‘Proposed SHD on lands at former Greenpark Racecourse, Limerick City’

Voyage Properties Ltd.

WoodsPS - Building Services Engineers

Energy Statement
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1 Introduction

Woods Project Service Ltd. (WPS) have been commissioned as Mechanical and Electrical Consultants to provide design guidance for typical Mechanical and Electrical system requirements, including but not limited to those requirements set out in TGD Part L 2019: Conservation of Fuel and Energy (NZEB) for the “Proposed SHD on lands at former Greenpark Racecourse, Limerick City”.

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

As NZEB and part L 2019 compliance is not achieved by Mechanical and Electrical systems alone, WPS will engage the whole design team to take a holistic approach to compliance and ensure that the building fabric and 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 and 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 and effectiveness of any given technology.

The document has been produced for the benefit of “Voyage properties Ltd” 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.

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 and best practice guides have also been referred to where applicable as have manufacturers data sheets and other NZEB reference documents.

All conclusions drawn or recommendations made in this document are the opinion of WoodsPS 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.

2 Scope

This document will focus on the various factors within the “Proposed SHD on lands at former Greenpark Racecourse, Limerick City” residential housing development, encompassing lands off the Dock Rd and next to the Greyhound Stadium, that could potentially affect the incorporation of renewable technologies and will address the advantages and disadvantages of proposed technologies whilst comparing them against each other to identify the most suitable solution for this project.

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) and maximum carbon dioxide emissions as calculated using the DEAP methodology.

This document shall explore the proposed items with respect to TGD Part L 2019 Compliance:

Legislative Requirements

Calculation Requirements

Building Fabric Requirements

Proposed Technologies

3 Summary

This report investigates the proposed energy strategy for the development of new units consisting of 371 no. residential units comprising 157 no. two storey houses (consisting of 10 no. 4 bedroom units, 110 no. 3 bedroom units and 37 no. 2 bedroom units); 76 no. three storey duplex units (consisting of 14 no. 3 bedroom units, 38 no. 2 bedroom units and 24 no. 1 bedroom units) and 138 no. apartments (consisting of 92 no. 2 bedroom units and 46 no. 1 bedroom units arranged in 3 no. blocks ranging between 4 and 5 storeys together with communal amenity space) and a childcare facility (550 sq m), including all private, communal and public open space provision (including balconies and terraces to be provided on to front and rear elevations and related play areas); surface car parking (510 no. spaces in total, including car sharing and accessible spaces); electric vehicle charging points; bicycle parking (long and short stay spaces including secure stands); storage areas; internal roads and pathways; hard and soft landscaping and boundary treatments; piped infrastructural services and connections; plant; revised entrances and tie-in arrangements to adjoining roads, including emergency access via Log na gCapall; waste management provision; solar panels; attenuation tank and related SUDS measures; signage; public lighting; bulk earthworks; and all site development and excavation works above and below ground. Vehicular access to the site will be from Dock Road, via the proposed access road.

At “Proposed SHD on lands at former Greenpark Racecourse, Limerick City” the report will investigate the legislative requirements in addition to the requirements and expectations of the local council to ensure that the energy strategy is compliant with both statutory and local authorities. Several potential mechanical systems are reviewed within this report with the aim of selecting the most suitable system for this development. Advantages and disadvantages are provided for each system along with a further cost review and Part L comparison for the most appropriate systems.

4 Limerick City and County Council Requirements

Our design will consider the current council policies and objectives of the County Development Plan 2010-2016 and Climate change action plan 2019 – 2024 to ensure the development meets the council’s requirements for sustainability, Greenhouse Gas Reduction and Energy Efficiency.

This will ensure that the development adheres to the policies of Limerick County Council to ensure that homes are energy efficient and equipped for challenges anticipated from a changing climate. As part of this process, product selection shall consider the lifespan, renewable contribution, efficiency and embodied energy to limit the overall environmental impact of new.

To this end, the homes will be designed to make good use of the site to achieve natural lighting 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 and reduce Carbon emissions. Further to this, renewable technologies will be incorporated into the scheme.

Below noted LCC requirements-

Promote the efficient use of land and of energy and minimize greenhouse gas emissions.

The Council aims to provide a systematic analysis of how a residential development, when submitted as a planning application, measures against criteria as required by the ‘Urban Design Manual–A Best Practice Guide–A Companion Document to the Planning Guidelines on Sustainable Residential Development in Urban Areas,’ by the DEHLG May 2009. The aim is to optimize sustainability throughout the process of the building of a residential development, from the design stage to the final product of a person living in an energy efficient dwelling, connected to existing or improved infrastructural and community services such as education, transport, amenities, etc. The design of residential estates should be guided by the principle of universal design, which is the design of an environment so that it can be accessed, understood, and used to the greatest extent possible by all people regardless of their age, size, ability or disability. 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.

5 Energy Strategy

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

Ensuring Building fabric controls heat gain and heat loss as necessary to limit the requirement for external energy usage for heating or cooling.

