EDMONDSTOWN, RATHFARNHAM, HOUSING DEVELOPMENT
Whitechurch Road, Dublin 16
Co. Dublin

Applicant:
BCDK Ltd & Coill Avon LTD

PROJECT No: 3817

PLANNING ISSUE

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Author(s) **Dathaí ó Bardáin**

Signature ....

Date **25th January 2022**..................................

Approved By **Mark Bennett**...

Signature ....

Date **25th January 2022**..................................

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1.0 Introduction

1.1 Dynamic Design Consultants Ltd. (DDC) have been commissioned as Mechanical & Electrical Consultants to provide design guidance for typical Mechanical & Electrical system requirements, including but not limited to those requirements set out in TGD Part L 2019:Conservation of Fuel & Energy for Both Dwellings & Non Dwellings.

1.2 To this end, DDC will advise on the appropriate technologies required to achieve TGD Part L 2019 Compliance & satisfy NZEB legislation.

1.3 As NZEB & part L 2019 compliance is not achieved by Mechanical & Electrical systems alone, DDC have encouraged the design team to take a holistic approach to compliance & ensure that the building fabric & the thermal envelope are optimised to reduce energy usage. This will primarily limit the energy usage of the building regardless of what heating or ventilation technology is used & will in turn limit the amount of energy required to be offset by renewables or low energy technologies. Improvements in building fabric will also improve the performance & effectiveness of any given technology.

1.4 The document has been produced for the benefit of the developer of the property whom shall be referred to as 'the client' or 'our client' throughout this document. The document shall be at the disposal of the client and parties that they deem privy to disclosure of same.

1.5 The information contained within this report is based on drawing packages received from various members of the design team which address site specific requirements. Statutory documents & best practice guides have also been referred to where applicable as have manufacturers data sheets & other NZEB reference documents.

1.6 All conclusions drawn or recommendations made in this document are the opinion of Dynamic Design Consultants Ltd. Where conclusions based upon statutory regulations are made, the document name and year shall be cited. Similarly, where conclusions based upon industry best practices are made, the name and year of publication reference document shall be cited.

Scope

1.1 This document will focus on the various factors within the Edmondstown residential development (North & south site), that could potentially affect the incorporation of renewable technologies & will address the advantages & disadvantages of proposed technologies whilst comparing them against each other to identify the most suitable solution for this project.

1.2 The proposed development will meet or exceed, where feasible, the requirements of TGD Part L 2019, which stipulates requirements on building fabric (U-Values), air permeability, maximum energy use (System Efficiency) & maximum carbon dioxide emissions as calculated using the DEAP methodology.

2.3 This document shall explore the proposed items with respect to TGD Part L 2019 Compliance:
1. Legislative Requirements
2. Calculation Requirements
3. Building Fabric Requirements
4. Proposed Technologies

2.0 Summary

2.1 This report investigates the proposed energy strategy for the development of 89no new Houses & 83no New apartments along with 5no commercial units on Whitechurch Road, Edmondstown, Rathfarnham Dublin 16. The report will investigate the legislative requirements in addition to the conditions & expectations of the local council to ensure that the energy strategy is compliant with both statutory & local authorities. Several potential mechanical systems are reviewed within this report with the aim of selecting the most suitable system for this development. Advantages & disadvantages are provided for each system along with a further cost review & Part L comparison for the most appropriate systems.

4.0 Nomenclature

AC	Alternating Current
ASHP	Air Source Heat Pump
CHP	Combined Heat & Power
COP	Coefficient of Performance
CPC	Carbon Performance Coefficient
DC	Direct Current
DEAP	Domestic Energy Assessment Procedure
DHW	Domestic Hot Water
EAHP	Exhaust Air Heat Pump
EPC	Energy Performance Coefficient
HIU	Heat Interface Unit
IAQ	Indoor Air Quality
LTHW	Low Temperature Hot Water
MEV	Mechanical Extract Ventilation
MPCPC	Maximum Permitted Carbon Performance Coefficient
MPEPC	Maximum Permitted Energy Performance Coefficient
MVHR	Mechanical Ventilation Heat Recovery
NEAP	Non Domestic Energy Assessment Procedure
NZEB	Nearly Zero Energy Building
PV	Photo Voltaic (Solar PV)
RER	Renewable Energy Ratio
SBEM	Simplified Building Energy Model
SFP	Specific Fan Power

5.0 <u>Site & Location</u>

Residential Development on Lands at Kilmashogue House and Coill Avon house, Whitechurch Road, Rathfarnham, Dublin 16

The proposed development on a site that extends to 6.77 hectares includes the derelict Kilmashogue House (southern lands) and Coill Avon house (northern lands), adjacent roads in the control of South Dublin County and Dun Laoghaire Rathdown County Councils and consists of the following developments: -

- Demolition of Kilmashogue House and outbuildings and demolition of Coill Avon house and outbuildings;
- The refurbishment and re-use of 2 no. stone outbuildings for community use, to be incorporated into an area of public open space on the southern lands;
- The construction of a mixed-use development comprising neighbourhood centre and 178 no. residential units comprising 72 no. houses, 38 no. apartments and 68 no. duplex apartments;
- The 72 no. houses will comprise 2, 2.5 and 3-storey detached, semi-detached and terraced units to include:-
    - 6 no. 2-bed houses;
    - 45 no. 3-bed houses;
    - 21 no. 4-bed houses;
- The 38 no. apartments and 68 no. duplex apartments are located across 7 no. buildings ranging in height from 3 to 5-storey consisting of 1 no. Block A/B, 1 no. Block C, 1 no. Block E, 1 no. Block S and 3 no. Blocks T-type as follows: -
    - **Block A/B:** 5-storey over basement and podium accommodating 10 no. 1-bed apartments, 16 no. 2-bed duplex apartments and 1 no. 3-bed duplex apartment with associated balconies/terraces;
    - **Block C:** 5-storey over basement accommodating 4 no. 1-bed apartments and 8 no. 2-bed duplex apartments with associated balconies/terraces;
    - **Block E:** 4-storey over basement accommodating 8 no. 1-bed apartments and 16 no. 2-bed duplex apartments with associated balconies/terraces;
    - **Block S:** 3-storey accommodating 2 no. 2-bed duplex apartments and 1 no. 3-bed apartment and 1 No. 3-bed duplex apartments with associated balconies/terraces;

- **Block T:** 3no. 3-storey buildings accommodating 6 no. 1-bed apartments, 18 no. 2-bed duplex apartments, 9 no. 3-bed apartments and 6 no. 3-bed duplex apartments, all with associated balconies/terraces;

- Block A/B and Block C are arranged around a landscaped podium. The neighbourhood centre is located below this podium and accommodates a 2-level creche (313m²) at lower ground and ground floor level, and 3 no. retail/non-retail/cafe service units (470m^2) at ground level;
- The basement below Block A/B and Block C accommodates 50 no. car parking spaces, bicycle parking, bin stores, plant and staff service area (80m^2);
- The basement below Block E accommodates 35 no. car parking spaces, bicycle parking, bin store and plant;
- A section of link street with footpath and cycle path (approx. 438 linear metres) extending from the junction of Whitechurch Road and College Road on an alignment parallel to the M50, to provide access to the southern development lands and incorporating a bus turning circle;
- Upgrade works to College Road including a new two-way cycle track and relocated footpath from the Whitechurch Road junction to provide connectivity to the Slang River pedestrian/cycle Greenway;
- A new signalised crossroads junction to connect the proposed link street with Whitechurch Road and College Road;
- Upgrade to the existing vehicular access at the entrance to Coill Avon house on Whitechurch Road;
- Foul sewer drainage works along Whitechurch Road from the Kilmashogue junction to the existing junction at Glinbury housing estate;

All landscaping, surface car parking, boundary treatments, infrastructure works, ESB substation, and associated site works and services.

Image Above Showing google Map of Site with Boundary Highlighted in Red

Image Above Showing 3D Google Map of Site (Boundary in Red) - Overlooking Edmondstown Facing North Bound

Image Above Showing excerpt from SDCC Development Plan Map 10 – Site Boundary in Blue

6.0 South Dublin County Council Requirements

6.1 Our design will consider the current council policies and objectives of the County Development Plan 2016-2022 & Climate change action plan 2019 – 2024 to ensure the development meets the council's requirements for sustainability, Greenhouse Gas Reduction & Energy Efficiency.

6.2 As SDCC works closely with Codema to continuously implement initiatives and projects to raise awareness of energy issues, monitor energy use, and increase the share of renewable energy and improve energy efficiency at work and in the home. "The aim of these Energy Reviews is to help SDCC in its energy planning programmes, in order to meet the public sector 2020 energy targets." Dynamic Design will ensure that energy strategy is in line with SDCC requirements for providing an energy efficient & renewable housing schemes.

6.3 This will ensure that the development adheres to the policies of Dublin City Council to ensure that homes are energy efficient & equipped for challenges anticipated from a changing climate. As part of this process, product selection shall consider the lifespan, renewable contribution, efficiency & embodied energy so as to limit the overall environmental impact of new homes as per DCC Climate change action plan 2019 & Urban Design Manual: A Best Practice Guide' (2009).

6.4 SDCC aim to support a 33% improvement in energy efficiency 2020 (Based on the 2009 baseline) & are committed to a reduction of 40% CO2 emissions by 2030 across the SDCC area. "The plan will focus on the energy areas where actions can be taken to introduce energy efficiency measures and reduce CO2 emissions, such as district energy systems and renewable energy technologies."

6.5 To this end, the homes will be designed to make good use of the site to achieve natural lighting so as to limit energy requirements of artificial lighting (all of which shall be high efficiency LED). The building fabric will be enhanced to minimise heating/cooling demands and so that low energy technologies can be utilised to reduce fossil fuel requirements & reduce Carbon emissions. Further to this, renewable technologies will be incorporated into the scheme.

