PROGRESSIVE ENGINEERING

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1	For Information	15/06/2022	T. McDonnell	S. Steele	T. McDonnell
2	For Information	07/09/2022	T. McDonnell	R. O'Farrell	T. McDonnell
3	For Information	10/11/2022	T. McDonnell	R. O'Farrell	T. McDonnell

TABLE OF CONTENTS

APPENDICES

APPENDIX A - CALCULATION ASSUMPTIONS

LIST OF FIGURES

LIST OF TABLES

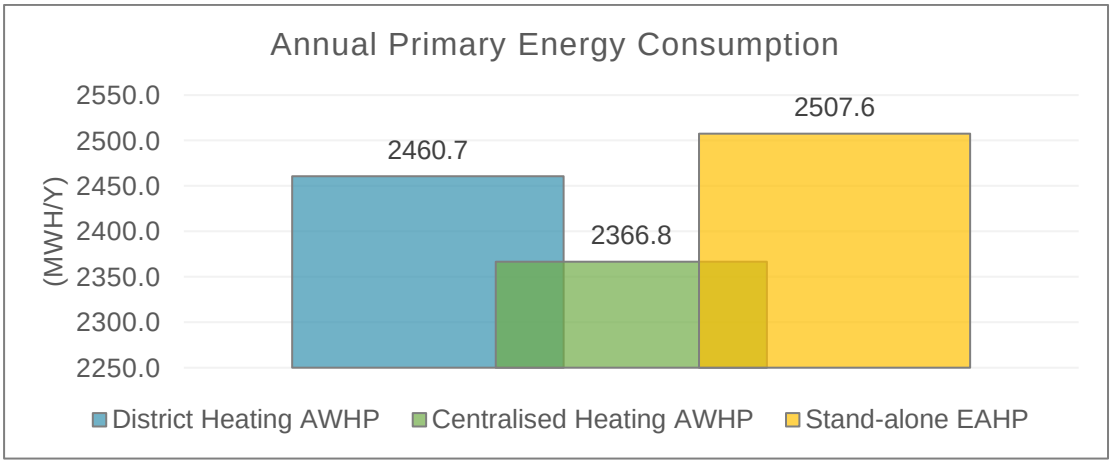
EXECUTIVE SUMMARY

The intention of this report is to provide technical guidance on mechanical strategy options for the Sandy Road Masterplan located in Galway. This revision was updated to include a centralised heating system per apartment block.

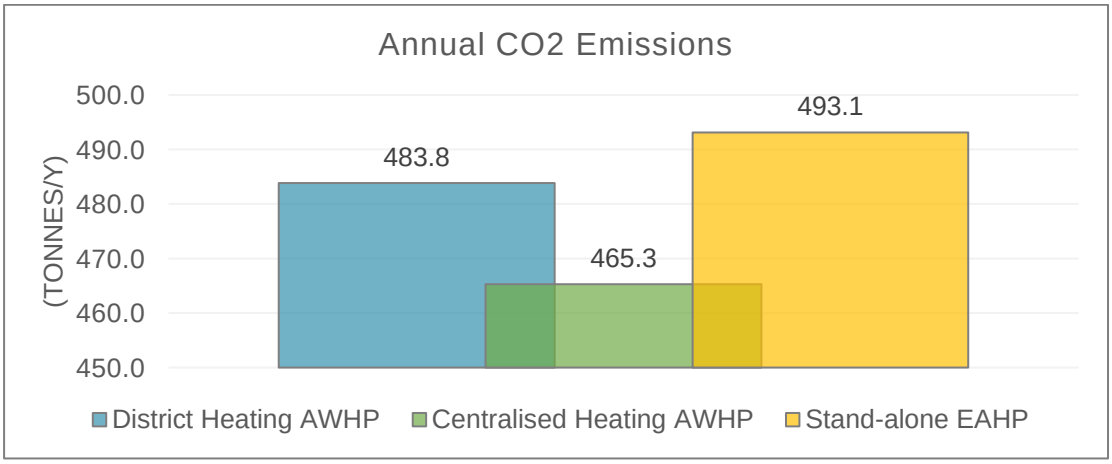
The following guidance provides a comparison of a district heating system, centralised heating system and a standalone exhaust air heat pump system. The district heating system will be made up of air-water heat pumps, it will provide space and water heating to multiple apartment blocks from a remote energy centre. The centralised heating system will be made up of air-water heat pumps, it will provide space and water heating to a single apartment block from a centralised location within that block. The standalone exhaust air heat pump will provide space and water heating to each individual apartment. This report does not deal with building fabric u-values, air-permeability, thermal bridging, or any other Part L requirements.

The DEAP calculation methodology was used to determine the Primary Energy Consumption, CO2 Emissions, Delivered Energy and Annual Running Costs for typical apartment types. The same parameters were then calculated for the total number of apartments in the development. The following findings were made when comparing each system for the development.

