IN2
ENGINEERING DESIGN PARTNERSHIP

D1861
42A Parkgate Street,
Dublin 8

Energy Analysis Report Planning
Block B2

CONTENTS

1.0 EXECUTIVE SUMMARY

This report outlines the current building regulations framework and the requirement to achieve a Nearly Zero Energy Building(NZEB) for all new developments. The NZEB standard is demonstrated using the Dwelling Energy Assessment Procedure (DEAP) software. The principal energy use associated with residential developments as assessed under DEAP is the domestic hot water to showers, sinks, basins etc. which accounts for over half of the total annual energy consumption for an apartment.

Energy consumption is not the same as energy produced however, this is due to the inefficiencies associated with generation and transmission of electricity. The DEAP software therefore analyses Primary Energy use which is a measure of the total energy required to deliver the energy consumed. This multiplier factor in Ireland is 2.08 for Electricity and 1.1 for Natural Gas.

NZEB includes a requirement for on-site renewable technology, considered suitable for Parkgate Street are Heat Pumps and PV panels each of which are examined in detail.

The table below summarises the results of our proposed heating strategy which could be considered suitable for the Parkgate Street development

Although all options perform well with low associated CO_2 emissions the centralised solution is the optimal whole life cycle cost solution. The remaining units in the Parkgate street scheme already have approved planning for a Centralised Heating system utilising Gas Boilers & Air Source Heat pump. We therefore recommend maintaining this strategy for the Parkgate Street B2 Block of apartments.

	Heating Strategy	PV panels Required for NZEB	Annual CO_2 Emisssions Per Apartment
	Centralisd Gas Boiler & Air Source Heat Pump	0.0	650 kg

2.0 BUILDING REGULATIONS

2.1 NZEB

Building energy has been long understood as contributing a major component of greenhouse gas emissions which was acknowledged within the 2030 Communication published by the European Commission (2014) which stated that "the majority of the energy-saving potential (for the EU) is in the building sector." Figure 2.1.1 illustrates comparative Primary Energy (see Section 3.3) for Dwellings in Ireland from 1970's through to NZEB,

The EU Energy Performance of Buildings Directive set out the target that all *new* developments should be Nearly Zero-Energy Buildings (NZEB) by the end of 2020, with the intention having been that all Public buildings be in accordance with this by the end of 2018.

A Nearly-Zero Energy Building is defined as having "very high energy performance", with Article 2 of the EPBD outlining that "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 produced on-site or nearby"; the latter understood to refer to district heating systems and centralised plant arrangements.

Interpretation and implantation of these statements within the directive are at the discretion of each EU Member State in accordance with their "National, Regional or Local considerations" and thus the definition of NZEB itself varies greatly between different countries.

For new dwellings in Ireland, NZEB has been defined was being (primarily) associated with demonstrating the following characteristics are achieved:

- Primary Energy/ Carbon Emissions: 70% reduction against Part L 2005
- Renewable Energy: 20% of this Primary Energy required

Figure 2.1.2 illustrates the NZEB targets for Primary Energy (and Carbon Emissions) and Renewable Energy. The Part L 2005 benchmark could be expected to be achieving a B3 BER, in comparison to A2/A3 for NZEB compliance.

These NZEB targets have been now incorporated within the Technical Guidance Document (TGD) Part L 2019, as discussed below.

