.8	16.98	0.26	0.175	0.358	0.00		0.00			
1B2P (GF/TF)	A2	41.69	5.34	23.82	0.239	0.159	0.381	135.92		90.42			
2B4P (GF/TF)	A3	51.19	6.55	29.25	0.32	0.21	0.275	374.59		245.83			
3B5P (GF/TF)	A2	45.27	5.79	25.87	0.334	0.219	0.268	0.00		0.00			

	Part L Individual Compliance: Ref Building Primary Energy (kWh/m2/yr)	Part L Individual Compliance: Required PV (kWh/yr)	10% EPC Improvement: Ref Building Primary Energy (kWh/m2/yr)	10% EPC Improvement: Required PV (kWh/yr)
1B2P (MF)	45.53	-15494.14	40.97	-9038.25
2B4P (MF)	41.43	-10567.16	37.28	-960.65
3B5P (MF)	34.28	0.00	30.85	0.00
1B2P (GF/TF)	52.33	-3457.87	47.10	-1757.28
2B4P (GF/TF)	47.99	2140.11	43.19	5350.27
3B5P (GF/TF)	40.66	0.00	36.60	0.00
Estimated PV Required:		0		0
No of PV Required:		0		0

Centralised Heating (100% Elec AHWP + HIU)

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC Weight	EPC Weighted Average	CPC Weight	CPC Weighted Average	Part L Compliant	10% EPC Improvement
1B2P (MF)	A2	35.8	4.58	51.42	0.234	0.159	0.47	580.69	0.252	394.57	0.169	Yes	Yes
2B4P (MF)	A2	35.83	4.59	51.81	0.259	0.174	0.473	1051.04		706.11			
3B5P (MF)	A2	33.81	4.33	49.05	0.295	0.198	0.474	0.00		0.00			
1B2P (GF/TF)	A2	43.23	5.53	63.33	0.247	0.165	0.478	140.47		93.84			
2B4P (GF/TF)	A2	43.23	5.53	63.67	0.27	0.178	0.48	316.06		208.37			
3B5P (GF/TF)	A2	41.19	6.37	60.89	0.303	0.199	0.482	0.00		0.00			

	Part L Individual Compliance: Ref Building Primary Energy (kWh/m2/yr)	Part L Individual Compliance: Required PV (kWh/yr)	10% EPC Improvement: Ref Building Primary Energy (kWh/m2/yr)	10% EPC Improvement: Required PV (kWh/yr)
1B2P (MF)	45.90	-14318.74	41.31	-7810.22
2B4P (MF)	41.50	-13152.66	37.35	-3528.76
3B5P (MF)	34.38	0.00	30.94	0.00
1B2P (GF/TF)	52.51	-3014.46	47.26	-1308.16
2B4P (GF/TF)	48.03	-3213.02	43.23	0.00
3B5P (GF/TF)	40.78	0.00	36.70	0.00
Estimated PV Required:		0		0
No of PV Required:		0		0

Assumptions All landlord areas are heated

Project Name:	C23024-Reddy Architecture-LDA ESB Site
Date:	16/12/2024
Revision:	4
Document	**Estimated PV requirements - Summary**

Exhaust Air Heat Pump - Joule ModulAir All-E

Thermal Bridging Factors as per ACDs

Heated landlord spaces

Location	Apartment - Part L Block Compliance					PV Requirements			Development			
	EPC	CPC	BER	Part L Compliant	10% EPC Improvement	Apartment - Part L Compliant	Apartment - 10% EPC Improvement	Landlord	Primary Energy	CO2 Emissions	Delivered Energy	Running Costs
East Block	0.259	0.174	A2	Yes	Yes	0.00	0.00	3,429.24	186,315	23,849	106,472	€ 37,584
Middle Block	0.260	0.175	A2	Yes	Yes	0.00	0.00	11,161.32	340,003	43,531	194,310	€ 68,591
West Block	0.261	0.175	A2	Yes	Yes	0.00	0.00	10,693.20	319,347	40,889	182,506	€ 64,425
					Sub-Total:	**0**	**0**	**25,284**	**845,664**	**108,269**	**483,288**	**170,601**