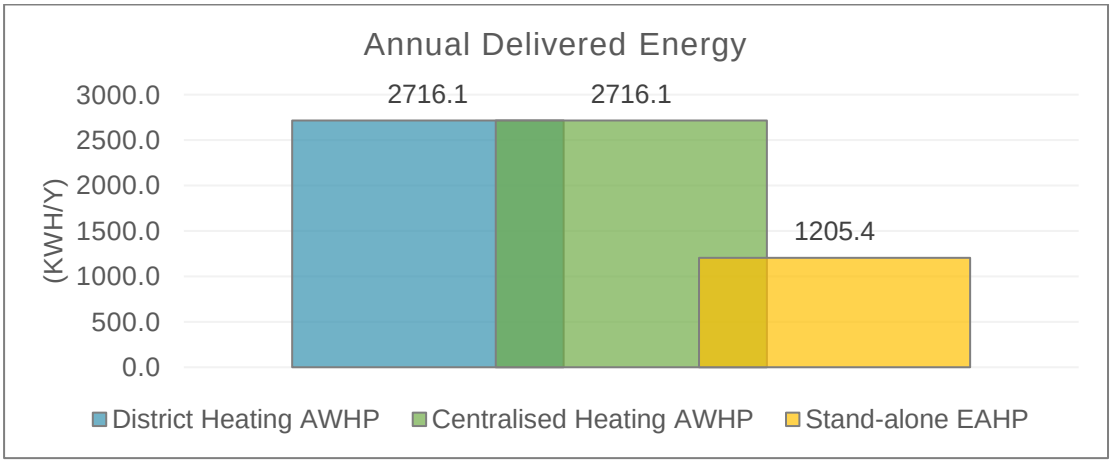
- Primary Energy Consumption is estimated to be **1.9% less** if a district heating scheme is installed and **5.6% less** if a centralised heating system is installed when compared to a stand-alone system.



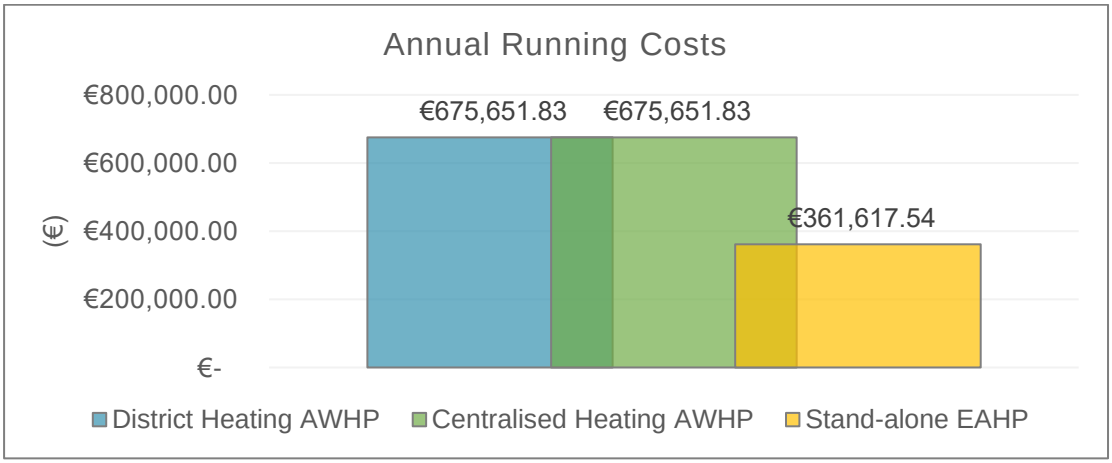
- CO2 Emissions are estimated to be **1.9% less** if a district heating scheme is installed and **5.6% less** if a centralised heating system is installed when compared to a stand-alone system.



- Delivered Energy Consumption is estimated to be **55.6% less** if stand-alone EAHP systems are installed when compared to district heating and centralised heating systems. District and centralised heating systems consume the same amount of energy within the dwelling. As discussed in Section 3.2 above, DH systems consume more primary energy as they have additional primary circuit losses. Delivered energy is the energy the end-user/tenant will be consuming. It is much less than the primary energy as they used different conversion factors. The EAHP is also much more efficient than a typical district heating system.



- Annual Running Costs are estimated to be **46.5% less** if stand-alone EAHP systems are installed when compared to district heating and centralised heating systems. This has reduced from the delivered energy as the district heating system would be charged a commercial rate for electricity, this is lower than domestic electricity prices.



1 INTRODUCTION

The intention of this report is to provide technical guidance on three principle mechanical strategies for the Sandy Road Masterplan located in Galway.

The following guidance provides a comparison of a District Heating Scheme (DH), Centralised Heating Systems (CH) and a Stand-alone Exhaust Air-Water Heat Pump (EAHP) system. This report does not deal with building fabric u-values, air-permeability, thermal bridging, or any other Part L requirements.

Figure 1 below shows an overview of the proposed development.

Figure 1 - Proposed Development

2 OVERVIEW OF SYSTEMS

Description of both systems are outlined below.

2.1 District Heating (ASHP)

The DH scheme 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 central location to reduce distribution losses. The renewable energy requirements set out in TGD Part L 2021, are expected to be met in all unit types with this type of system. Fossil fuels have been excluded in this study.

Figure 2 below shows a typical flow diagram of a DH system in a multi-building development. Figure 3 below shows a typical flow diagram for a multi dwelling building.

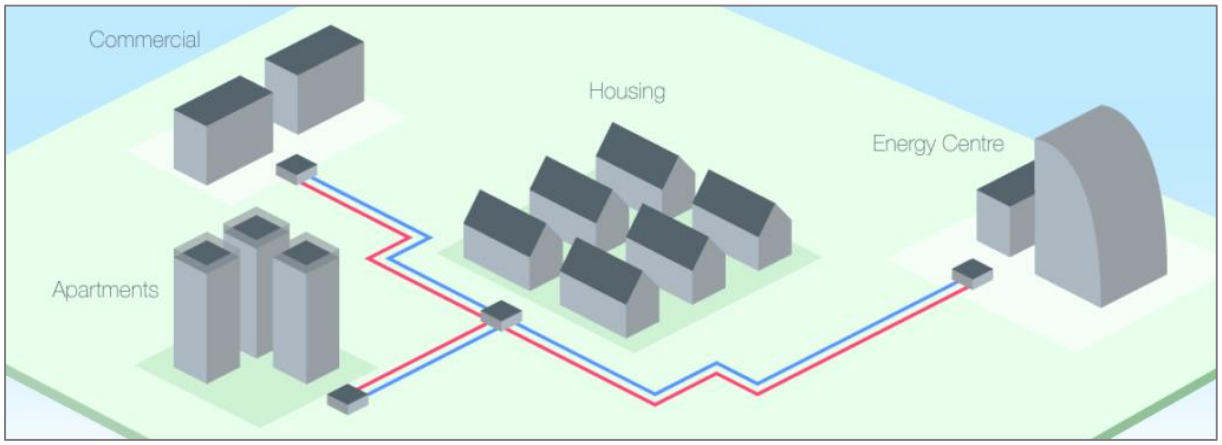


Figure 2 - District heating flow diagram (overview)