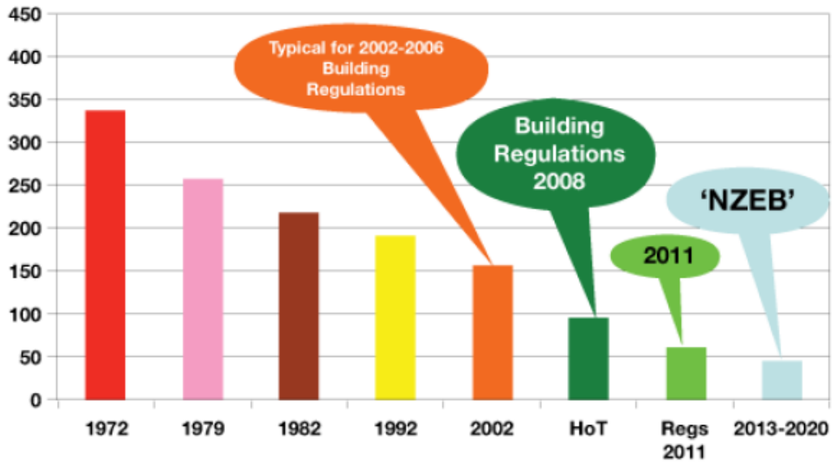


Figure 2.1.1 - Primary Energy Consumption in Irish Housing 1972-2020

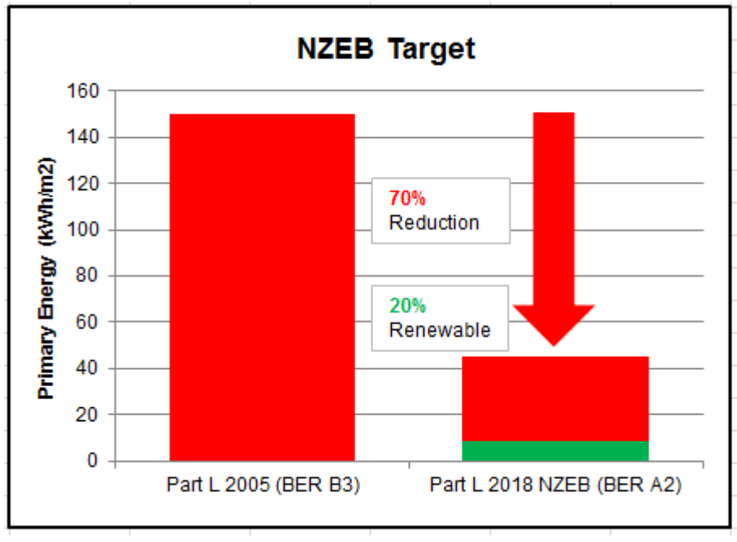


Figure 2.1.2 - NZEB Targets

2.0 BUILDING REGULATIONS

2.2 Part L 2019

Technical Guidance Document (TGD) Part L Conservation of Fuel and Energy – Dwellings outlines how compliance to this element of the Building Regulations can be demonstrated through the utilisation of the Dwelling Energy Assessment Procedure (DEAP) software, which analyses comparative energy usage for a particular residence.

The energy assessment is determined annually on a floor area basis (kWh/m^2.ann) for the following usages, known as "regulated loads":

- Heating
- Hot Water
- Auxiliary (Fans, Pumps and Controls)
- Lighting

It may be noted therefore that considerable energy usages within dwellings; particularly equipment associated with cooking, washing etc. are excluded from DEAP analysis and associated Part L Compliance/ BER calculations. These energy usages, known as "unregulated loads" are deemed to be associated with *operational* usage, as opposed to the building's fabric and services performance.

Figure 2.2 indicates an energy breakdown for a typical apartment (100m^2, local gas-fired boiler) compliant to NZEB/ Part L 2018. It can be seen that Hot Water Energy consumption pre-dominates, with Heating Energy considerably lower; reflective of the extensive improvement in insulation/ air permeability/ thermal bridging/ glazing/ heating system efficiency etc. through successive Building Regulations improvements.

However, as both Hot Water and Lighting Energy consumption are effectively fixed within the calculation methodology (as based on standardised databases of hot water usage etc.), further improvements to Heating related items (insulation etc.) are generally required to ensure overall compliance can be achieved.

In addition, minimum Fabric Performance is defined as follows in Part L 2019:

<u>Thermal Transmittance (U-Values)</u>

- Roofs: 0.16 W/m^{2}K
- External Walls: 0.18 W/m^{2}K
- Ground/ Exposed Floors: 0.18 W/m^{2}K
- Windows/ Doors/ Rooflights: 1.40 W/m^{2}K