Total PV Requirements		
Part L	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74
10% EPC improvement	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74

Hot Water Heat Pump - Dimplex Edel

Thermal Bridging Factors as per ACDs

Heated landlord spaces

Location	Apartment - Part L Block Compliance					PV Requirements			Development			
	EPC	CPC	BER	Part L Compliant	10% EPC Improvement	Apartment - Part L Compliant	Apartment - 10% EPC Improvement	Landlord	Primary Energy	CO2 Emissions	Delivered Energy	Running Costs
East Block	0.264	0.176	A2/A3	Yes	Yes	0.00	0.00	3,429.24	188,672	24,149	107,813	€ 38,058
Middle Block	0.262	0.175	A2/A3	Yes	Yes	0.00	0.00	11,161.32	341,878	43,766	195,357	€ 68,961
West Block	0.261	0.175	A2/A3	Yes	Yes	0.00	0.00	10,693.20	319,117	40,852	182,351	€ 64,370
					Sub-Total:	**0**	**0**	**25,284**	**849,667**	**108,767**	**485,521**	**171,389**

Total PV Requirements		
Part L	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74
10% EPC improvement	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74

Centralised Heating (100% Elec AHWP + HIU)													
Thermal Bridging Factors as per ACDs													
Heated landlord spaces													
Location	Apartment - Part L Block Compliance					PV Requirements			Development				
	EPC	CPC	BER	Part L Compliant	10% EPC Improvement	Apartment - Part L Compliant	Apartment - 10% EPC Improvement	Landlord	Primary Energy	CO2 Emissions	Delivered Energy	Running Costs
East Block	0.262	0.176	A2	Yes	Yes	0.00	0.00	3,429.24	187,269	24,428	272,234	€ 62,886
Middle Block	0.253	0.170	A2	Yes	Yes	0.00	0.00	11,161.32	330,728	42,335	479,678	€ 110,806
West Block	0.252	0.169	A2	Yes	Yes	0.00	0.00	10,693.20	309,432	39,611	448,401	€ 103,581
					Sub-Total:	**0**	**0**	**25,284**	**827,429**	**106,374**	**1,200,313**	**277,272**

Total PV Requirements		
Part L	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74
10% EPC improvement	Total (kWh/yr)	25,283.76
	Estimate no. of PV panels:	74

Project Name:	C23024-Reddy Architecture-LDA ESB Site
Date:	16/12/2024
Revision:	4
Document	**Estimated PV requirements - Middle Block Apartments - TB as per ACDs**

Accomodation Schedule

Apartment type	Qty	Area	Total floor area
1B2P (MF)	48	51.7	2481.6
2B4P (MF)	52	78.04	4058.08
3B5P (MF)	0	104.4	0
1B2P (GF/TF)	16	51.7	827.2
2B4P (GF/TF)	18	78.04	1404.72
3B5P (GF/TF)	0	104.4	0
	134		8771.6

Joule ModulAir All E

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC		CPC		Part L Compliant	10% EPC Improvement
								Weight	Weighted Average	Weight	Weighted Average		
1B2P (MF)	A2	43.66	5.59	24.95	0.288	0.196	0.268	714.70	0.260	486.39	0.175	Yes	Yes
2B4P (MF)	A2	34.66	4.44	19.81	0.251	0.168	0.257	1018.58		681.76			
3B5P (MF)	A2	28.67	3.67	16.38	0.251	0.169	0.242	0.00		0.00			
1B2P (GF/TF)	A2	45.5	5.82	26	0.26	0.174	0.276	215.07		143.93			
2B4P (GF/TF)	A2	37.99	4.86	21.71	0.238	0.156	0.281	334.32		219.14			
3B5P (GF/TF)	A2	32.53	4.16	18.59	0.24	0.158	0.274	0.00		0.00			