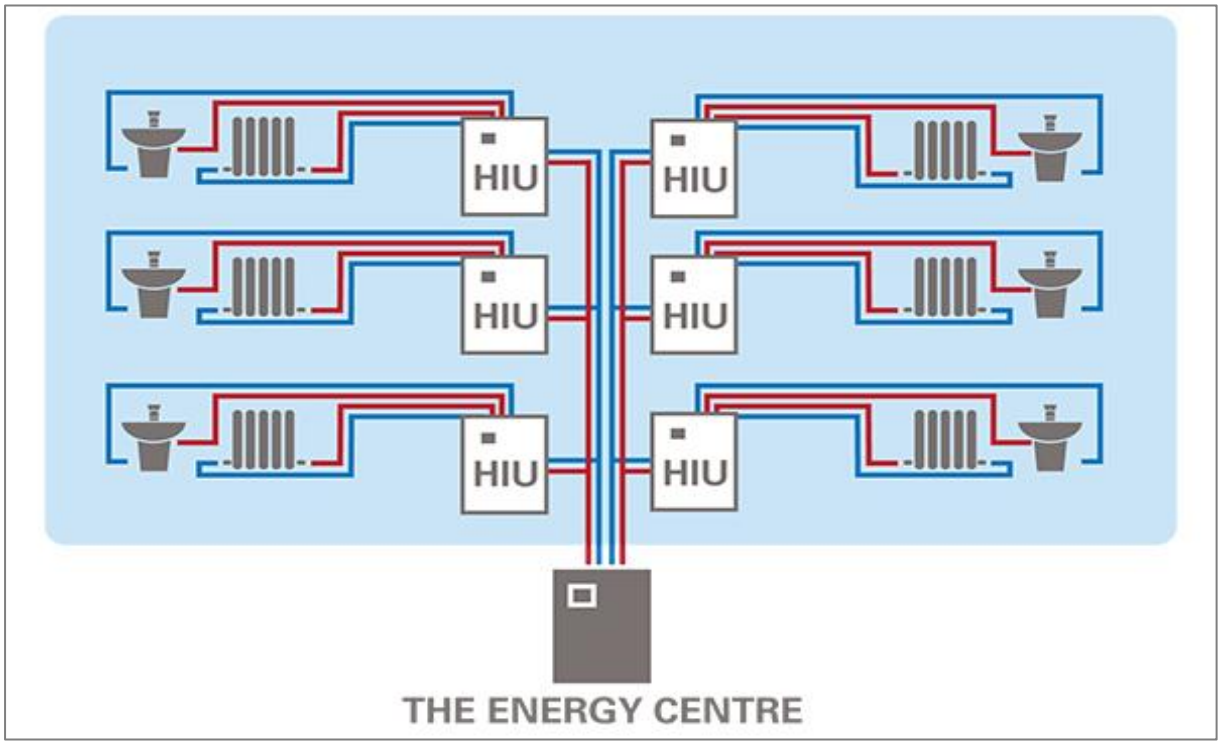


Figure 3 - Typical district heating flow diagram for multi dwelling building

Figure 4 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.

Typical service cupboard spatial requirements for a DH scheme and MVHR unit is 0.9m x 1.4m. Figure 1 below shows a typical arrangement.