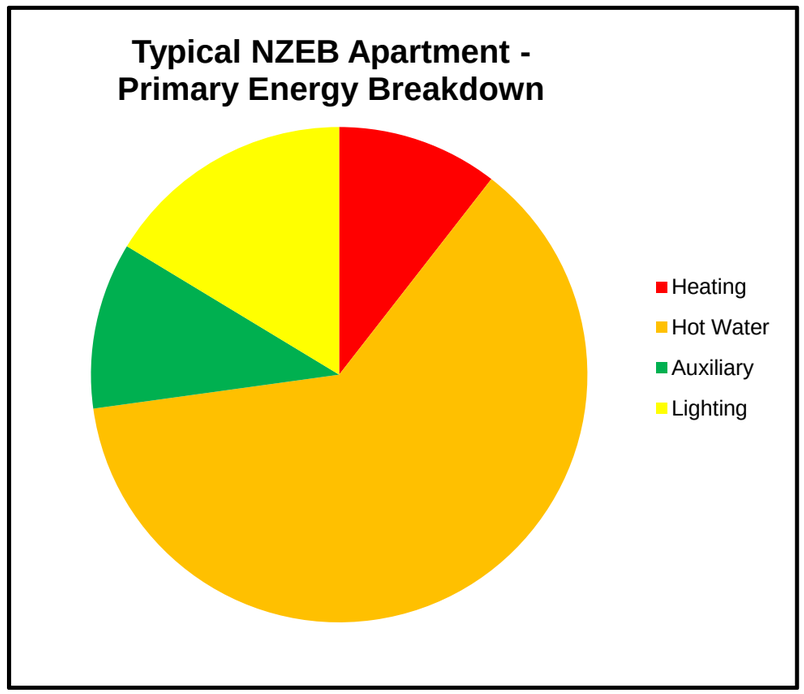


Figure 2.2 -Energy Breakdown

2.0 BUILDING REGULATIONS

2.2 Part L 2019 (Cont'd)

Air Permeability

- Maximum Air Leakage: 3 $m^3/hr.m^2$ @ 50Pa

In terms of apartments or other terraced residential buildings, Part L allows that the compliance can be demonstrated based on the *average* of all dwellings for each of the parameters associated with Part L, namely Primary Energy (EPC), Carbon Emissions (CPC) and Renewable Energy (RER). Therefore, for the purposes of analysis, an apartment representative of the average attributes of the dwellings has been selected.

In summary, DEAP analysis must demonstrate the following to ensure compliance to Part L 2019:

- Energy Performance Coefficient (EPC): 0.30 or lower (i.e. 70% reduction in Primary Energy against Part L 2005 benchmark)
- Carbon Performance Coefficient (CPC): 0.35 or lower
- Renewable Energy Ratio (RER): 0.20

2.0 BUILDING REGULATIONS

2.3 Primary Energy

In assessing energy performance for dwellings, Part L (and BER) utilises *Primary Energy* as a means of comparative analysis. This relates to the energy *at source* as required for the dwelling, as opposed to that consumed within the actual building. For example, electrical Primary Energy relates to that required for both generation (based on average of power plant fuels and efficiencies) and transmission for electricity through the ESB grid.

Primary Energy Factor (PEF) conversions for main fuel types are as follows:

- Electricity: 1.83
- Natural Gas/ LPG/ Oil/ Biomass: 1.10

It can be seen from the above that the Primary Energy conversion for Electricity is twice that of Natural Gas (as well as other fossil fuels and biomass); therefore a direct electric heater would consume double the Primary Energy of a LPHW radiator. However, as can be seen from Figure 2.3, the underlying trend over time has been that the Primary Energy of electricity with respect to Natural Gas (and other fuels) has been reducing (due to the increased "greening" of the ESB grid with Wind and Solar renewables and more efficient plant operation), with the following impacts in terms of technologies and associated Part L compliance, as PEF for electricity reduces.

- Heat Pump, both Air Source and Geothermal, are becoming increasingly viable.
- Natural Gas Combined Heat and Power (CHP) is becoming less viable.
- Larger Photovoltaic (PV) arrays required to offset electricity usage (albeit offset by increases in PV efficiency for equivalent array sizes).

The associated Carbon Factors for main fuel types in Ireland are as follows:

- Electricity: 330.4 gCO_2/kWh
- Natural Gas: 203 gCO_2/kWh

The Carbon Factors associated with Electricity have fallen by approximately 26% in Ireland over recent years (from 635 gCO2/kWh in 2005) as renewable technologies are added to the grid however the reliance on natural gas, peat and coal ensures electricity remains a relatively significant source of carbon emissions.