Images Above showing excerpt from SDCC Climate Change Action Plan 2019

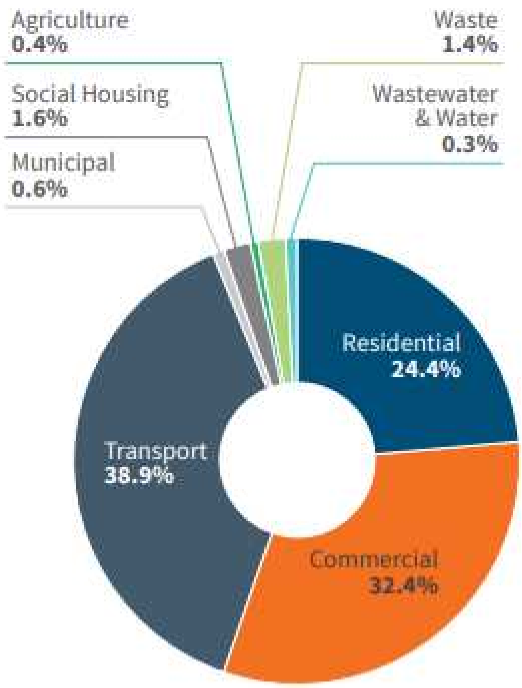


Image Above showing Total Green House Gas Emissions of South dublin per sector

6.5 SDCC requirements

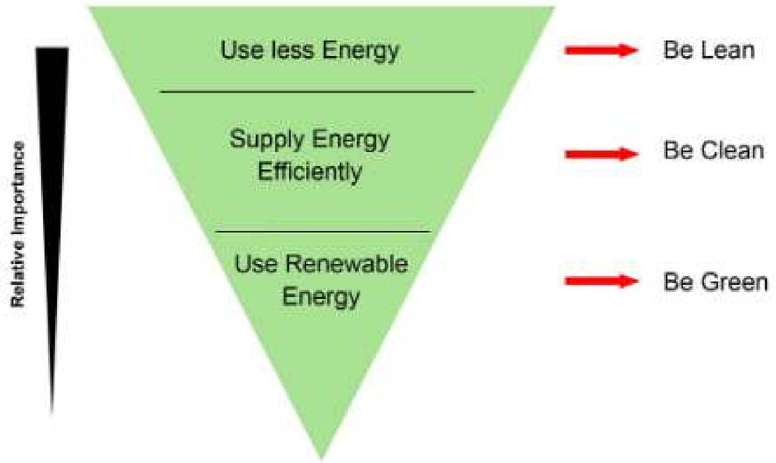
- To promote more sustainable development through energy end-use efficiency, increasing the use of renewable energy, and improved energy performance of all new development throughout the region by requiring planning applications to be supported by information indicating how the proposal has been designed in accordance with the development standards set out in the development plan. To encourage responsible environmental management in construction
- To promote sustainable approaches to developments - "South Dublin County should aspire to becoming as carbon neutral as possible and make every effort to increase energy efficiency and unlock renewable energy potential".
- To ensure high standards of energy efficiency in existing and new developments and encouraging developers, owners and tenants to improve the environmental performance of the building stock, including the development of renewable energy.
- To continue to participate in projects along with the European Union, CODEMA & SEAI to carry out special energy demand analysis (SEDA) to gather information on the current & future energy demand for SDCC with the aim of using these studies to help incorporate the most suitable renewable energy systems into the council areas.

7.0 Energy Strategy

7.1 It is the intent of Dynamic Design Ltd to ensure that this development achieves, at minimum, the requirements set out in TGD L 2019 & The EU Energy Performance of Buildings Directive – EPBD (recast) (2010/31/EU of 19 May 2010), This includes:

- Ensuring Building fabric controls heat gain & heat loss as necessary to limit the requirement for external energy usage for heating or cooling.
- Ensuring that Oil or Gas plant has a seasonal efficiency >90%
- Production of a DEAP Calculation is provided for all dwellings and that the result shows:
    - A 25% improvement in energy performance on the former TGD Part L 2011
    - A MPEPC of 0.3
    - A MPCPC of 0.35
    - A RER of 0.2
- Production of a NEAP Calculation is provided for all Non Dwellings and that the result shows:
    - A 60% improvement in energy performance on the former TGD Part L 2008
    - A MPEPC of 1.0
    - A MPCPC of 1.15
    - A RER of 0.2

7.2 As per the above requirements, the overall design of this residential development shall follow the principals of the be Lean>Be Clean>Be Green energy hierarchy in order to ensure compliance or betterment of TGD Part L requirements. This hierarchy has been adopted by many international bodies & councils who are currently achieving or exceeding NZEB requirements.



Source: Interreg Europe ZEROCO2 Technology options towards nzeb

7.3 This is Therefore considered an acceptable strategy in achieving maximum carbon reduction & energy efficiency in new buildings by;

- primarily using less energy through minimising heat loss & incorporating low energy technologies
- Secondly, by ensuring that the energy source is efficient & utilises Low Carbon production methods
- Lastly, by means of incorporating renewable energy sources to offset the essential energy consumption for the running of the building.

7.4 Dynamic Design Consultants Ltd considers this hierarchy – proposed by a body representing Local Government in the UK and now endorsed by many local authorities – to be well considered and an appropriate set of principles to adhere to in tackling climate change. In adopting the hierarchy, the CO2 savings at each stage are maximised before strategies at the next stage are considered.

7.5 Within SDCC "Of the total social housing stock, 47 units had an A3 rating. However, no A1 or A2 dwellings could be found in South Dublin for 2016 and data gathered from SEAI's BER Research Tool did not contain any A1 or A2 dwellings" DDC aim to achieve A2 ratings on all social housing within this development.

7.6 The proposed development will meet the highest standards of sustainable design and construction solutions where possible. During design and construction, the following energy considerations will be inherently addressed to ensure the overall development;

- Makes most efficient use of land and existing buildings
- Reduces carbon dioxide and other emissions that contribute to climate change
- Is designed for flexible use throughout its lifetime
- Makes most effective and sustainable use of water, aggregates and other resources
- Minimises energy use, including passive solar design and natural ventilation
- Uses renewable energy where feasible
- Reduces air and water pollution
- Is comfortable and secure for its users
- Promotes sustainable waste behaviour
- Reduces adverse noise impacts internally and externally

7.7 The new development shall be designed such as to ensure that the energy performance of the building is such as to limit the amount of energy required for the operation of the building and the amount of CO2 emissions associated with this energy insofar as is reasonable practicable. The new development will meet the current building regulations and particular attention will be paid to the requirements regarding the conservation of fuel and energy as laid out in Part L 2017 for Non-Domestic Buildings.

7.8 During the design process a full DEAP calculation will be carried out to ensure that the proposed design is in compliance with TGD Part L 2019. The new development will be designed and constructed to limit heat loss and where appropriate, limit heat gains through the fabric of the building.

8.0 Legislative Requirements

8.1 The Energy Efficiency Directive (EED) is the main legislative mechanism through which energy efficiency policy at EU level is delivered. This was adopted by the EU Council in October 2012.

8.2 The EED will translate certain ambition elements of the European Energy Efficiency Plan into binding measures. The proposed legislative provisions set binding measures on member states, including an annual rate of renovation for central government building of 3%; an obligation on public bodies to procure products, services and building with high energy-efficiency performance; obligations on industry relating to energy audits and energy management systems, and a common framework for national energy savings obligation schemes equivalent to 1.5% of energy sales. The new directive entered into force on 4th December 2012 and must be transposed into law by each member state by 5th June 2014.

8.3 Ireland transposed the ESD through the Energy End Use Efficiency and Energy Services Regulations 2009 (S.I. 542 of 2009) which provided for national energy efficiency savings targets; energy services including the availability of energy audits to final customers; the exemplary role of the public sector, and the promotion of energy efficiency by energy suppliers.

8.4 A primary focus of EED is on domestic and commercial buildings, as these sectors account for 40% of total energy consumption in the EU. The Directive on Energy Performance in Buildings (EPBD), adopted in 2002, primarily affects energy use and efficiency in the building sector in the EU. Ireland transposed the EPBD through the Energy Performance of Buildings Regulations 2003 (S.I. 666 of 2006) which provided for the Building Energy Rating system to be administered and enforced by the Sustainable Energy Authority of Ireland (SEAI).

8.5 The Recast EPBD, adopted in May 2010, states that reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union's energy dependency and greenhouse-gas emissions. The directive aims to have the energy performance of building calculated on the basis of a cost-optimal methodology. Member states may set minimum requirements for the energy performance of buildings.

8.4 The recast Energy Performance of Buildings Directive requires Ireland to ensure, among other obligations, that building energy ratings are included in all advertisements for the sale or lease of buildings; that Display Energy Certificates (DECs) are displayed in public and privately owned buildings frequently visited by the public; that heating and air-conditioning systems are inspected; that consumers are advised on the optimal use of appliances, their operation and replacement, if by suitable qualified persons acting in an independent manner, and are underpinned by a robust regime of verification; and that a national plan is developed to increase the number of low – or nearly zero-energy buildings, with the public sector leading by example.

8.5 The directive was transposed by the European Unions (Energy performance of Buildings) Regulations 2012 (S.I. 243 2012).
The Eco-design Directive (2009/125/EC) was transposed by the EU Regulations 2011 (S.I. No 203 of 2011) which extends the scope of an earlier directive to a wider variety of products that can contribute to energy saving.

8.6 The Energy Labelling Directive (2010/30/EU) was transposed by the EU (Energy Labelling) Regulations 2011 (S.I. No 366 of 2011), which extend the application of the directive to an increasing range of products which have a direct or indirect impact on energy consumption during use. The regulations oblige supplies of energy-using products covered by an EU measure to supply an energy label and fiche with product.

8.7 Part 2 of S.I. 666 (EPBD) deals with Alternative Energy Systems and applies to the design of any large new building, where a planning application is made, or a planning notice is published, on or after 1st January 2007. This calls for a report into the economic feasibility of installing alternative energy systems to be carried out during the design of the building.

Systems considered as alternative energy systems are as follows:

- Decentralised energy supply systems based on energy from renewables
- Cogeneration i.e. Combined heat and power systems
- District or block heating or cooling, if available, particularly where it is based entirely or partially on energy from renewable sources
- Heat pumps

8.8 The EPBD framework lays down the following items which should be considered at minimum in the design of new buildings to help achieve EU targets.

(a) The Following Actual Thermal Characteristics of The Building Including Its Internal Partitions:

(I) Thermal Capacity.
(Ii) Insulation.
(Iii) Passive Heating.
(Iv) Cooling Elements; And
(V) Thermal Bridges.

(B) Heating Installation and Hot Water Supply, Including Their Insulation Characteristics; (C) Air-Conditioning Installations.
(D) Natural and Mechanical Ventilation Which May Include Airtightness.
(E) Built-In Lighting Installation (Mainly in The Non-Residential Sector).
(F) The Design, Positioning and Orientation of The Building, Including Outdoor Climate.
(G) Passive Solar Systems and Solar Protection.
(H) Indoor Climatic Conditions, Including the Designed Indoor Climate.
(I) Internal Loads.

The positive influence of the following aspects shall, where relevant in the calculation, be taken into account:

(a) Local Solar Exposure Conditions, Active Solar Systems and Other Heating and Electricity Systems Based on Energy from Renewable Sources.
(B) Electricity Produced by Cogeneration.
(C) District or Block Heating and Cooling Systems.
(D) Natural Lighting.

9.0 Part L Requirements (Dwellings)

9.0.1 TGD Part L 2019 – Conservation of Fuel & Energy (Dwellings) has the following sub sections & Requirements for all new dwellings where planning approval or permission is applied for after 31st October 2019. It is a requirement that all new building meet the NZEB criteria as part of these regulations.