Part L Individual Compliance		10% EPC Improvement	
Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
45.48	-2579.68	40.93	3869.52
41.43	-15690.38	37.28	-6084.03
34.27	0.00	30.84	0.00
52.50	-3308.80	47.25	-827.20
47.89	-7943.94	43.10	-4100.10
40.66	0.00	36.60	0.00
Estimated PV Required:	0		0
No of PV Required:	0		0

Dimplex Edel

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC		CPC		Part L Compliant	10% EPC Improvement
								Weight	Weighted Average	Weight	Weighted Average		
1B2P (MF)	A2	34.6	4.43	19.77	0.228	0.155	0.416	565.80	0.262	384.65	0.175	Yes	Yes
2B4P (MF)	A2	36.87	4.72	21.07	0.267	0.179	0.344	1083.51		726.40			
3B5P (MF)	A2	29.71	3.8	16.98	0.26	0.175	0.358	0.00		0.00			
1B2P (GF/TF)	A2	41.69	5.34	23.82	0.239	0.159	0.381	197.70		131.52			
2B4P (GF/TF)	A3	51.19	6.55	29.25	0.32	0.21	0.275	449.51		294.99			
3B5P (GF/TF)	A2	45.27	5.79	25.87	0.334	0.219	0.268	0.00		0.00			

Part L Individual Compliance		10% EPC Improvement	
Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
45.53	-15494.14	40.97	-9038.25
41.43	-10567.16	37.28	-960.65
34.28	0.00	30.85	0.00
52.33	-5029.63	47.10	-2556.04
47.99	2568.13	43.19	6420.32
40.66	0.00	36.60	0.00
Estimated PV Required:	0		0
No of PV Required:	0		0

Centralised Heating (100% Elec AHWP + HIU)

Apartment type	BER	Primary Energy	CO2 Emissions	Delivered Energy	EPC	CPC	RER	EPC		CPC		Part L Compliant	10% EPC Improvement
								Weight	Weighted Average	Weight	Weighted Average		
1B2P (MF)	A2	35.8	4.58	51.42	0.234	0.159	0.47	580.69	0.253	394.57	0.170	Yes	Yes
2B4P (MF)	A2	35.83	4.59	51.81	0.259	0.174	0.473	1051.04		706.11			
3B5P (MF)	A2	33.81	4.33	49.05	0.295	0.198	0.474	0.00		0.00			
1B2P (GF/TF)	A2	43.23	5.53	63.33	0.247	0.165	0.478	204.32		136.49			
2B4P (GF/TF)	A2	43.23	5.53	63.67	0.27	0.178	0.48	379.27		250.04			
3B5P (GF/TF)	A2	41.19	6.37	60.89	0.303	0.199	0.482	0.00		0.00			

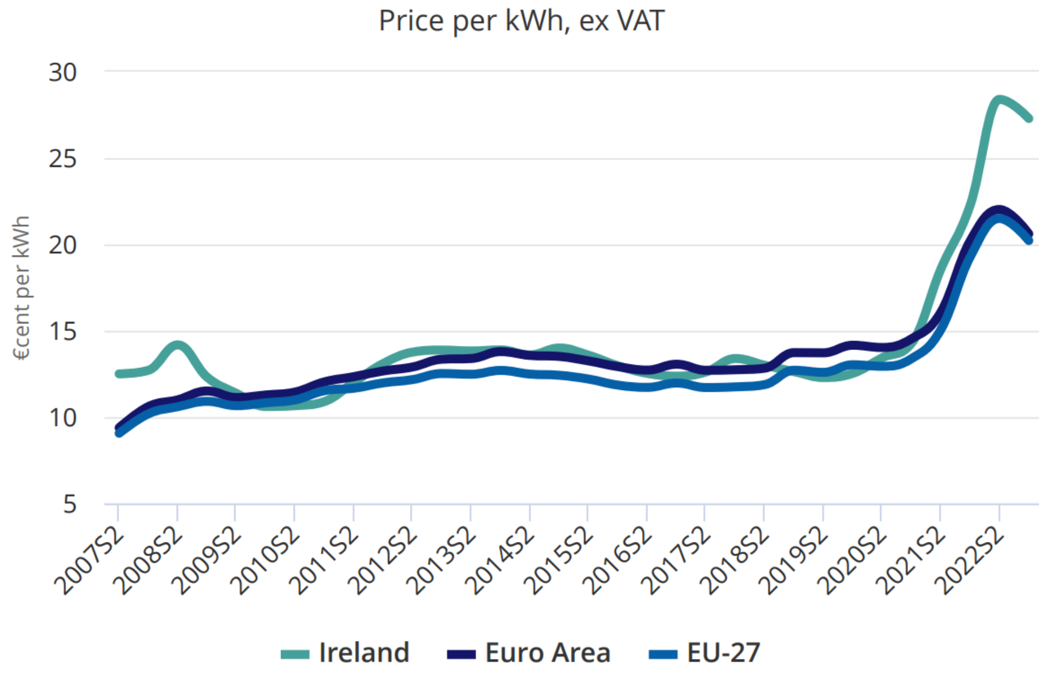
Part L Individual Compliance		10% EPC Improvement	
Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)	Ref Building Primary Energy (kWh/m2/yr)	Required PV (kWh/yr)
45.90	-14318.74	41.31	-7810.22
41.50	-13152.66	37.35	-3528.76
34.38	0.00	30.94	0.00
52.51	-4384.67	47.26	-1902.78
48.03	-3855.62	43.23	0.00
40.78	0.00	36.70	0.00
Estimated PV Required:	0		0
No of PV Required:	0		0