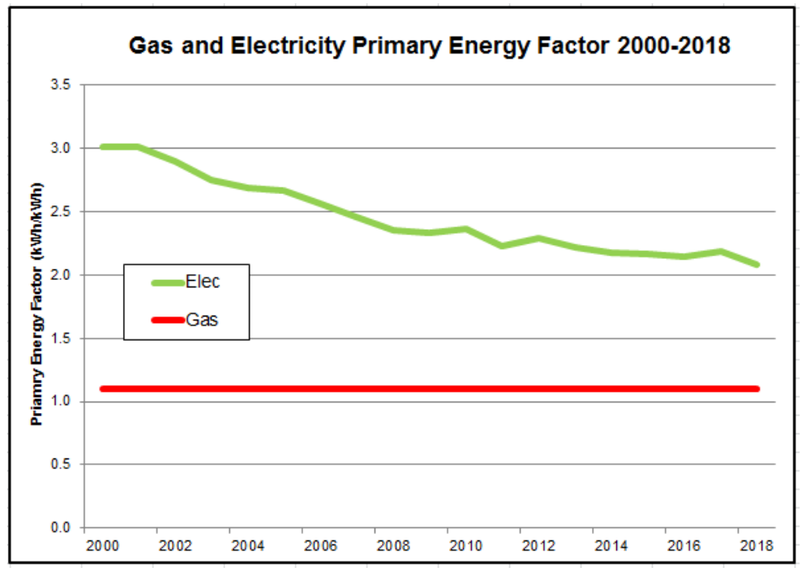


Figure 2.3 -Primary Energy Factors for Gas and Electricity 2000-2018

2.0 BUILDING REGULATIONS

2.4 Renewable Technologies

In addition to improving heating energy related aspects, renewable technologies can be utilised to significantly reduce Primary Energy requirements (in addition to ensuring the RER renewable energy percentage is achieved). Figure 2.2.2 indicates how, for a typical apartment (notional 100m², gas boiler plant) designed to ensure NZEB compliance, 4 no. (250W) PV panels would offset the excess energy within the gross consumption. This extent of renewable energy must be at least 20% of the overall Primary Energy (RER =0.20+).

With regards to renewable energy technology types, the most effective for integration within apartment design to ensure compliance to Part L in a cost-effective manner are as follows:

- Air Source Heat Pumps (ASHP)

  Reduces Primary Energy associated with both Heating and Hot Water compared to gas boilers. Can be implemented on either a centralised or decentralised basis (see Section 2.5 below). The project will target Heat Pump efficiencies(seasonal CoP) of 450%.

  All three options considered for the Parkgate Street development rely on Air Source Heat Pump technology. Both decentralised solutions include heat pumps within the apartment while the centralised option includes a basement level heat pump with boiler back up.

- Combined Heat and Power (CHP)

  Offsets Primary Energy associated with Hot Water (and potentially some Heating) where used in conjunction with centralised plant/ district heating. Viable for larger (300+ unit) apartment developments where larger, higher efficiency units can be deployed.

  May also be considered in tandem with a central air source heat pump where the electricity generated by the CHP powers the heat pump delivering further savings. This strategy, although complex to implement, delivers lower running costs than a central heat pump only option.

- Photovoltaics (PV)

  Offsets Primary Energy associated with Electricity. Most cost-effective where installed as part of Centralised plant arrangement, with single array interlinked to Landlord electricity supply (as opposed to individual units).