9.0.2 **Nearly Zero-Energy Building**
"Means a building that has a very high energy performance, as determined in accordance with Annex I of the EU Energy Performance of Buildings Directive Recast (EPBD Recast) 2010/31/EU of 19th May 2010. 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 onsite or nearby."

9.0.3 **Limitation of Primary Energy Use and CO2 Emissions**
The primary energy consumption and CO2 emissions of the proposed development including the services design, will be calculated using the DEAP methodology. In order to demonstrate that an acceptable primary energy consumption rate has been achieved, the calculated Energy Performance Coefficient will be no greater than the Maximum Energy Performance Coefficient which is 0.3. Likewise, the Carbon Performance Coefficient will be no greater than the Maximum Permitted Carbon Performance Coefficient which is 0.35.

Limiting the primary energy consumption shall be achieved by means of reviewing all items laid down in the EPBD framework as highlighted in section 8.8 above & ensuring that energy reductions have been made using each item.

9.0.4 **Renewable Energy Technologies**
"Means technology, products or equipment that supply energy derived from renewable energy sources (non-fossil Sources), e.g. solar thermal systems, solar photovoltaic systems, biomass systems, systems using biofuels, heat pumps, aerogenerators and other small scale renewable systems"…"wind, hydropower, biomass, geothermal, ambient energy, wave, tidal, landfill gas, sewage treatment plant gas and biogases."

Where the MPEPC of 0.3 & the MPCPC of 0.35 are achieved, a renewable energy ratio of 0.2 is required. This represents 20% of the primary energy from renewables to total primary energy as per calculation methodology within the DEAP software programme.

Where buildings contain multiple dwellings such as apartments every individual dwelling should meet the minimum provision from renewable energy technologies specified in paragraph 1.2.3 of TGDL; or - the average contribution of renewable technologies to all dwellings in the building should meet that minimum level of provision per dwelling.

As an alternative to providing an RER, a CHP unit could be utilised to contribute to space heating & hot water heating however the primary energy savings of the CHP system should be equivalent to an RER of 0.2. CHP units should be suitable for following the thermal & electrical load profile of the building & should be designed as per CIBSE AM12.

Renewable energy technologies are also subject to compliance with TGD Part D 2013 – Materials & workmanship & should be of suitable quality satisfy the requirements laid out therein. The SEAI database should be consulted for acceptable Renewable products before design & specification of systems.

As per Table E.2 of TGD L 2019 (shown below) – The most appropriate example buildings for this development include Example E & Example F where a Primary energy consumption of 37 kWh/m2 yr. & 40 kWh/m2 are required alongside a RER of 0.23 (achieved via Solar PV) & 0.34 (achieved using an ASHP) respectively.

Both apartments have triple glazing & other factors that are improvements on Part L baseline requirements. Where our apartments cannot meet the specific rating for each system or element, further improvements shall be made on other systems or elements to compensate.

Table E2 Example Dwellings - Results

	Example E - Apartment heated by gas and MVHR	Example F - Apartment heated by heat pump and cMEV
Primary energy [kWh/m^2 yr]	37	40
CO_2 emissions [kg/m^2 yr]	7	8
EPC	0.28	0.295
CPC	0.26	0.29
RER	0.23	0.34

Image Showing Table E.2 of TGD L 2019

9.0.5 **Building Fabric**

TGD Part L 2019 outlines the minimal acceptable provisions in the building fabric to ensure that heat loss is limited as far as reasonably practicable. It is however recommended to improve on these valves where practicable to assist in minimising the overall primary energy consumption & improving the impact that renewables installations will have on the development.

The main issues where guidance is given on building fabric are as follows

<u>Insulation levels to be achieved by the plane fabric elements.</u>
The stipulation on limiting U-Values are given to minimise the direct heat loss trough the fabric of a building & also to minimise direct & indirect heat gains from adjacent buildings or ambient conditions. All new dwellings must ensure that the area weighted U-Values of each element meet or exceed the values as given below to meet Part L requirements.

Diagram 1 Average Area Weighted Elemental U-values
(Par. 1.3.2.2)

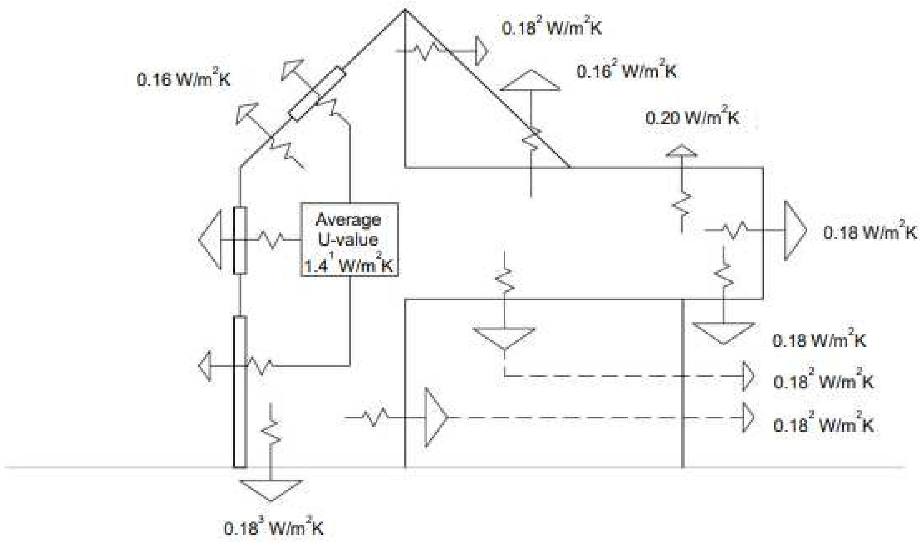


Image above Showing Average Area Weighted U-Values from Diagram 1 of TGD L 2019

Table 1: Maximum elemental U-value (W/m2K)

Element	Area weighted Average Elemental U-Value	Average Elemental U-Value – Individual Section or Element	Area Weighted Average Elemental U-Value (This Development - >10% Improvement)
Roofs Pitched Roofs Flat Roof	 0.16 0.20	 0.3 0.3	 0.14 0.14
Walls	0.18	0.6	0.16
Floors Ground Floors Other Exposed Floors	 0.18 0.18	 0.6 0.6	 0.16 0.16
External doors, windows and roof lights	1.4	3.0	1.20

Thermal Bridging
The key purpose of minimising thermal bridging coefficients is to avoid excessive heat loss & potential condensation issues at critical junctions & details, including, Wall to wall, Wall to Roof, Windows & Doors along with other penetrations for Services fixings. DEAP calculation methodology considers thermal bridging & attributes energy usage to this item in the primary energy section.

Architectural details should limit thermal bridging coefficients where possible by ensuring that they comply with those details as shown in TGD L supporting document - Limiting thermal bridging & air Infiltration – Acceptable Construction Details".

Limitation of air permeability
Further to limiting fabric heat loss & thermal bridging, the reduction of air permeability in a given dwelling can have significant reductions in primary energy consumption & can enhance the efficiency of ventilation systems such as MVHR units. Air infiltration can be caused by poor construction details or finishing around wall to wall, floor & ceiling joints,
service openings, doors & windows amongst others. Where air permeability is reduced, it is important to ensure adequate ventilation is provided to ensure occupant comfort and condensation/mould prevention.

TGD Part L required that air pressure tests are carried out on all dwellings on development sites as per the procedure for testing specified in I.S. EN ISO 9972:2015 Thermal performance of buildings - determination of air permeability of buildings - fan pressurization method. A maximum acceptable value of 5m3/ (h.m2) at 50Pa shall be achieved.

Limiting Heat Gains
Reasonable provision to limit heat gains can be demonstrated by showing through the DEAP calculation that the dwelling does not have a risk of high internal temperatures. (revised DEAP methodology to be published). Where an overheating risk is indicated in DEAP, further guidance is provided in CIBSE TM 59 to ensure overheating is avoided for normally occupied spaces. Openable windows, internal blinds & purge ventilation functions can offer reductions in thermal gains in dwellings however these are reactive measures & the selection of building fabric elements will have the most beneficial impact in limiting heat gains.

Passive solar design is the aim for design that optimises the capture of free heat, daylight, and ventilation, and minimises unwanted solar gain. The proposed development of a new multi-tenant space offers opportunities to explore many of the good practice passive solar design options. The proposed development will have glazing specified that minimises unwanted solar gain without impacting on day lighting levels. To achieve this, we would recommend a glazing g-value of between 0.3 and 0.5. The design intent is to achieve internal daylight factors where possible of between 2% and 5% where the windows give a predominately daylit appearance without supplementary electric lighting being needed. This is usually the optimum range of day lighting for overall energy use.

9.1 Part L Requirements (Non Dwellings)

9.1.1 TGD Part L 2017 – Conservation of Fuel & Energy (Buildings Other Than Dwelling) shares the same sub sections with regards to energy conservation & makes significant improvements on the previous Part L for Non Dwellings. The Non Domestic Part L document however represents an improvement from the previous in the order of 60%.

9.1.2 **Limitation of Primary Energy Use and CO2 Emissions**
The primary energy consumption and CO2 emissions of the proposed development including the services design, will be calculated using the NEAP methodology. In order to demonstrate that an acceptable primary energy consumption rate has been achieved, the calculated Energy Performance Coefficient will be no greater than the Maximum Energy Performance Coefficient which is 1.0. Likewise, the Carbon Performance Coefficient will be no greater than the Maximum Permitted Carbon Performance Coefficient which is 1.15.

Limiting the primary energy consumption shall be achieved by means of reviewing all items laid down in the EPBD framework as highlighted in section 8.8 above & ensuring that energy reductions have been made using each item.

9.1.3 **Renewable Energy Technologies**
"Means technology, products or equipment that supply energy derived from renewable energy sources (non-fossil Sources), e.g. solar thermal systems, solar photovoltaic systems, biomass systems, systems using biofuels, heat pumps, aerogenerators and other small scale renewable systems"…"wind, hydropower, biomass, geothermal, ambient energy, wave, tidal, landfill gas, sewage treatment plant gas and biogases."

Where the MPEPC of 1.0 & the MPCPC of 1.15 are achieved, a renewable energy ratio of 0.2 is required. This represents 20% of the primary energy from renewables to total primary energy as per calculation methodology within the NEAP software programme. Where an EPC of 0.9 and a CPC of 1.04 is achieved an RER of 0.10 is required.

Where buildings contain multiple commercial units such as the commercial centres or community hubs, every individual commercial unit should meet the minimum provision from renewable energy technologies specified in paragraph 1.2.1 of TGDL;

As an alternative to providing an RER, a CHP unit could be utilised to contribute to space heating & hot water heating however the primary energy savings of the CHP system should be equivalent to an RER of 0.2 or 0.1 (as applicable). CHP units should be suitable for following the thermal & electrical load profile of the building & should be designed as per CIBSE AM12.