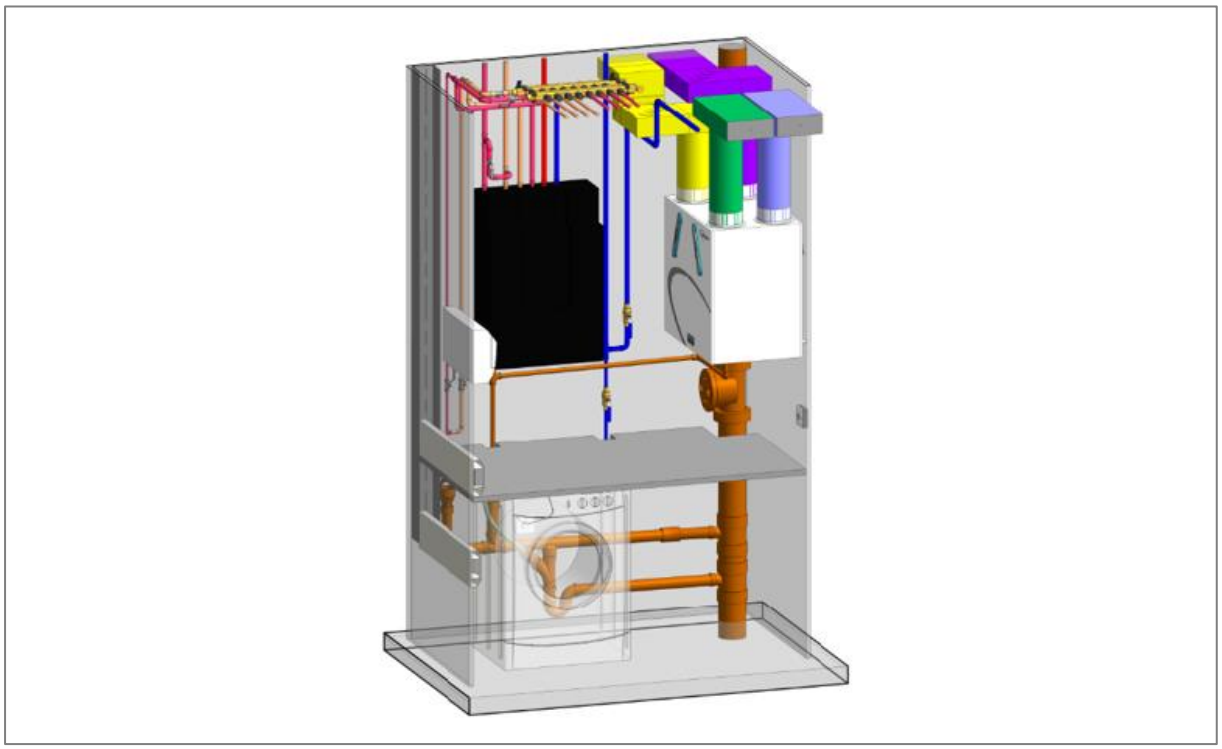


Figure 4 - DH and MVHR Service Cupboard

2.1.1 How it works

- The DH system is heated by the Central Air-Water Heat Pumps.
- 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 DH 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.

2.1.2 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 DH 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.

2.1.3 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.
- Management/third party company must manage and maintain the system, implement billing system, and collect monies.
- The system is constantly circulating hot water which is costly and inefficient.
- The extensive pipework network can add to the energy losses.
- 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.

2.2 Centralised Heating (ASHP)

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, most likely the roof. The renewable energy requirements set out in TGD Part L 2021, 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 2.1. 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 3 and 4 above.

2.2.1 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 DH 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.

2.2.2 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.

2.2.3 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.

2.3 Stand-alone Exhaust Air Heat Pump system

An EAHP can provide over 100% of the space and water heating requirements of a well-insulated apartment in some of the coldest conditions and when working efficiently can reduce a home's energy consumption by up to 50%.

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

EAHPs 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 CO2 emissions.

Figure 5 below shows a typical flow diagram for an EAHP system.

Figure 5 – Typical EAHP flow diagram

Figure 2 below shows 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 1.5m, 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 6 - EAHP Service Cupboard

2.3.1 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.

2.3.2 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 systems, energy is recycled from apartment.
- Produces less CO2 Emissions than a DH 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.
- Annual end-user energy consumption is much less than DH systems.

2.3.3 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 ENERGY, CO2 EMISSIONS & RUNNING COSTS

To compare each system (like for like), The DEAP calculation methodology was used to conducted building energy rating calculations on a typical 1, 2 and 3 bed apartments. Three calculations were conducted for each apartment with the space heating, water heating and ventilation systems were changed in each apartment type, all other parameters were not changed, such as building fabric, lighting, number of showers etc.

The calculations were conducted at apartment 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 1 below show the floor areas and proposed quantity of apartments in the development.

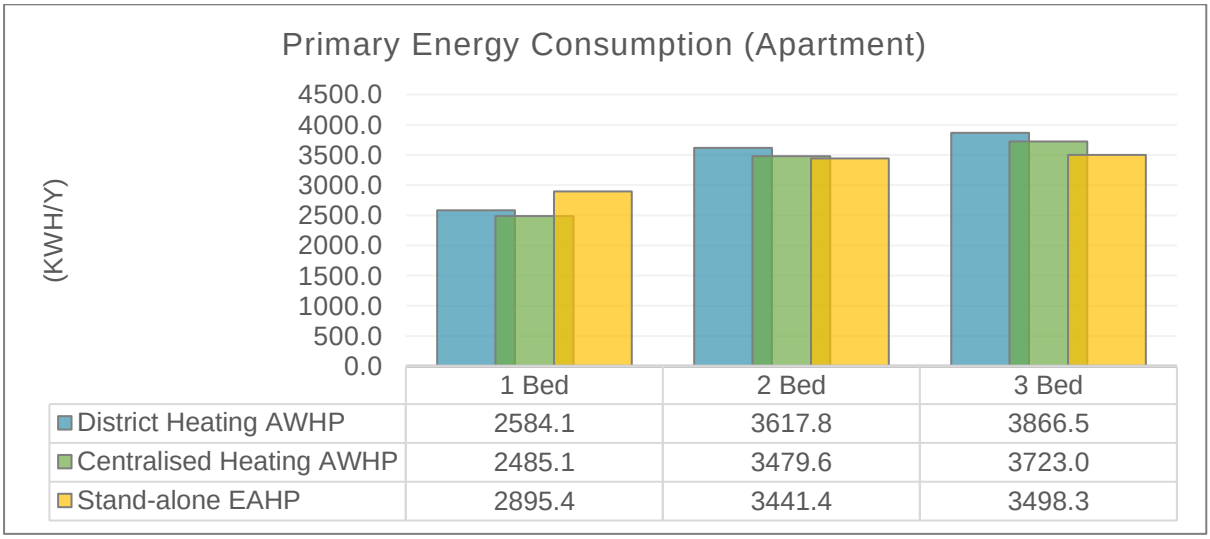
Table 1: Typical Apartment Details

Typical Apartments		
Type	**Average Floor Area (m2)**	**Quantity of Apartments in Development**
1 Bed	53.5	397
2 Bed	79.46	356
3 Bed	98.99	38

3.2 Primary Energy Consumption

A comparison of the primary energy consumption of each apartment type can be seen in Figure 7 below. The results have determined the following.