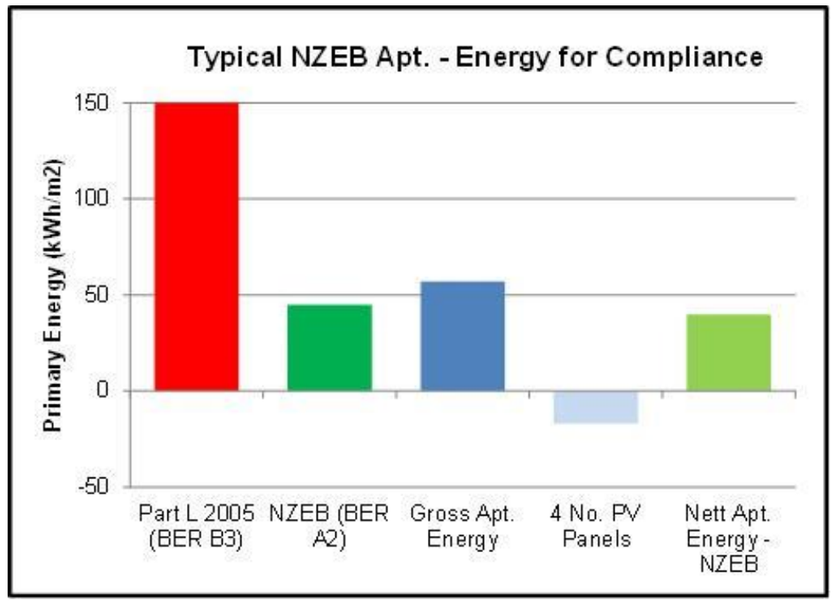


Figure 2.4 -EPC Compliance for Typical Apartment

3.0 ENERGY ANALYSIS

We have completed detailed analysis based on the proposed heating strategy for the Parkgate Street residential elements. The detailed results of this analysis are contained within the attached appendices. The analysis was completed using the building control approved Dwelling Energy Assessment Procedure (DEAP) software administered by Sustainable Energy Authority Ireland (SEAI) of behalf of the Department of Housing, Planning and Local Government.

3.1 Building Construction

A full floor of the tower building and a west and an east facing apartment from blocks B1/B2 were selected for the purposes of analysis with a small element of exposed floor and roof allowed for to simulate the whole block average. The following building performance was assumed for analysis, in terms of Thermal Transmittance, Glazing Parameters, Air Permeability and Thermal Bridging respectively:

Thermal Transmittance (U-Values)

- Roofs: 0.12 W/m^{2}K
- External Walls: 0.18 W/m^{2}K
- Ground/ Exposed Floors: 0.12 W/m^{2}K
- Windows/ Doors/ Rooflights: 1.40 W/m^{2}K

Glazing Parameters

- Total Solar Heat Transmittance: 0.60
- Framing Factor: 0.70
- Overshadowing: Average

Air Permeability

- Air Leakage: 3.0 m^3/hr.m^2 @ 50 Pa

Thermal Bridging

- Heat Transmission Coefficient: 0.08 W/m^{2}K (standard construction details)

Domestic Potable Water Services and Lighting

- Shower Flowrate: 9l/min
- Water usage: 125l/person/day
- Lighting: 100% LED

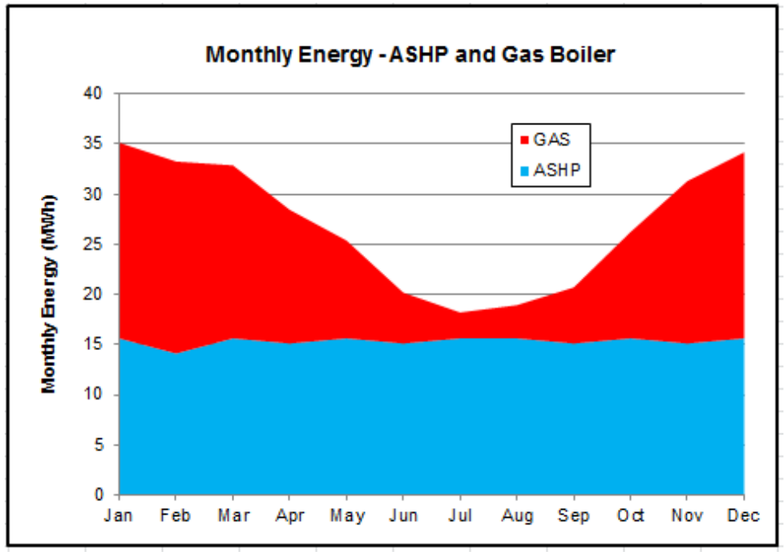


Figure 3.2 – Extent of Heating and Hot Water delivered by ASHP and Gas Boiler

4.0 HEATING STRATEGY

4.1 Centralised Energy Centre / Air Source Heat Pump

The centralised plant solution will receive all heating energy from an Energy Centre located at basement level of Block B&C (Phase I). The central energy centre plant will consist of an Air Source Heat Pump to provide the base heating load to the development, with back-up modulating gas-fired condensing boilers.