Renewable energy technologies are also subject to compliance with TGD Part D 2013 – Materials & workmanship & should be of suitable quality & satisfy the requirements laid out therein. The SEAI database should be consulted for acceptable Renewable products before design & specification of systems.

As commercial buildings can significantly vary in use, there are no set examples as to how a commercial building can easily achieve compliance. As such, each commercial unit must be reviewed independently based on the BRIRL (NEAP) calculators & the most appropriate renewable energy technologies should be utilised to ensure compliance.

9.1.4 **Building Fabric**

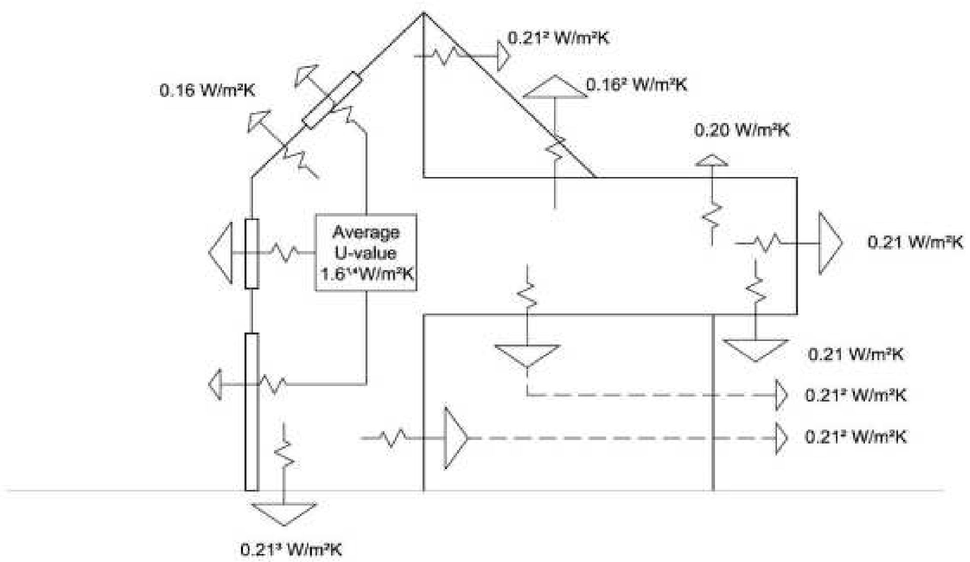
TGD Part L 2017 (Non Domestic) outlines the minimal acceptable provisions in the building fabric to ensure that heat loss is limited as far as reasonably practicable. It is however recommended to improve on these valves where practicable to assist in minimising the overall primary energy consumption & improving the impact that renewables installations will have on the development.

The main issues where guidance is given on building fabric are as follows

Insulation levels to be achieved by the plane fabric elements.

The stipulation on limiting U-Values are given to minimise the direct heat loss trough the fabric of a building & also to minimise direct & indirect heat gains from adjacent buildings or ambient conditions. All new buildings must ensure that the area weighted U-Values of each element meet or exceed the values as given below to meet Part L requirements.

Diagram 1 Average Area Weighted Elemental U-values



NOTES

Average U- values of all elements may vary as set out in Paragraph 1.3.2.3

1. The U-value of 1.6 W/m2K for windows and personnel doors applies
2 The U-values include the effect of unheated voids and other spaces.
3. Refer to Par. 1.3.2.2 for underfloor heating
4. For vehicle access doors and high usage entrance doors refer to Table 1-

Image above Showing Average Area Weighted U-Values from Diagram 1 of TGD L 2019

Table 1: Maximum elemental U-value (W/m2K)

Element	Area weighted Average Elemental U-Value	Average Elemental U-Value – Individual Section or Element	Area Weighted Average Elemental U-Value (This Development - >10% Improvement)
Roofs Pitched Roofs Flat Roof	 0.16 0.20	 0.3 0.3	 0.14 0.14
Walls	0.21	0.6	0.19
Floors Ground Floors Other Exposed Floors	 0.21 0.21	 0.6 0.6	 0.19 0.19
External doors, windows and roof lights	1.4	3.0	1.20
Curtain Walling	1.8	3.0	1.60
Vehicle Access Doors	1.5	3.0	1.35
High usage Entrance doors	3.0	3.0	2.70

Thermal Bridging
The key purpose of minimising thermal bridging coefficients is to avoid excessive heat loss & potential condensation issues at critical junctions & details, including, Wall to wall, Wall to Roof, Windows & Doors along with other penetrations for Services fixings. NEAP calculation methodology considers thermal bridging & attributes energy usage to this item in the primary energy section.

Architectural details should limit thermal bridging coefficients where possible by ensuring that they comply with those details as shown in TGD L supporting document - Limiting thermal bridging & air Infiltration – Acceptable Construction Details".

Limitation of air permeability
Further to limiting fabric heat loss & thermal bridging, the reduction of air permeability in a given unit can have significant reductions in primary energy consumption & can enhance the efficiency of ventilation systems such as MVHR &AHUs. Air infiltration can be caused by poor construction details or finishing around wall to wall, floor & ceiling joints,
service openings, doors & windows amongst others. Where air permeability is reduced, it is important to ensure adequate ventilation is provided to ensure occupant comfort.

TGD Part L required that air pressure tests are carried out on all dwellings on development sites as per the procedure for testing specified in I.S. EN ISO 9972:2015 Thermal performance of buildings - determination of air permeability of buildings - fan pressurization method. A maximum acceptable value of 5m3/ (h.m2) at 50Pa shall be achieved.

Limiting Heat Gains
Reasonable provision to limit heat gains can be demonstrated by showing through the NEAP calculation that the dwelling does not have a risk of high internal temperatures. Where an overheating risk is indicated in NEAP, further guidance is provided in CIBSE TM 59 to ensure overheating is avoided for normally occupied spaces. Openable windows, internal blinds & purge ventilation functions can offer reductions in thermal gains in commercial units however these are reactive measures & the selection of building fabric elements will have the most beneficial impact in limiting heat gains such as Solar controlled glazing or external blinds.

Passive solar design is the aim for design that optimises the capture of free heat, daylight, and ventilation, and minimises unwanted solar gain. The proposed development of a new multi-tenant space offers opportunities to explore many of the good practice passive solar design options. The proposed development will have glazing specified that minimises unwanted solar gain without impacting on day lighting levels. To achieve this, we would recommend a glazing g-value of between 0.3 and 0.5. The design intent is to achieve internal daylight factors where possible of between 2% and 5% where the windows give a predominately daylit appearance without supplementary electric lighting being needed. This is usually the optimum range of day lighting for overall energy use.

10.0 Building Services Compliance (Part L Dwellings)

10.0.1 In TGL Part L 2019 Guidance is given on three main building service areas:
- Heat generator efficiency
- Space heating and hot water supply system controls
- Insulation of hot water storage vessels, pipes and ducts
- Biomass independent boilers
- Mechanical ventilation systems

10.0.2 The mechanical plant strategy for this development shall be designed to maximise the efficiency of the system through the use of:

a. Efficient heating/hot water production, distribution & storage.
b. Intelligent control systems to optimise efficiency & provide the end user with appropriate energy usage information.
c. Mechanical ventilation systems with heat recovery & SFPs in compliance with TGD L 2019
d. Renewable heat sources & or incorporation of Solar PV systems

Various components shall be utilised as per below to ensure compliance with the

10.0.3 Heating & Hot Water Production: Distribution & Storage
The minimum acceptable heat generator seasonal efficiency for oil or gas fired boiler plant shall be 90%. Where biomass boilers are utilised, the minimum seasonal efficiency shall be 77%.

All hot water storage vessels, pipes and ducts (where applicable) will be insulated to minimise heat loss. Adequate insulation of hot water storage vessels will be achieved by the use of a storage vessel with factory applied insulation tested to BS 1566-1:2002+A1:2011, Annex B. All distribution pipework shall also be insulated to standards as set out in BS 1566-1:2002+A1:2011 & frost protection shall be utilised where pipework crosses unheated or external spaces.

10.0.4 Control systems shall be capable of providing automatic control of space heating based on room temperature & shall automatically control of heat input to stored hot water based on stored water temperature.

Hot water Production shall be via a dedicated time control system independent from the space heating controls & hot water storage vessels shall be fitted with a thermostatic control to shut off at set point temperature

The minimum requirements for controls to all other heating plant including heat pumps shall be as per those highlighted in tables 3 & 3 of TGD L 2019 & as per "achieving compliance with Part L" document yet to be published.

10.0.5 Mechanical Ventilation
All ductwork will be appropriately sized and service routes shall be optimised to minimise fan power requirements & improve system efficiency. All SFPs will be in compliance with TGD L 2019 & DEAP minimum requirements & the appropriate ventilation system shall be selected based on the dwellings designed air pressure test. Results show that full MVHR systems do not perform adequately in houses that have air pressure tests greater than 3m3/ (h.m2) at 50Pa & actually use more energy in fan power than the savings achieved. In instances such as this, demand-controlled ventilation can offer a more cost effective & efficient solution.

10.0.6 Renewable Heat Sources or Incorporation of Solar PV

There are many readily available technologies that can provide renewable heat such as Air source & Ground Source heat pumps, Biomass Boilers, Solar Thermal systems, Exhaust air heat pumps, Biogas boilers, amongst others. Various systems will be explored in the below chapter with comparisons made & suitability for this development highlighted or questioned.

The installation of Solar PV panes should never be overlooked in any project given the low cost of the technology & ease of install. Solar PV also generates electricity which is the highest grade of energy with the most versatility in application. Further to this the high service life & low maintenance requirements make PV a feasible option for many projects as the energy generated from solar PV can be utilised to offset electricity demand, generate hot water or be exported to the grid (where grid infrastructure permits) to lower carbon emissions.

10.0.7 Low Energy Lighting Solutions

Energy efficient lighting should maximise the use of natural daylight, avoid unnecessarily high illuminance, incorporate the most efficient luminaires, control gear and lamps and include effective lighting controls. These good practice design principles will be followed during the detailed design stage of the proposed development works.

High efficiency LED lamps with efficacy's greater than 90lm/W will be considered for the apartments as the most energy efficient and practical solutions. PIR occupancy control will be used for lighting in areas that will have intermittent occupancy.

10.0.8 Building User Guide

After the completion of the proposed units the end user(s) will be provided with sufficient information about the building, its installed services and their maintenance requirements so that the Units can be operated in such a manner as to use no more fuel and energy than is reasonable. Anecdotal evidence shows that many new buildings lose up to 30% of their energy efficiency in the first year due mainly to a lack of understanding by the users / occupants on its M&E systems and their operation, A comprehensive & easy to interpret building user guide will help to prevent these un necessary energy losses.