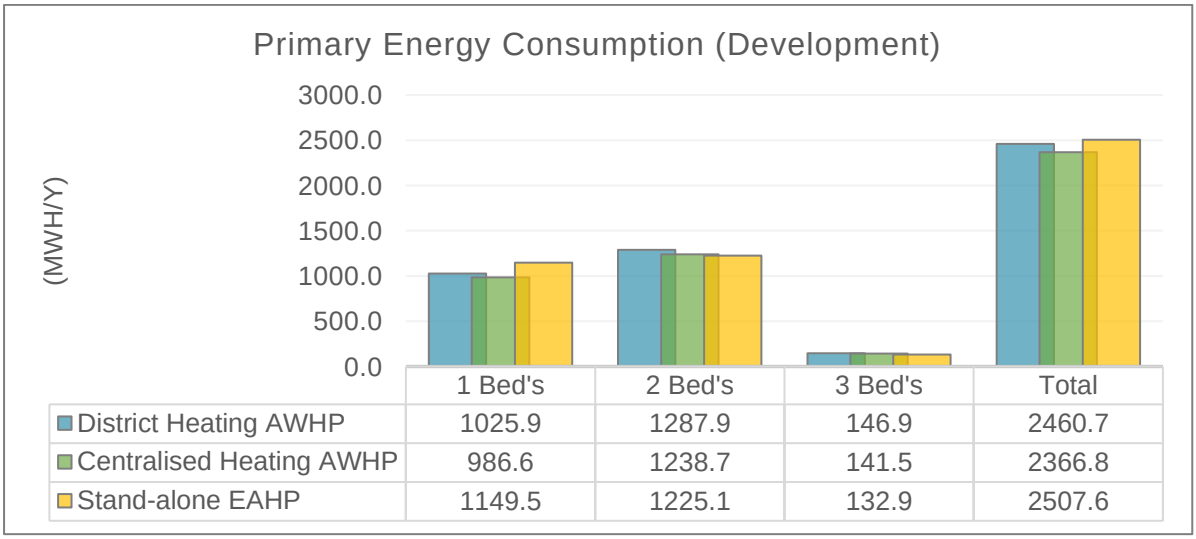
- 1-bed apartments will consume **10.8% less** primary energy with a district heating system, and **14.2% less** with a centralised heating system.
- 2-bed apartments will consume **5.1% more** primary energy with a district heating system, and **1.1% more** with a centralised heating system.
- 3-bed apartments will consume **10.5% more** primary energy with a district heating system, and **6.4% more** with a centralised heating system.



	1 Bed	2 Bed	3 Bed
District Heating AWHP	2584.1	3617.8	3866.5
Centralised Heating AWHP	2485.1	3479.6	3723.0
Stand-alone EAHP	2895.4	3441.4	3498.3

Figure 7 - Primary Energy Consumption (Apartment)

When we look at the above findings across all apartments in the development as outlined in Table 1, it shows a district heating system will consume **1.9% less** primary energy, and a centralised heating system will consume **5.6% less** primary energy overall. Please refer to Figure 8 below.



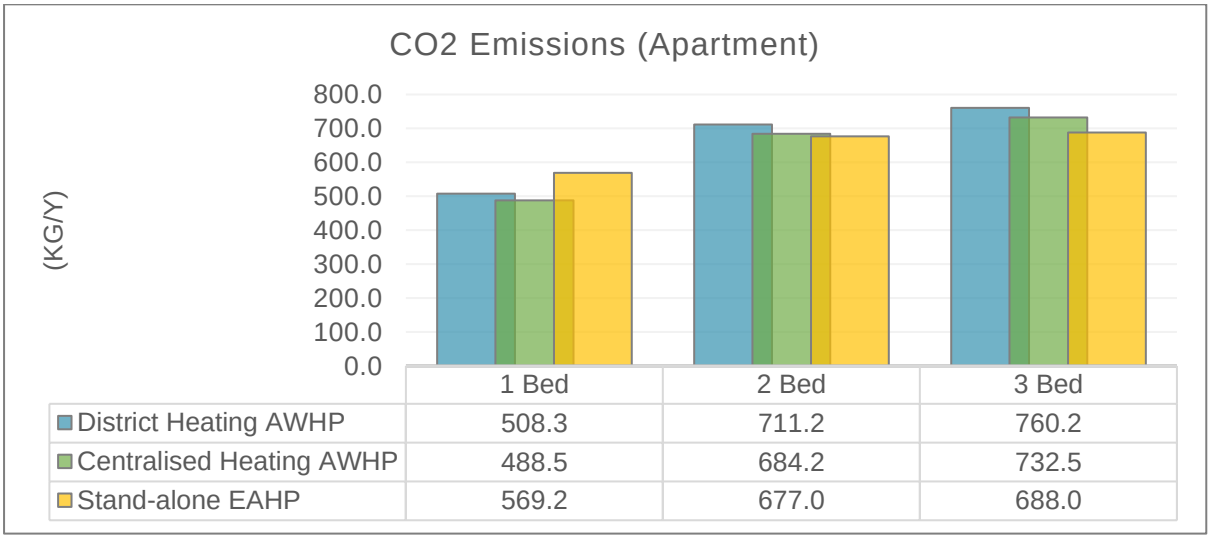
	1 Bed's	2 Bed's	3 Bed's	Total
District Heating AWHP	1025.9	1287.9	146.9	2460.7
Centralised Heating AWHP	986.6	1238.7	141.5	2366.8
Stand-alone EAHP	1149.5	1225.1	132.9	2507.6

Figure 8 - Primary Energy Consumption (Development)

3.3 CO2 Emissions

A comparison of the CO2 Emissions for each apartment type can be seen in Figure 9 below. The results have determined the following.