LPHW would be distributed throughout the site via buried district heating mains and circulated vertically through a tower core riser to serve apartments above. This riser would include a motorised isolation valve for each apartment at every floor controlled by an automatic metering system. The metering system would provide functionality for a pre-pay or billed heat metering solution and would include for remote isolation of heat to individual apartments.

A ducted heat recovery ventilation unit would be provided to each apartment to maintain air quality while minimising heat losses associated with air infiltration.

All maintenance to the systems would be remote from the Apartment avoiding co-ordination with the tennants for access. Systems would be provided with duty/standby resiliance thorughout to ensure services are maintained to apartments at all times.

Heat billing would be calculated based on metered heat use against system efficiency and gas cost, plus a fixed standing charge and a sinking fund charge for plant replacement.

Sustainability

Under the DEAP methodology for the tower this system will NOT require any PV panels per apartment, as the centralised heat pump will provide the necessary renewable contribution, to achieve NZEB compliance.

The CO_2 emmissions associated with the heating, hot water, ventilation and lighting for a typical Parkgate Street apartment averages **650kg/year**.

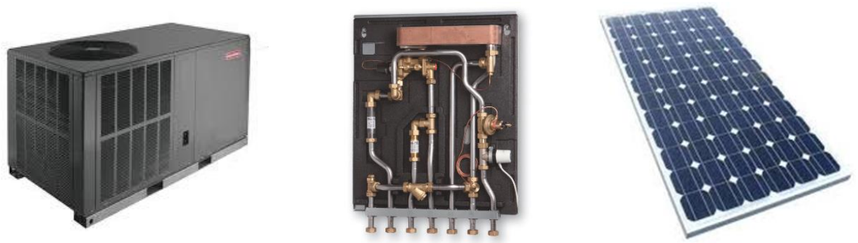


Figure 4.3 – Central Air Source Heat Pump, HIU & PVs

Key Figures (per Apartment)

- PV requirement: **0 panels**
- Annual CO_2 emissions: **650kg**

Pro's

- Sustainable efficient solution – low CO_2 emissions
- Low maintenance
- Reliability – proven technology, commercial standard plant
- Option to include plant replacement sinking fund in heating bills
- Flexibility – potential to add new sustainable technology in future

Con's

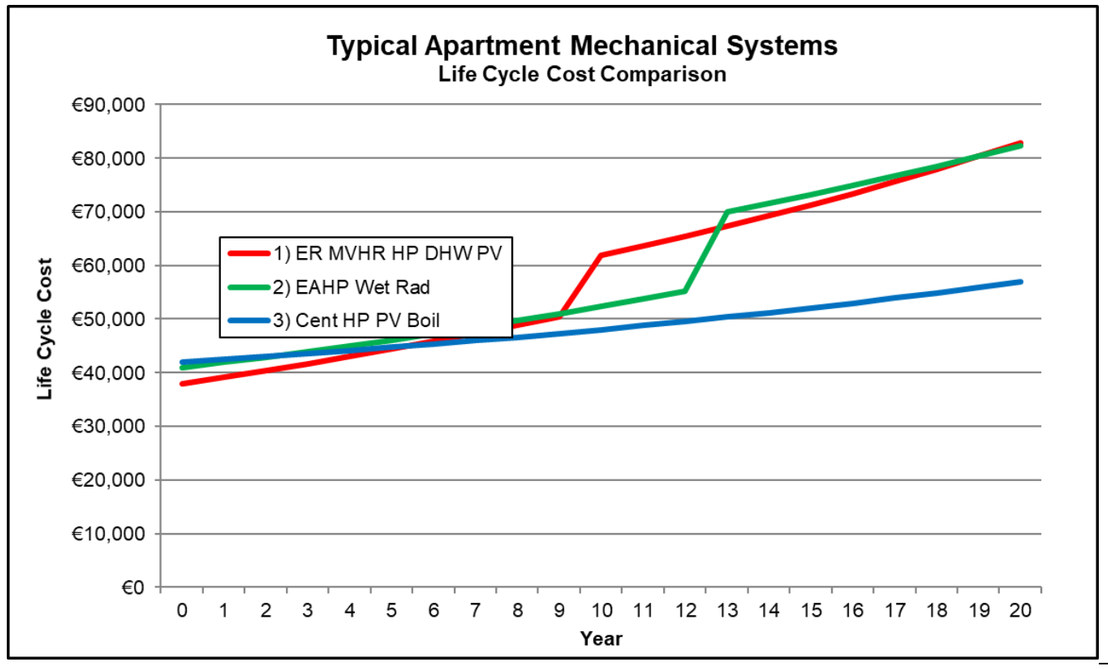
- Higher capital cost when compared to decentralised heat pump
- Requires energy manager to maintain plant and equipment, procure fuel and bill tenants.