10.1 Building Services Compliance (Part L Non Dwellings)

10.1.1 In TGD Part L 2017 Guidance is given on three main building service areas:

- Heat generator efficiency
- Space heating and hot water supply system controls
- Air Conditioning & Mechanical Ventilation (ACMV)
- Insulation of hot water storage vessels, pipes and ducts
- Artificial Lighting
- Construction Quality & commissioning of services;
    - Commissioning of, Space & Water Heating systems, ACMV Systems & Renewable Systems

10.1.2 The mechanical plant strategy for this development shall be designed to maximise the efficiency of the system through the use of:

e. Efficient heating/hot water production, distribution & storage.

f. Intelligent control systems to optimise efficiency & provide the end user with appropriate energy usage information.

g. Mechanical ventilation systems with heat recovery & SFPs in compliance with TGD L 2017

h. Air Conditioning, Heating or Cooling systems which incorporate variable speed drives & efficient controls for maximum energy conservation.

i. Renewable heat sources & or incorporation of Solar PV systems

j. Low Energy/High Efficacy LED lighting systems with energy saving switching & controls such & daylight sensors & presence detectors.

Various components shall be utilised as per below to ensure compliance with the

10.1.3 Heating & Hot Water Production: Distribution & Storage
The minimum acceptable heat generator seasonal efficiency for oil or gas fired boiler plant shall be as per table 2 of TGD L 2017 ranging from 56% to 93%. Where biomass boilers are utilised, the minimum seasonal efficiency shall be 77%.

All hot water storage vessels, pipes and ducts (where applicable) will be insulated to minimise heat loss. Adequate insulation of hot water storage vessels will be achieved by the use of a storage vessel with factory applied insulation tested to BS 1566-1:2002+A1:2011, Annex B. All distribution pipework shall also be insulated to standards as set out in BS 1566-1:2002+A1:2011 & frost protection shall be utilised where pipework crosses unheated or external spaces.

10.1.4 Control systems shall be capable of providing automatic control of space heating based on room temperature & shall automatically control of heat input to stored hot water based on stored water temperature.

Hot water systems shall be designed to minimise losses in storage & distribution & shall also be sized to prevent low load operation. The minimum controls shall be as specified in table 3, 4 & 5 of TGD L 2017

10.1.5 Mechanical Ventilation & Air Conditioning
All ductwork will be appropriately sized and service routes shall be optimised to minimise fan power requirements & improve system efficiency. All SFPs will be in compliance with TGD L 2017 & NEAP minimum requirements & the appropriate ventilation system shall be selected based on the dwellings designed air pressure test.

Building fabric shall be designed to ensure that the loads required for MVAC are kept to a minimum. Where cooling plant is required, the products shall be as provided for in the eco design Eco-design Regulations.

Where appropriate, Natural Ventilation, Mixed Mode Ventilation & Free Cooling shall be considered & installed to limit the energy attributed to MVAC.

The specific fan power for any ventilation systems shall be no greater than the requirements of table 6 & 6a of TGD L 2017 where a centralised balanced system shall have an SFP no greater than 1.6

10.1.6 Renewable Energy Installations

There are many readily available technologies that can provide renewable heat such as Air source & Ground Source heat pumps, Biomass Boilers, Solar Thermal systems, Exhaust air heat pumps, Biogas boilers, amongst others. Various systems will be explored in the below chapter with comparisons made & suitability for this development highlighted or questioned.

The installation of Solar PV panes should never be overlooked in any project given the low cost of the technology & ease of install. Solar PV also generates electricity which is the highest grade of energy with the most versatility in application. Further to this the high service life & low maintenance requirements make PV a feasible option for many projects as the energy generated from solar PV can be utilised to offset electricity demand, generate hot water or be exported to the grid (where grid infrastructure permits) to lower carbon emissions.

Measure	Cost	Carbon Dioxide Emissions Reduction	Carbon cost effectiveness
Solar PV panels	Medium-High	Low-Medium	Medium
Solar thermal panels	Medium	Low-Medium	Medium
Air source heat pumps	Medium	Low-Medium	Low
Biomass heating	Medium	Low-Medium	Low-Medium
Wind turbine	Medium	Low	Low
Solid Wall insulation	High	High	Medium
Double glazing	Medium-High	Low-Medium	Low-Medium
Loft insulation	Low	High	High
Floor insulation	Medium	Medium-High	Low-Medium
Condensing boiler	Medium	Low-Medium	Medium
Draught-proofing	Low	Low-Medium	High
Led Lighting	Low-Medium	High	High

Image Above from SDCC Energy Efficiency Pre Planning Guidance showing SDCC rough guide to cost & effectiveness of renewable systems

10.1.7 Low Energy Lighting Solutions

Energy efficient lighting should maximise the use of natural daylight, avoid unnecessarily high illuminance, incorporate the most efficient luminaires, control gear and lamps and include effective lighting controls. These good practice design principles will be followed during the detailed design stage of the proposed development works.

High efficiency LED lamps with efficacy's greater than those specified in table 8 will be considered for the apartments as the most energy efficient and practical solutions. PIR occupancy control will be used for lighting in areas that will have intermittent occupancy & Daylight dimming/switching control shall be incorporated as appropriate.

10.1.8 Building User Guide

After the completion of the proposed units the end user(s) will be provided with sufficient information about the building, its installed services and their maintenance requirements so that the Units can be operated in such a manner as to use no more fuel and energy than is reasonable. Anecdotal evidence shows that many new buildings lose up to 30% of their energy efficiency in the first year due mainly to a lack of understanding by the users / occupants on its M&E systems and their operation, A comprehensive & easy to interpret building user guide will help to prevent these un necessary energy losses. This shall include: Drawings, Manuals, Datasheets, Maintenance Routines, & Equipment Details, Controls Demos

11.0 Energy Efficient Heating & ventilation Systems & Renewables

The following low & zero carbon technologies will be reviewed and considered in terms of their applicability for this development. Traditional Gas & oil-fired boilers will not be discussed in length as it not deemed acceptable to install individual gas fired boilers in apartments or housing developments due to complexities in gas distribution & flue termination & advances in alternative technologies & NZEB requirements. It is expected that any new solid fuel boiler systems for commercial units would be a condensing type with a system efficiency to table 2.

11.1 Solar Thermal

Solar water heating systems use the energy from the sun to heat water, DHW requirements in a building. Solar heating systems use a heat collector that is usually mounted on a roof in which a fluid transfers energy absorbed from sunlight to a hot water cylinder. A controller compares the temperature of the water in the collectors with the temperature of the water in the cylinder and activates a circulating pump whenever the water in the collector is around 8C hotter than that of the cylinder. The indirectly heated water in the tank is then supplied to hot water outlets. A secondary system is used to boost the stored hot water when required as solar water typically only capable of providing 50% of DHW requirements in Ireland.

Solar collectors can be categorised into the following two types.

- Glazed flat plate collectors (lower cost
- Evacuated tube collectors (Higher cost but more suitable for cloudy climates such as Ireland)

Advantages

a. Low running & Maintenance Costs
b. Simple technology
c. Reduces carbon emissions for DHW production

Disadvantages

a. High capital cost compared to other more effective technologies
b. Long Payback
c. Drastic drop in efficiencies if not mounted withing 10degrees of south
d. Requires a secondary source for DHW production in winter months
e. Complex distribution for multi tenancy complexes
f. Can only produce heat (a low-grade energy source)

Applicability to this Development

In the Dublin area there is an annual average solar energy availability of 1MWh/m² at the optimum (south facing) angle of 35-45 from the horizontal plane. This development does have access to south facing roofs which could be utilised for mounting panels.

The effective distribution of thermal energy from these panels to a multi tenancy building such would provide many challenges in the following areas; unbalanced ratio of apartment DHW demand to available roof area, complex distribution networks for end user connection, excessive pipe funs, all of which would contribute to an unjustified material usage, significant heat losses & inefficiency in distribution. This technology is therefore not considered appropriate for the apartment install but may be suitable for the individual houses.


Image above showing flat plate (left) & Evacuated Tube (Right) Solar Thermal Panels

11.2 Wind Power

Wind turbines convert kinetic energy from wind into mechanical energy that is then converted to electricity. Turbines are available in a range of sizes and can either be free standing, mounted on a building or integrated into the building structure.

Applicability to this Development

Wind turbines were not considered for the site as the scale of the turbine that would be required would not be suitable for an urban environment like this one. Building mounted turbines create structural, vibration and noise implications. Also, the proximity of the site to the surrounding residential developments deemed it impractical. The appropriate installation of wind turbines are also subject to environmental impact studies & wind speed feasibility studies. Alternative renewables are better suited to this site as described in this chapter.

11.3 Biomass Heating

Biomass is any plant-derived organic material that renews itself over a short period. Biomass energy systems are based on either direct or indirect combustion of fuels derived from those plant sources. The most common form of biomass is the direct combustion of wood in treated or untreated forms. Other possibilities include the production and subsequent combustion of biogas produced by either gasification or anaerobic digestion of plant materials. Liquid biofuels such as bio ethanol can also be used. The environmental benefits relate to the significantly lower amounts of energy used in biomass production and processing compared to the energy released when they are burnt. This can range from a four-fold return for biodiesel to an approximate twenty-fold energy return for woody biomass.

Applicability to this Development

Biomass heating was discounted on the basis that the development will take up to 100% site coverage to satisfy other planning conditions and the requirement for a large wood fuel storage area, truck access and the number of truck movements required for the supply of biomass material and the security of the biomass supply would be prohibitive.

11.4 Photovoltaic Cells (PV)

Photovoltaic (PV) modules convert sunlight to electricity. The solar cells consist of a thin semiconductor material, typically silicon & through a process called doping, two different silicone membranes called n-type and p-type layers are created, which, when energised by photons of electromagnetic radiation, educe an electron transfer & a potential deference. This flow of electrons produces a DC current which can be converted to AC by means of an Inverter to produce 230V of 400V AC electricity which can easily be used in any domestic or commercial environment or exported to the grid network.

Panels connected in large strings can generate high DC currents before being inverted to AC. This can require large cabling & can induce large copper losses in the panel to inverter distribution. Further to this, Sub distribution of electricity from a master invert to individual units can prove complicated for ensuring that individual apartments get equal benefits from a large solar PV array.

For this reason, Micro inverters on each panel are often preferred in large scale installs as each PV module can be controlled independently. This option would also help to achieve compliance with section 1.2.4 of TGL Part L 2019 which states that "every individual dwelling should meet the minimum provision from renewable energy technologies specified in paragraph 1.2.3; or - the average contribution of renewable technologies to all dwellings in the building should meet that minimum level of provision per dwelling."