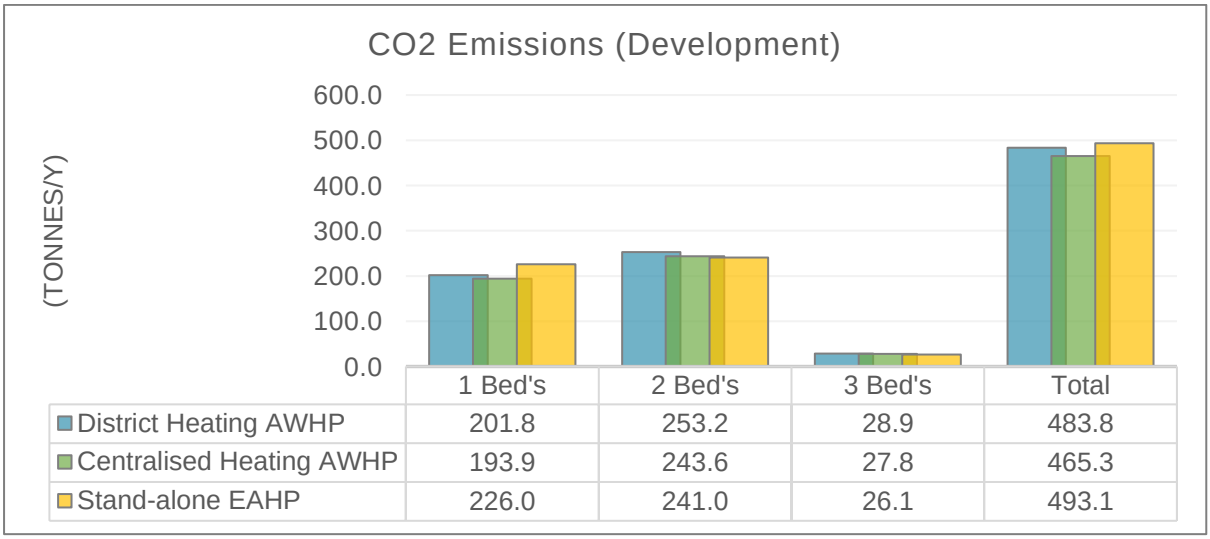
- 1-bed apartments will produce **10.7% less** CO2 emissions with a district heating system, and **14.2% less** with a centralised system.
- 2-bed apartments will produce **5.0% more** CO2 emissions with a district heating system, and **1.1% more** with a centralised system.
- 3-bed apartments will produce **10.5% more** CO2 emissions with a district heating system, and **6.5% more** with a centralised heating system.



	1 Bed	2 Bed	3 Bed
District Heating AWHP	508.3	711.2	760.2
Centralised Heating AWHP	488.5	684.2	732.5
Stand-alone EAHP	569.2	677.0	688.0

Figure 9 - CO2 Emissions (Apartment)

When we look at the above findings across all apartments in the development as outlined in Table 1, it shows a district heating system will produce **1.9% less** CO2 emissions, and a centralised heating system will produce **5.6% less** CO2 emission overall. Please refer to Figure 10 below.



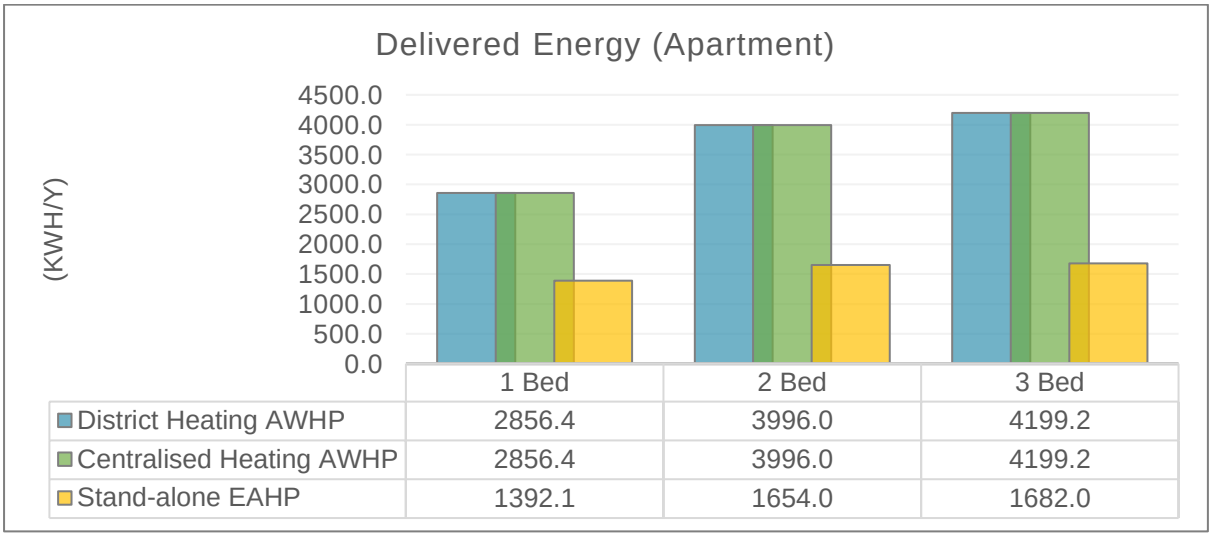
	1 Bed's	2 Bed's	3 Bed's	Total
District Heating AWHP	201.8	253.2	28.9	483.8
Centralised Heating AWHP	193.9	243.6	27.8	465.3
Stand-alone EAHP	226.0	241.0	26.1	493.1

Figure 10 - CO2 Emissions (Development)

3.4 Delivered Energy

A comparison of the delivered energy consumed by each apartment can be seen in Figure 11 below. District and centralised heating systems consume the same amount of energy within the dwelling. As discussed in Section 3.2 above, DH systems consume more primary energy as they have additional primary circuit losses. The results have determined the following.