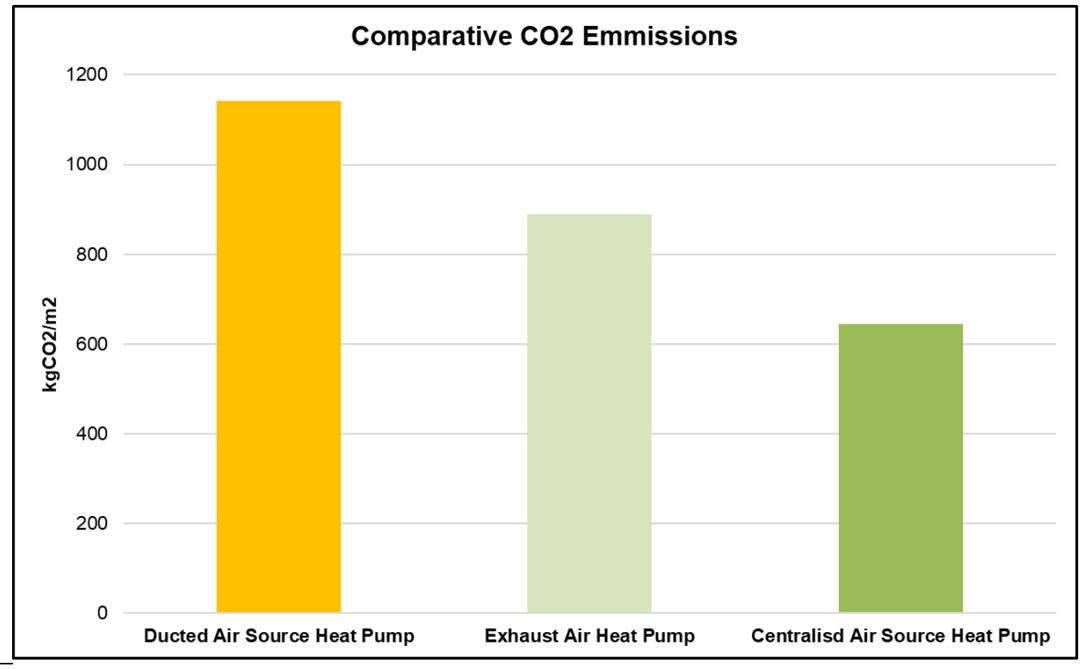
5.0 CONCLUSION

All three options considered for Parkgate Street will achieve NZEB compliance and would be suitable options for this development. All three options considered rely on Heat Pump technology which uses the energy released from a phase change of the refrigerant to deliver more heating energy than inputed to the system. The application of this technology for each solution results in variable CO_2 emissions and running costs for each as outlined below:

Central Air Source Heat Pump supplemented by Gas boilers

The proposed strategy delivers approximately 60% of the annual heating and hot water load from a centrally located air source heat pump. The remaining load is met by condensing gas boiler plant. This system combines the efficiencies of a heat pump with the efficiencies of a district heating system. This option also achieves the lowest life cycle cost combined with the lowest CO_2 emissions of the three options considered. **Therefore, we recommend this option.**





Amenity and commercial units

Amenity and commercial units shall be provided with the following PV panels (located on Block C roof and connected directly to the associated space), to ensure overall building compliance.