Image above of Solar PV Array

Advantages

d. Low running & Maintenance Costs
e. High equipment lifespan of 30 years with guarantees often lasting 20 years & above
f. Simple & proven technology
g. Reduces carbon emissions & can offset electricity consumption
h. Option to export to grid during high production & low usage (TBC by ESB)
i. Produces Electricity (a high-grade energy) which can power vast items of equipment
j. Electricity generation can be easily predicted based on historical data (powered by UV irritation, not light)
k. Technology is falling significantly in cost
l. Battery technology can be stored for later use at times of high demand
m. Efficiency is directly related to orientation, but PV can still provide acceptable yield at east/west orientation.

Disadvantages

a. Complex distribution for multi tenancy complexes if micro inverters are not used & if number of panels does not match the number of developments.
b. Can be impacted significantly by shading, dirt & bird droppings.

Applicability to the Development

Solar PV Panels are suitable for this development however the main disadvantage would be in the ability to provide an even split of power distribution to all apartments given that the roof scape does not permit the same number of panels as apartments. Further to this, the various orientation of the roofs would not give equal efficiencies or power generation of each panel & some residents may have advantages over others in terms of solar PV benefits & cost offsets. It is therefore recommended that Solar PV be utilised for commercial units & individual Houses.

11.5 Air Source Heat Pumps

ASHPs upgrade naturally occurring low grade, low temperature heat from the atmosphere into useful high temperature heat via means of the vapour compression refrigeration principle. The high temperature heat produced (35ºC to 55ºC) can be used to heat DHW or internal spaces via radiators or under floor heating systems. The energy taken from the ambient air via an evaporator is used to increase the temperature of refrigerant in the system to boiling point. During the temperature change of the refrigerant, a significant energy is gained. This is often referred to as the free energy in an ASHP as it requires very little work from the unit. The boiling refrigerant is then compressed to further increase the temperature & pressure allowing the temperature to ride to a suitable level. The refrigerant is then passed through a heat exchanger to transfer the energy from the refrigerant to an LTHW system by heating the water. This portion of the process requires work in the form of electric energy used to drive the compressor. The ratio of work in (from the compressor) to heat out (via the heat exchanger) is referred to as the coefficient of performance (Often wrongly referred to the efficiency). Typically, ASHPs in Ireland climate operate at a COP of 3.0 to 4.5 thus giving up to 4.5kW heat output for every 1.5 kW of electricity input. The final stage of the cycle allows the refrigerant to return to its original temperature & pressure, which then re-enters the evaporator to absorb more free energy from the atmosphere & continue the cycle.

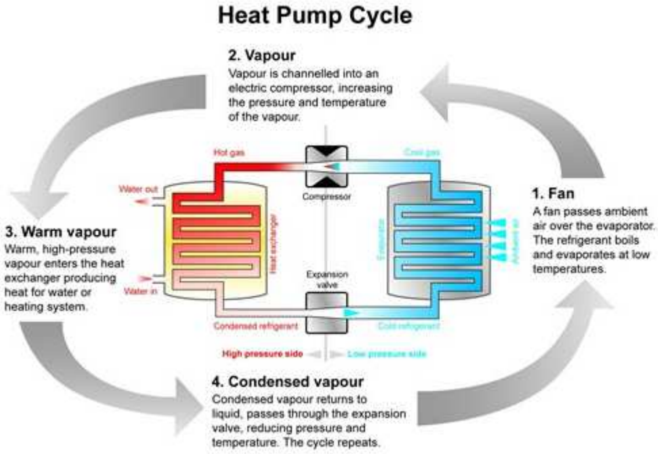


Image above showing ASHP refrigeration Cycle *Balcony ASHP in Apartment Block*

ASHPs operate at maximum efficiencies in mild conditions as the free energy available from the atmosphere is dependent on external air temperatures & humidity. The COP also drops of when heating water to a temperature greater than 35°C as the compressor requires more work input to achieve higher refrigerant temperatures. In order to heat DHW effectively, the LTHW needs to be 55°C to allow stored DHW to reach at least 50°C. When these two situations are combined, e.g. the external air temperature is below freezing & the desired LTHW set point is 55 °C, the ASHP would be expected to run at quite low efficiencies (typically at a COP of 2.0). Even at these low efficiencies however, ASHPs are still able to provide a 1 kW saving over alternative systems & the further saving offered during normal, mild Irish weather conditions when the COP would be greater than 3.0, help to offset the loss during the rare situations when weather drops below freezing for long periods.

Advantages

a. Very high Coefficient of Performance achieves a system efficiency comparable to 200% – 400% of a conventional system. - Low running & Maintenance Costs
b. High equipment lifespan of 20+ years with guarantees often lasting 5-10 years
c. Simple & proven technology with many trained & accredited installers available
d. Reduces carbon emissions (ASHPs are a renewable heat source)
e. Further savings can be achieved when used in conjunction with solar PV to offset electricity usage
f. No requirements for Gas, Tenant only requires an electric supply (i.e., no landlord plant or landlord billing systems)
g. ASHPs alone can achieve A2 – A3 BER ratings with no additional renewables or need for MVHR systems
h. Technology is falling in cost & becoming more understood & available.
i. Small footprint of unit
j. Large scale ASHPs can be used to supplement LTHW production in large centralised plant thus effectively replacing the use of CHP units
k. Effective for heating & hot water production all year round
l. No distribution losses or overheating of corridors when compared to a central Plant system

Disadvantages

a. Inappropriate unit selection/Specification can lead to corrosion issues in salt air environments if units are not Enamel coated, this can reduce efficiency & increase cost.
b. Efficiency is dependent on external conditions (This is only a very slight disadvantage in Ireland)
c. Require continual operation for high efficiency & noise could cause problem if units are not selected or located appropriately
d. A suitable location can be difficult to find in large apartment complexes (balconies can be used but often pose noise & aesthetic problems)
e. Must be mounted externally & cannot be boxed in

f. A dedicated ventilation system is required such as MVHR, MEV or Continuous MEV
g. Low temperature of LTHW network requires oversized radiators or underfloor heating for space conditioning.
h. Still required additional renewables in the form of solar PV to Pass DEAP calculation.
i. Low temperature of DHW production of 55 ^{O}C (this is still an acceptable temperature for hot water usage in the home)

Applicability to this Development
ASHP technology is well suited to this development for many of the advantage highlighted above. The Main complication however would be the location of each individual ASHP. The roof could be utilised to mount a high number of ASHPs. This however would require a shared plant space & could pose complications for maintenance & replacement. Balconies could also be used but space is limited, and the acoustics could cause potential issues when windows or doors are open. ASHPs would me a more feasible solution for the duplex apartments & individual houses which have more external ground space & also have a greater floor area to benefit from the higher output available in ASHPs (up to 16kW)

11.6 Exhaust Air Heat Pump

These systems were invented by NIBE in the 1980s & operate on the same technological principal as AHSPs however, they utilise the available energy in waste air, which is extracted from wet rooms such as bathrooms, kitchens & utility rooms. This extracted air is then passed over the evaporator in the refrigerant cycle to boil the refrigerant. The refrigerant cycle then continues as described in section 11.5 above, however the key differences are that the air exhausted to atmosphere in EAHP units is exhausted at -10^{o-}C and almost all the available energy has been extracted from it gaining more of a thermal advantage over traditional ASHPs. The unit is also mounted internally (usually in a utility cupboard) & the extract & exhaust air is transferred via a duct network & fresh air is brought into the house via specialist wall grilles mounted at high or low level to balance the internal pressures. Where the standard 4kW unit is not large enough for the apartment/ Dwelling, external ambient air can be ducted into the unit to allow for a 2kW increase in output.

These systems also satisfy the whole house ventilation requirements for fresh air & extract air meaning that there is reduced material usage when compared to installs where multiple separate systems are used. As supply air is provided by wall grilles, less ducting material is required.

Outdoor air operation

Explanation

EB100 F730

BT28 Ambient sensor

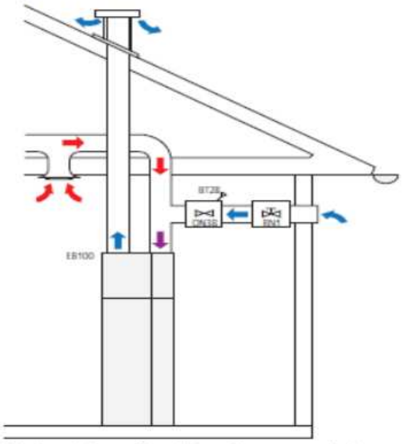
QN38 Outdoor air damper

RN1 Adjustment damper[1]

[1]Not supplied F730

Designations according to standard IEC 61346-2.

Outline diagram



The hot air is transferred from the rooms to the heat pump (EB100) via the building's ventilation system.

The outdoor air is moved via an outdoor air duct via the outdoor air damper (QN38), adjustment damper (RN1) to the heat pump (EB100).

F730

- In most cases, the F730 requires additional air from outside
- The outside terminals can be fitted horizontally and vertically but they must not be terminated beside each other.
- The supplied weather sensor must be mounted on a north facing wall for each heat pump
- Condensate and safety valves to drain for each heat pump.
- Fresh air inlet TL98-F in living rooms.

Image above showing the typical install of an NIBE EAHP

Advantages

a. Very high Coefficient of Performance achieves a system efficiency comparable to 535% of a conventional system
b. Low running & Maintenance Costs
c. High equipment lifespan of 20+ years with guarantees lasting 7 Years
d. Simple & proven technology.
e. Units are prewired &p re plumbed & can be installed by plumbers & electricians without specialist EAHP training.
f. Reduces carbon emissions (EAHPs are a renewable heat source)
g. Further savings can be achieved when used in conjunction with solar PV to offset electricity usage
h. No requirements for Gas, Tenant only requires an electric supply (i.e., no landlord plant or landlord billing systems)
i. EAHPs alone can achieve A2 BER ratings with no additional renewables
j. No need for additional ventilation system as this units satisfies all ventilation requirements with less material than an MVHR system
k. Night cooling is available through these units.
l. Small footprint of unit can be located in cupboards or in kitchen spaces in 600x625mm footprint.
m. Internally mounted systems are not subject to corrosion from sea air environments & there are none of the complications in finding a suitable location as described in section 11.5 above.
n. Effective for heating & hot water production all year round
o. No distribution losses or overheating of corridors when compared to a central Plant system
p. This unit with 3no technologies (heating, hot water & ventilation) is often cheaper than the install of a conventional ASHP alone.
q. Full integrated controls for heating & hot water with wireless connectivity & remote access & control
r. System was invented in 1980s & is produced by a very reputable manufacturer at a rate of 300 Units per day

Disadvantages

a. kW output is limited to 6kW so heat losses must be kept to a minimum. As such, larger homes & apartments may not be suitable for this technology.
b. Only 1 reputable manufacturer available capable of providing confidence in after sales servicing & maintenance – NIBE
c. Low temperature of LTHW network requires oversized radiators or underfloor heating for space conditioning.
d. Low temperature of DHW production of 55 ^{O}C (this is still an acceptable temperature for hot water usage in the home)

Applicability to this Development

EAHP technology is ideally suited to this development for many of the advantages highlighted above. These units remove the potential complication that a standard ASHP system would have. The main consideration would be the locations or the multiple external wall openings required to facilitate inlet air to the unit, make up air to the habitable rooms & exhaust air from the units. Further to this, the apartments will need to be insulated to a high degree with low air permeability to ensure heat loss in below 5kW (6kW at Maximum).