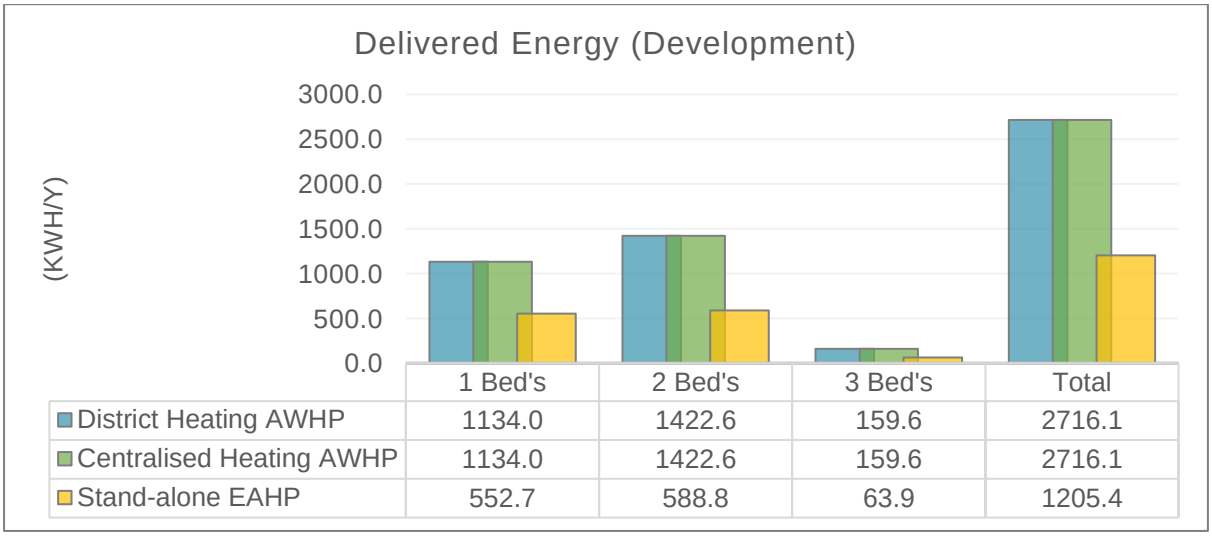
- 1-bed apartments consume **51.3% less** energy with a standalone EAHP system.
- 2-bed apartments consume **58.6% less** energy with a standalone EAHP system.
- 3-bed apartments consume **59.9% less** energy with a standalone EAHP system.



	1 Bed	2 Bed	3 Bed
District Heating AWHP	2856.4	3996.0	4199.2
Centralised Heating AWHP	2856.4	3996.0	4199.2
Stand-alone EAHP	1392.1	1654.0	1682.0

Figure 11 - Delivered Energy (Apartment)

When we look at the above findings across all apartments in the development as outlined in Table 1, it shows a standalone EAHP system will consume **55.6% less** energy overall. Please refer to Figure 12 below.



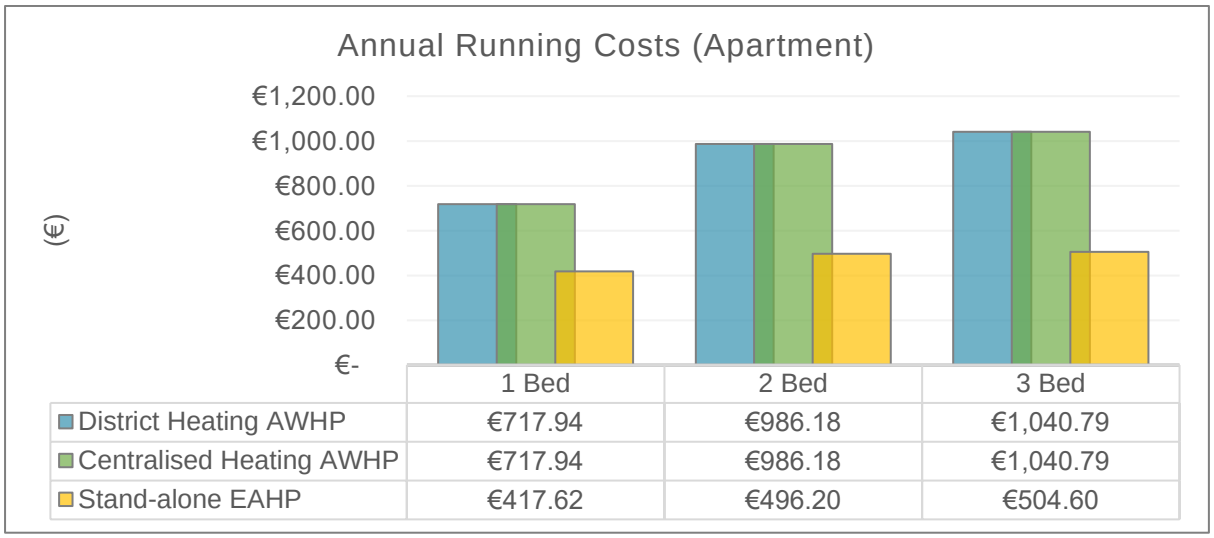
	1 Bed's	2 Bed's	3 Bed's	Total
District Heating AWHP	1134.0	1422.6	159.6	2716.1
Centralised Heating AWHP	1134.0	1422.6	159.6	2716.1
Stand-alone EAHP	552.7	588.8	63.9	1205.4

Figure 12 - Delivered Energy (Development)

3.5 Annual Runnings Costs (Estimate)

A comparison of the estimated annual running costs for each apartment can be seen in Figure 13 below. District and centralised heating systems consume the same about of energy within the dwelling, resulting in the same annual running costs. The results have determined the following.