The PV allowance below were calculated using sBEM methodology.

Block B2							
Building Space			**Photovoltaic Provision**				**Heating System**
Ref	Description	Floor Area (m^2)	PV (No.)	PV (kW)	PV (^2)	PV (%)	
Block B2	Cafe	174	8	2.32	12.8	7.4%	Central FCU-ASHP(67%) + PV
Block B2	Mezzanine	128	6	1.74	9.6	7.5%	Central FCU-ASHP(67%) + PV
Total			23	6.67	36.8	7.5%	

7.0 Appendix A: DEAP Results for typical Apartment types

7.1 Block B2 - Typical 2 Bed Apartment

The following sub section details the DEAP analysis for the below apartment.

Figure 7.1 - Typical 2 Bed Apartment

7.2 Part L Compliance.

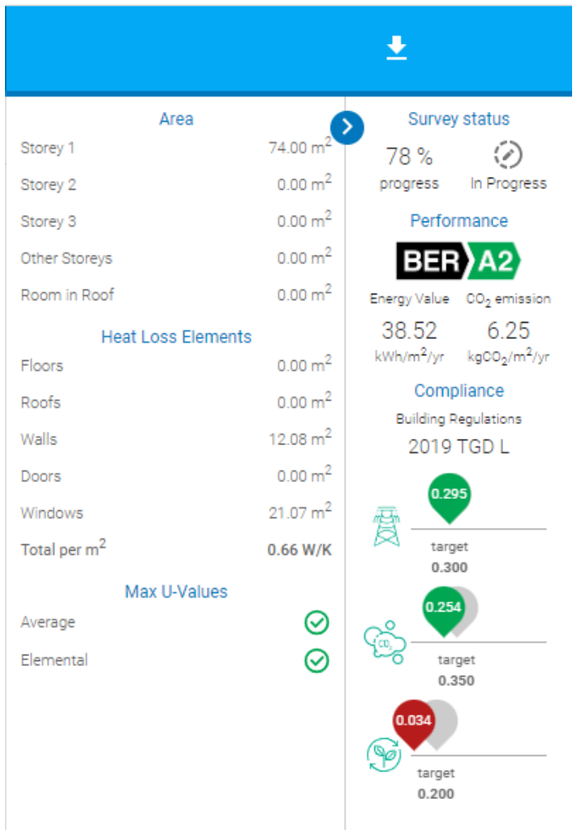


Figure 4.4.2 above, indicates confirmation of compliance to Part-L for one of the Studio apartments on the tenth floor of the Tower Block A, **without the need for PV panels to the residental unit**, with the following parameters achieved:

- Energy Performance Coefficient (EPC) < 0.30
- Carbon Performance Coefficient (CPC) < 0.35

From figure 4.5.2, it is clear that the renewable energy ratio, RER, shown is not sufficient to meet the requirement within DEAP 4.2.1. The RER requirement is as per the value indicated below:

- Renewable Energy Ratio (RER) > 0.20

The SEAI have released a new heat pump calculator which considers heat pumps used within group schemes. Based on inputs from both DEAP and the overall design of the system, an adjusted RER is generated and is shown in Figure 4.5.3.

Figure 4.5.3 shows that a centralised system, as designed, for the 3 bed apartment alone, would not comply with the regulations for the Parkgate St. Development. However as the results are averaged for the entire block we will see in section 4.6 below, that this result is acceptable, and the building **still complies with regulations**.

RESULTS: Part L compliance Renewable Energy Ratio (RER) Adjustment. Applies to New final and New provisional assessments only. BER Assessor must advise the client of any adjustment to RER, and attach details of adjusted RER to Part L compliance report. This section is completed AFTER the above heat pump calculation results are entered in DEAP software.	
Total renewable contribution adjustment	562.74
Total renewables primary energy from DEAP software	84.30
Total Primary Energy from DEAP software	2480.86
Adjusted Renewable Energy Ratio to be attached to compliance report	**0.21**

Figure 7.2 - Adjusted RER