In 2022, NIBE are expected to introduce a 7kW EAHP that will be suitable for use in larger houses and therefore the entire domestic side of this development may be suited to a fully localised & internal renewable solution for heating, ventilation & hot water using the EAHP system.

11.7 Mechanical Ventilation Heat Recovery

MVHR systems have become an industry standard in recent years as homes become more airtight to improve energy efficiency & BER ratings it is essential that adequate ventilation is provided to ensure the indoor air quality does not become stale or harmful to the inhabitants. MVHR is a whole house ventilation system that recovers the latent energy within warm moist air in wet rooms such as kitchens, utility rooms & bathrooms & transfers this energy in the form of heat to fresh air which is brought into the building by dedicated ductwork. Typical modern units can achieve heat recovery of up to 92%. This recovered heat preheats the fresh air which means that there is minimal supplementary heat required to maintain a comfortable internal environment. This is more efficient that continuous MEV systems where this the heated air is simply dumped to atmosphere.

Advantages

a. Fresh air is preheated to comfortable conditions reducing demand of LTHW system
b. Provides a high level of IAQ, prevents condensation & mould formation & promotes good occupant health
c. Recovers waste heat when compared with MEV systems
d. Ventilation can be controlled by the occupant for boost or night cooling in warmer months to remove heat gains & improve comfort

Disadvantages

a. Requires additional material compared & expertise when compared to MEV or EAHP systems which adds unnecessary expensive
b. Requires deep ceiling void space for ductwork crossover
c. Units with air permeability above 3m3/ (h.m2) at 50Pa do not benefit from MVHR system efficiencies
d. Adds another technology to the project & increases system complication which requires further end user awareness for the system to remain effective.

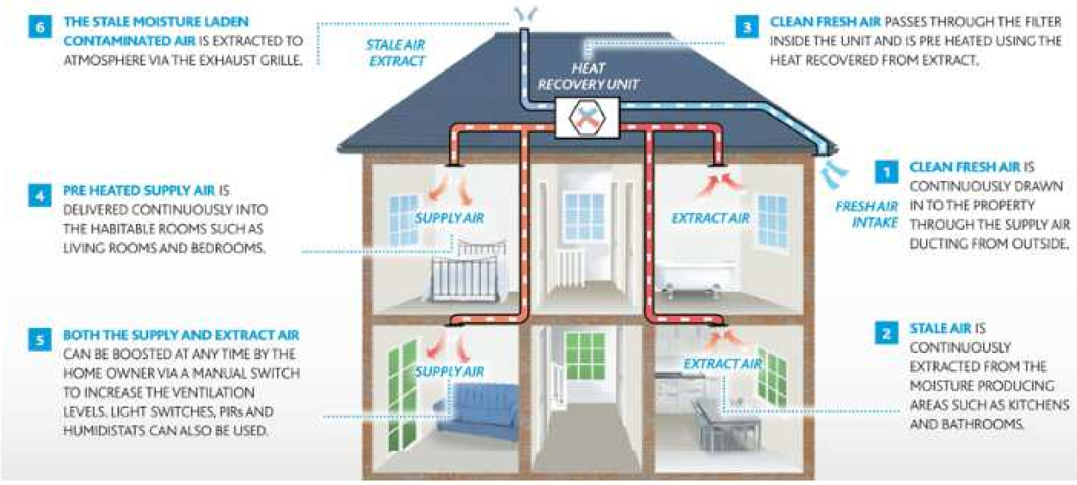


Image above showing MVHR system operation in a typical dwelling

Applicability to this Development

If EAHP technology is not incorporated into a dwelling, then an MVHR system would be suitable provided that the building design & layouts permit the routing of ductwork & that the air permeability remains below 3m3/ (h.m2) at 50Pa. Where the above permeability is not met, MEV would be a more cost-effective install with minimal complexity or complication.

11.8 Centralised Systems

Centralised systesm typically incorporate a large central boiler plant with high efficiency condensing gas fired boilers. The gas boilers produce LTHW in excess of 75ºC which is then distributed to each dwelling/Apartment via a netowrk of flow & return pipework containd in landlord coridors & ceiling voids. Each apartment is then fitted with a HIU that contains 2no heat exchangers to generate secondary side LTHW for space heating & DHW for washing & cleaning. The central boiler plant limts the gas ditribtion required with conventiaotnboilers in apartments & also increases system efficiencies where the total boiler load in kW for central boiler plant allows for system diversity & is much lower than the total boiler demand of ever apartmentd summed together. The low return temperatures in heat networks also induce condensing mode in boilers & ensure high system efficiencies are maintained.

Advantages

a. Improved system efficiencies & single point of gas supply when compared to individual standalone boilers.
b. Single flue termination.
c. Renewables in the form of CHP or commercial ASHPs can be incorporated into the system for Renewable energy input.
d. High temperature LTHW is available for rapid space & water heating with standard sized radiators.
e. Almost silent operation with no external plant in apartments.
f. Hot water production is Instant & at 65ºC
g. Radiators can be sized normally & heated to as high as 75ºC for rapid apartment warmup & space saving.
h. Can be easily connected to district heating schemes as a retrofit.

Disadvantages

a. High boiler efficiencies are often offset through distribution losses in heat network pipework.
b. Overheating in landlord corridors is common due to distribution losses as central plant network must circulate 24/7 to ensure end user demand heating & hot water demand is satisfied.
c. Requires deep Landlord ceiling void space for pipework & insulation.
d. Heat loss in ceilings can cause overheating of mains water pipework
e. Complex system design & costly installation & commissioning requirements.
f. Landlord or management company is responsible for regular maintenance of central plant
g. Expensive building management system required for control & monitoring
h. Dedicated heat metering & billing system is required with annual overheads for management as the landlord needs to act as the energy supply company.
i. Central plant needs to be supplemented with renewables to meet RER
j. A large gas connection to site is required
k. Apartments still require tenant plant/utility cupboards for HIUs
l. Dedicated mechanical ventilation is required.

Applicability to this Development

When proper design & selection of central boiler plant is carried out it can offer several advantages as mentioned above. Namely all the benefits of an individual boiler with on demand heating & hot water requirements easily satisfied & versatility in radiator size & type. The incorporation of external renewables can also help to contribute to the RER & offset any distribution losses. There are many disadvantages to this system however which require a high level of design to mitigate or overcome. To this end, central plant is not the preferred option for this development but should not be ruled out for comparison against other technologies.

12.0 Energy Assessments

Domestic Energy Assessment Procedure – DEAP - Apartments

We have successfully carried out a number of sample DEAP calculations to the residential units in order to demonstrate compliance with TGD Part L 2019 and to develop the design of the fabric and M&E systems.

The critical inputs to the DEAP software & the most beneficial results of the output have been broken down for the readers benefit. The full DEAP output reports as generated by SEAI DEAP 4.0 calculator will be provided with this document as supplementary information.

As per 2019 TGD Part L requirements all new homes typically must meet a BER rating of A2. To this end, the base target for these calculations was to meet or better an A2 rating whilst only changing the M&E plant & renewables required in each scenario to ensure a direct comparison could be made.

A single apartment was selected to provide a direct comparison on how 3 alternative systems perform. The North & East Facing fifth-floor, 2 bedroom, duplex apartment in block B as apartment type B6, was selected to carry out this comparison as a potential worst-case apartment given its north & East facing elevations, Roof exposure, Large Windows & large floor area.

Based on the system descriptions & comparisons as highlighted above in addition to the DEAP results it is proposed that the optimum apartment M&E system would be the Exhaust Air Heat Pump.

Domestic Energy Assessment Procedure – DEAP - Dwellings

A single dwelling was selected to provide a direct comparison on how 3 alternative systems perform. House Type K was selected to carry out this comparison as a potential worst-case apartment given its north & East facing elevations, 3 stories & large floor area.

Given the fact that typical dwellings floor areas Exceed 120m2 and the fabric heat loss may be in excess of 6kW, The EAHP option would not be considered for the dwellings due to its output limitations. If however the insulation levels of the dwelling were to be increased such that heat loss was below 6kW, The EAHP would be a viable heating solution.

Based on the system descriptions & comparisons as highlighted above in addition to the DEAP results it is proposed that the optimum apartment M&E system would be the Air Source Heat Pump

Non Domestic Energy Assessment Procedure – NEAP – Commercial Units

BRIRL calculators attribute energy usage for heating, hot water, ventilation, air conditioning & lighting etc. based on specific notional building usages. As the commercial usage of the units is not confirmed, sample calculations have not been completed.

Prior to development stage, "As Designed" NEAP / BRIRL calculations shall be carried out for the commercial units in accordance with TGD L 2017 to demonstrate compliance with NZEB & also SDCC requirements & recommendations based on their envisaged use. This will ensure the most appropriate M&E systems are selected for these units.

It is expected that the apartment roofs shall be used for solar PV arrays to provide renewable energy contribution to the commercial units regardless of usage.