Assumptions All landlord areas are heated

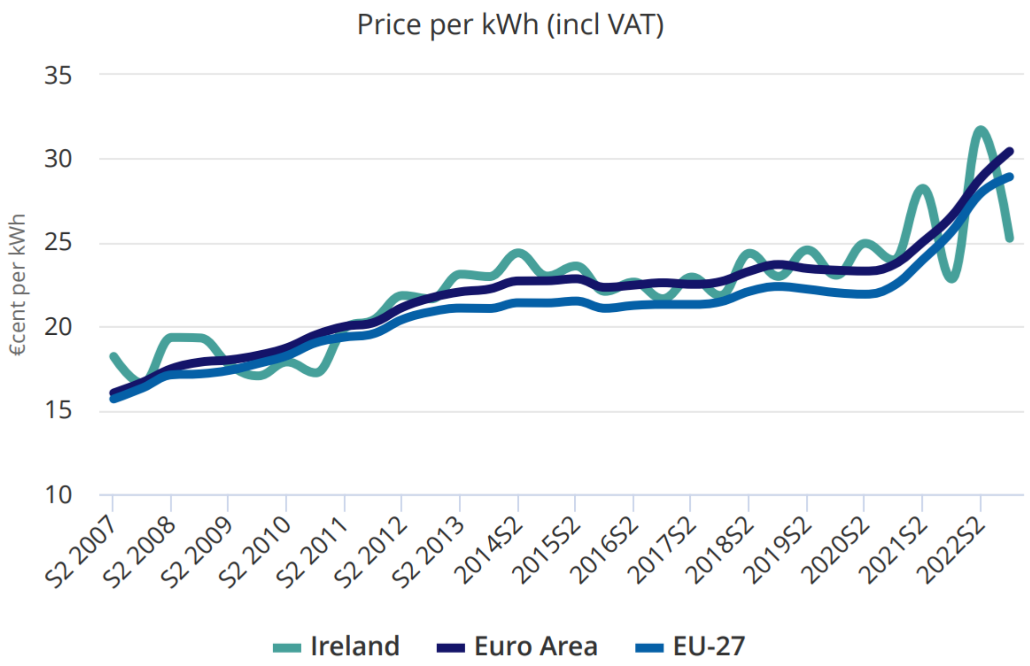
APPENDIX C

AVERAGE FUEL COSTS FOR IRELAND 2024

The Graph below shows the average **commercial** electricity costs trends for Ireland since 2007, there has been a sharp increase in electricity costs over the past 3 years.



The Graph below shows the average **domestic** electricity costs trends for Ireland since 2007, there has been a sharp increase in electricity costs over the past 3 years.



EDC