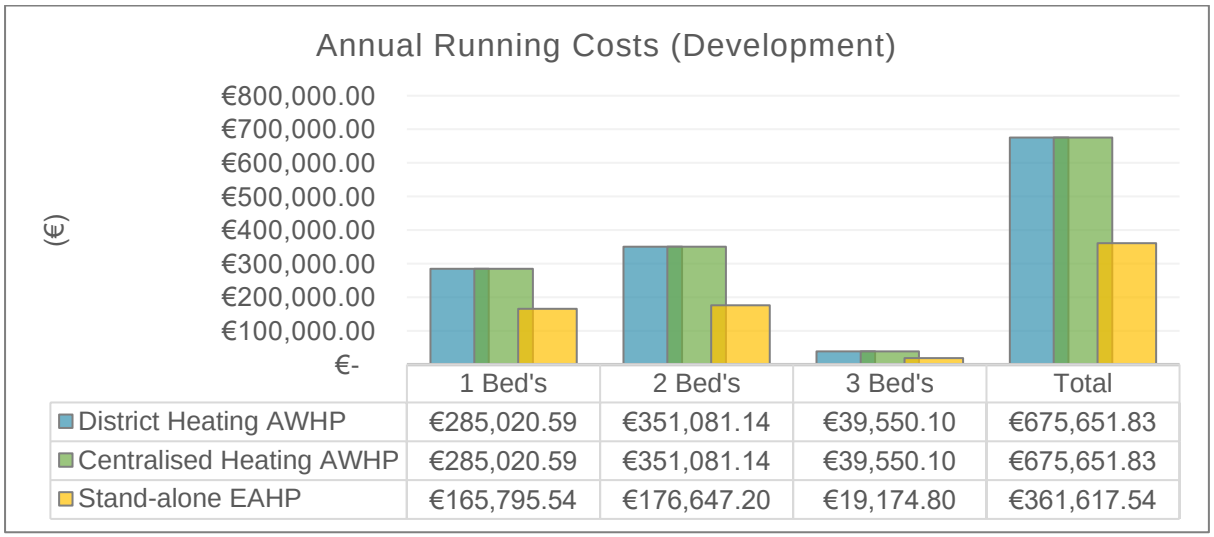
- 1-bed apartments will cost **41.8% less** annually with a standalone EAHP system.
- 2-bed apartments will cost **49.7% less** annually with a standalone EAHP system.
- 3-bed apartments will cost **51.5% less** annually with a standalone EAHP system.



	1 Bed	2 Bed	3 Bed
District Heating AWHP	€717.94	€986.18	€1,040.79
Centralised Heating AWHP	€717.94	€986.18	€1,040.79
Stand-alone EAHP	€417.62	€496.20	€504.60

Figure 13 - Annual Running Costs (Apartment)

When we look at the above findings across all apartments in the development as outlined in Table 1, it shows the estimated annual running costs for the development will be **46.5% less** with standalone EAHP systems. Please refer to Figure 14 below.



	1 Bed's	2 Bed's	3 Bed's	Total
District Heating AWHP	€285,020.59	€351,081.14	€39,550.10	€675,651.83
Centralised Heating AWHP	€285,020.59	€351,081.14	€39,550.10	€675,651.83
Stand-alone EAHP	€165,795.54	€176,647.20	€19,174.80	€361,617.54

Figure 14 - Annual Running Costs (Development)

4 CONCLUSION

The DEAP calculation methodology was used to determine the Primary Energy Consumption, CO2 Emissions, Delivered Energy and Annual Running Costs for typical apartment types. The same parameters were then calculated for the total number of apartments in the development. The following findings were made when comparing each system for the development.

- Primary Energy Consumption is estimated to be **1.9% less** if a district heating scheme is installed and **5.6% less** if a centralised heating system is installed when compared to a stand-alone system.

- CO2 Emissions are estimated to be **1.9% less** if a district heating scheme is installed and **5.6% less** if a centralised heating system is installed when compared to a stand-alone system.

- Delivered Energy Consumption is estimated to be **55.6% less** if stand-alone EAHP systems are installed when compared to district heating and centralised heating systems. District and centralised heating systems consume the same amount of energy within the dwelling. As discussed in Section 3.2 above, DH systems consume more primary energy as they have additional primary circuit losses. Delivered energy is the energy the end-user/tenant will be consuming. It is much less than the primary energy as they used different conversion factors. The EAHP is also much more efficient than a typical district heating system.

- Annual Running Costs are estimated to be **46.5% less** if stand-alone EAHP systems are installed when compared to district heating and centralised heating systems. This has reduced from the delivered energy as the district heating system would be charged a commercial rate for electricity, this is lower than domestic electricity prices.

APPENDIX A

CALCULATION ASSUMPTIONS

1. SEAI Fuel cost comparisons 01 Jul 2022 - Domestic (Band DB). Electricity: € 0.3000
2. SEAI Fuel cost comparisons 01 Jul 2022 - Commercial (Band I2/IB). Electricity: €0.2122 Gas: € 0.0741
3. District heating management fees assumed to be 15% additional to electricity rate. DH unit cost: € 0.2440
4. System distribution losses allowed for in DEAP calculation for District Heating system (distribution loss factor = 1.10)
5. District heating system includes 100% electric Air Source Heat Pumps with an efficiency of 280%.
6. Continuous mechanical extract ventilation included in district/centralised heating calculations.
7. System distribution losses allowed for in DEAP calculation for centralised heating system (distribution loss factor = 1.05)