12.1 Domestic Energy Assessment Procedure – System Comparison -Apartments

	System DEAP 4.0 Comparison		
Building	Option 1 - Apt B6	Option 2 - Apt B6	Option 3 - Apt B6
System Type	**Exhaust Air Heat Pump**	**Air Source Heat Pump**	**Central Boiler & HIU**
Technologies Used	**EAHP**	**ASHP, MVHR & PV**	**HIU, MVHR, PV & ASHP**
Apartment	L3 & 4-2Bed-North Facing	L3 & 4-2Bed-North Facing	L3 & 4-2Bed-North Facing
Floor Area (m2)	91.8	91.8	91.8
Height (m)	2.8	2.8	2.8
Living Room %	16.12	16.12	16.12
System Proposals	**DEAP Parameters**		
Minimum U-Values			
Floors	0.16	0.16	0.16
Pitched Roof	0.14	0.14	0.14
Flat Roof	0.14	0.14	0.14
Walls	0.16	0.16	0.16
Doors	1.20	1.10	1.10
Windows	1.20	1.10	1.10
Solar Transmission/Frame Factor	0.7/0.8	0.7/0.8	0.7/0.8
Global Factors			
Thermal Mass	Medium - High	Medium - High	Medium - High
Thermal Bridging (Acceptable Details)	(0.08 W/m2K)	(0.08 W/m2K)	(0.08 W/m2K)
Ventilation			
Mechanical System	From EAHP Unit	Balanced MVHR	Balanced MVHR
SFP (W/l/s)	0.62	0.92	0.92
Heat Recovery Efficiency (%)	N/A	85	85
Air Tightness (m3/m2/hr @50Pa)	5	3	3
Space Heating			
System	EAHP	ASHP	Gas Boiler & HIU
Controls	Time & Temperature	Time & Temperature	Programmer & TRV
Emitters	Radiators at 45C	Radiators at 45C	Radiators at 75C
Pumps	A Rated Circulator	A Rated Circulator	A Rated Circulator
System Max available Heating Capacity (kW)	6	12	12
DEAP Seasonal Efficiency % (*ns*)	564	414	97
Secondary Systems Required	No	No	Yes
System Type	N/A	N/A	Commercial ASHP
Secondary System Proportion of Total (%)			30%
Secondary System Seasonal Efficiency % (*ns*)			325
Water heating			
Storage Volume (L)	180	176	0
Storage Losses (kWh/24h)	1.2	2.35	0.5
Cylinder Stat/Dedicated Controls	Yes/Yes	Yes/Yes	(NA)/Yes
DHW Temperature (oC)	51	52	65
Type	LED	LED	LED
Efficacy (lm/W)	>85	>85	>85
Renewables			
Additional Renewables Required	No	Yes	Yes
System Type	N/A	Solar PV	Solar PV
Required output (kWh/y)	N/A	60	260
Panel Rating per apartment (W)	0	125	325
DEAP Output			
BER	A2	A2	A2
CPC	0.258	0.289	0.248
EPC	0.266	0.298	0.267
MPCPC	0.35	0.35	0.35
MPEPC	0.3	0.3	0.3
RER	0.359	0.405	0.221
Primary Energy Factor	2.08	2.08	2.08
CO2 Emissions (kg/m2/Year)	8.46	9.5	8.11
Energy Value (kWh/m2/Year)	43	48.33	430.9
Compliance	PASS	PASS	PASS
Additional Items Required Compared to EAHP			
Advantages compared to EAHP			
Disadvantages compared to EAHP			

12.2 System Cost Analysis & Space Comparison

	System Cost Comparison (€)		
	EAHP	**ASHP & MVHR & PV**	**HIU, MVHR, PV & ASHP**
Heating System (€)	10,000.00	5,000.00	9,500.00
Hot Water Systems (€)	Included	1,500.00	Included
Ventilation System (€)	Included	5,000.00	5,000.00
Required Renewables (€)	N/A	500.00	1,000.00
Total (€)	**10,000.00**	**12,000.00**	**15,500.00**

Costs Include Primary Side Production & Distribution & Do Not Include Secondary Components of Heating or Hot Water

	Space Requirements of Plant (m2)		
	EAHP	**ASHP,& MVHR & PV**	**HIU, MVHR, PV & ASHP**
Heating System Central Plant	0	0	2.5
Central Buffer vessels	0	0	4
Central Plant Misc. Equipment	0	0	1.5
Central ASHP/CHP	0	0	15
Gas Incomer	0	0	2
Plant Room Ventilation	0	0	2
Apartment Outdoor Plant	0	1.5	0
Roof Mounted Solar PV Panel	0	2	2
Apartment Heating Unit	0.5	0.5	0.4
Apartment Ventilation Unit	Included	0.5	0.5
Total Estimated Plant Area (m2)	**0.5**	**4.5**	**29.9**

Not Including Space for Primary or Secondary Distribution/Access/Electrical, Fire or Water Storage Requirements

12.3 Domestic Energy Assessment Procedure – System Comparison - Houses

	System DEAP 4.0 Comparison		
Building	Option 1 - Type K	Option 2 - Type K	Option 3 - Type K
System Type	**Air Source Heat Pump**	**Gas Boiler**	**Oil Boiler**
Technologies Used	**ASHP, MVHR**	**Boiler, MVHR & PV**	**Boiler, MVHR, PV**
Dwelling	House Type K	House Type K	House Type K
Floor Area (m2)	175.2	91.8	91.8
Height (m)	9.05	9.05	9.05
Living Room %	12.27	12.27	12.27
System Proposals	**DEAP Parameters**		
Minimum U-Values			
Ground Floors	0.12	0.12	0.12
Pitched Roof	0.14	0.14	0.14
Flat Roof	0.14	0.14	0.14
Walls	0.18	0.18	0.18
Doors	1.20	1.20	1.20
Windows	1.10	1.10	1.10
Solar Transmission/Frame Factor	0.7/0.8	0.7/0.8	0.7/0.8
Global Factors			
Thermal Mass	Medium - High	Medium - High	Medium - High
Thermal Bridging (Acceptable Details)	(0.08 W/m2K)	(0.08 W/m2K)	(0.08 W/m2K)
Ventilation			
Mechanical System	Balanced MVHR	Balanced MVHR	Balanced MVHR
SFP (W/l/s)	0.92	0.92	0.92
Heat Recovery Efficiency (%)	85	85	85
Air Tightness (m3/m2/hr @50Pa)	3	3	3
Space Heating			
System	ASHP	Gas Boiler & DHW Storage	Oil Boiler & DHW Storage
Controls	Time & Temperature	Time & Temperature	Programmer & TRV
Emitters	Radiators at 45C	Radiators at 80C	Radiators at 80C
Pumps	A Rated Circulator	A Rated Circulator	A Rated Circulator
System Max available Heating Capacity (kW)	<16	>15	>15
DEAP Seasonal Efficiency % (*ns*)	414	0.9	0.9
Secondary Systems Required	No	No	No
System Type	N/A	N/A	N/A
Secondary System Proportion of Total (%)			
Secondary System Seasonal Efficiency % (*ns*)			
Water heating			
Storage Volume (L)	203	203	203
Storage Losses (kWh/24h)	1.37	1.37	1.37
Cylinder Stat/Dedicated Controls	Yes/Yes	Yes/Yes	Yes/Yes
DHW Temperature (oC)	55	65	65
Type	LED	LED	LED
Efficacy (lm/W)	>85	>85	>85
Renewables			
Additional Renewables Required	No	Yes	Yes
System Type	N/A	Solar PV	Solar PV
Required output (kWh/y)	0	1700	2000
Panel Rating per Dwelling (W)	0	2000	2500
DEAP Output			
BER	A2	A2	A2
CPC	0.249	0.257	0.34
EPC	0.265	0.295	0.279
MPCPC	0.35	0.35	0.35
MPEPC	0.3	0.3	0.3
RER	0.291	0.311	0.366
Primary Energy Factor	2.08	2.08	2.08
CO2 Emissions (kg/m2/Year)	7.92	8.16	10.81
Energy Value (kWh/m2/Year)	40.25	44.78	41.22
Compliance	PASS	PASS	PASS
Additional Items Required Compared to ASHP			
Advantages compared to ASHP			
Disadvantages compared to ASHP			

12.4 System Cost Analysis & Space Comparison

	System Cost Comparison (€)		
	Air Source Heat Pump	**Gas Boiler**	**Oil Boiler**
Heating System (€)	7,500.00	2,500.00	2,500.00
Hot Water Systems (€)	2,000.00	2,000.00	2,000.00
Ventilation System (€)	6,500.00	6,500.00	6,500.00
Additional Required Renewables (€)	0.00	6,000.00	6,500.00
Total (€)	**16,000.00**	**17,000.00**	**17,500.00**

Costs Include Primary Side Production & Distribution & Do Not Include Secondary Components of Heating or Hot Water

	Space Requirements of Plant (m2)		
	Air Source Heat Pump	**Gas Boiler**	**Oil Boiler**
Heating System Central Plant	0	0	0
Central Buffer vessels	0	0	0
Central Plant Misc. Equipment	0	0	0
Central ASHP/CHP	0	0	0
Gas Incomer/Oil Tank	0	0.25	3
Plant Room Ventilation	0	0	0
ASHP/Boiler Plant	1	2	2
Roof Mounted Solar PV Panel	0	11	14
Hot Water Unit	0.5	0.5	0.5
Ventilation Unit	0.5	0.5	0.5
Total Estimated Plant Area (m2)	**2**	**14.25**	**20**

Not Including Space for Primary or Secondary Distribution/Access/Electrical, Fire or Water Storage Requirements

13.0 Conclusion

From the above review of the DEAP assessment it can be seen that all options can be made Part L 2019 compliant with proper design & the introduction of secondary systems and/or renewables. When comparing the results however it is apparent that the best performing system for the apartments, in terms of Part L requirements for Space heating, DHW production & ventilation is the EAHP (Option 1). This is not only due to the fact that the EAHP does not require any secondary ventilation or renewable technologies but is also due to the testament that it achieves the lowest CO_2 emissions of all technologies, even surpassing option 2 which is the ASHP with solar PV & MVHR. This option can also achieve these ratings with the proposed U-values as listed above. For option 2 & 3 however, the windows & doors need to be upgraded to a much higher standard to achieve an A2 rating.

In addition to the above, option 1 also provides the most cost-effective solution with significant savings when compared to the central plant & HIU but still provides reasonable savings when compared to the ASHP as per option 2. These savings are primarily due to the fact that the system comes fully plumbed & wired with minimal time required by the plumber for primary side components. Also, as it is a packages solution it negates the need for addition costs witnessed in MVHR or solar PV systems.

Further to this the EAHP is also the least demanding in terms of space requirements & therefore it will suit this scheme where floor space is at a premium & there is limited space for location external ASHPs & the distribution of central services could cause further complications.

For these reasons, along with the advantages & disadvantages of each system as laid out in section 11 above it is recommended that the EAHP shall be the chosen system for all apartments in this development.

However, Due to the EAHP heating limitations of 6kW max, any house within this development or any apartment with a heat loss greater than 6kW should be fitted with an ASHP, this is the most cost effective & efficient system to achieve an A2 BER rating for dwellings as per the comparisons made in section 12.3 (when the EAHP is excluded from the comparison). However, A larger 7kW EAHP expected to be available in 2022 & may provide a further option for heating, Hot water & Ventilation for the houses. Allowing the residential part of this development to work fully with an EAHP solution.

Design of the apartment LTHW system shall be done to ensure that radiators are sizes appropriately for LTHW at 50C with a MWT of no less than 40C. Alternatively and where applicable, UFH shall be utilised to mitigate the need for oversized radiators.

Commercial units shall also be fitted with ASHPs & solar PV where suitable to ensure compliance however, where hot water usage is high (such as hair dressers etc.) the use of a gas fired combi boiler can also achieve compliance without sacrificing service to occupants. It is also essential that the lighting throughout the commercial units is via high efficiency LED lighting with outputs no greater than 8W/m2

Preliminary BRIRL reports show that the creche can be heated with a mix of ASHP and AC units without the need for additional renewables-See attached prelim BRIRL.

It is our intention to ensure that the proposed M&E design will meet all the requirements of TGD part L 2019, TGD part L 2017 & SDCC.