Production of a DEAP Calculation is provided for all dwellings and that the result shows:

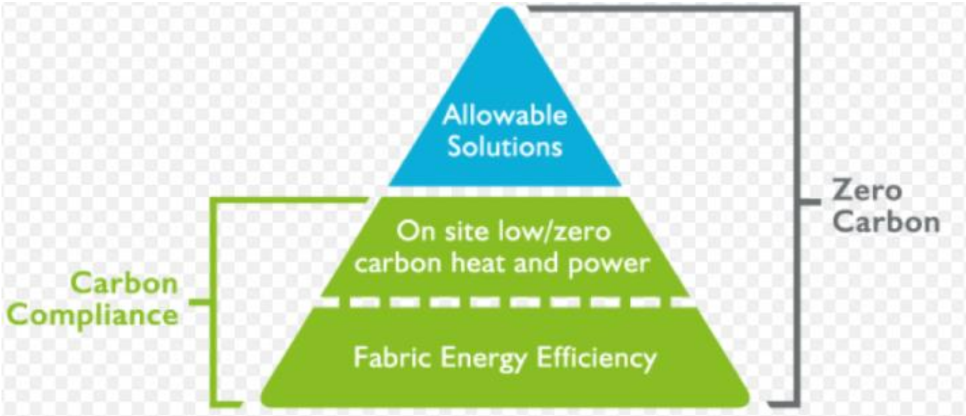
A 25% improvement in energy performance on the former TGD Part L 2011

A MPEPC of 0.3

A MPCPC of 0.35

A RER of 0.2

As per the above requirements, the overall design of this residential development shall follow the principles 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 and councils who are currently achieving or exceeding NZEB requirements.



This is Therefore considered an acceptable strategy in achieving maximum carbon reduction and energy efficiency in new buildings by-

- Primarily using less energy through minimizing heat loss and incorporating low energy technologies
- Secondly, by ensuring that the energy source is efficient and utilizes Low Carbon production methods.
- Lastly, by means of incorporating renewable energy sources to offset the essential energy consumption for the running of the building.
- 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 behavior.
- Reduces adverse noise impacts internally and externally.
- 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 reasonably 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 2019 Conservation of Fuel and Energy – Dwellings.
- 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.

6 Legislative Requirements

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 and amended in 2018 to “Directive on Energy Efficiency (2018/2002) which updates the policy framework to 2030 and beyond.

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.

The Department of Communications, Energy and Natural Resources (DCENR) is responsible for implementation of the EED in Ireland. The Sustainable Energy Authority of Ireland (SEAI) is responsible for measuring energy savings achieved and for implementation of many energy efficiency support programmes.

The EED was transposed into Irish law in 2014 by means of Statutory Instrument (SI) 426 of 2014 European Union (Energy Efficiency) Regulations 2014. A number of other SIs have been finalised and have become law since.

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.

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).

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 based on a cost- optimal methodology. Member states may set minimum requirements for the energy performance of buildings.

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.

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.

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.

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:

1. Decentralised energy supply systems based on energy from renewables.
2. Cogeneration i.e. Combined heat and power systems

3. District or block heating or cooling, if available, particularly where it is based entirely or partially on energy from renewable sources.
4. Air to Water Heat pumps

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.

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

- Thermal Capacity.
  - (Ii) Insulation.
  - (Iii) Passive Heating.
  - (Iv) Cooling Elements; And
  - (V) Thermal Bridges.
- Heating Installation and Hot Water Supply, Including Their Insulation Characteristics.
- Air-Conditioning Installations.
- Natural and Mechanical Ventilation Which May Include Airtightness.
- Built-In Lighting Installation (Mainly in The Non-Residential Sector).
- The Design, Positioning and Orientation of The Building, Including Outdoor Climate.
- Passive Solar Systems and Solar Protection.
- Indoor Climatic Conditions, Including the Designed Indoor Climate.
- Internal Loads.

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

- Local Solar Exposure Conditions, Active Solar Systems and Other Heating and Electricity Systems Based on Energy from Renewable Sources.
- Electricity Produced by Cogeneration.
- District or Block Heating and Cooling Systems.
- Natural Lighting.

7 Part L Requirements

7.1 TGD Part L 2019 – Conservation of Fuel and Energy (Dwellings)

Has the following sub sections and 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.

7.2 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 on-site or nearby.”

7.3 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 and ensuring that energy reductions have been made using each item.

7.4 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 and 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 program.

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 and 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 and electrical load profile of the building and should be designed as per CIBSE AM12.

Renewable energy technologies are also subject to compliance with TGD Part D 2013 – Materials and workmanship and should be of suitable quality satisfy the requirements laid out therein. The SEAI database should be consulted for acceptable Renewable products before design and 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 and Example F where a Primary energy consumption of 37 kWh/m2 yr. and 40 kWh/m2 are required alongside a RER of 0.23 (achieved via Solar PV) and

0.34 (achieved using an ASHP) respectively.

Both apartments have triple glazing and 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

7.5 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 and 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 is given to minimise the direct heat loss through the fabric of a building and also to minimise direct and 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.

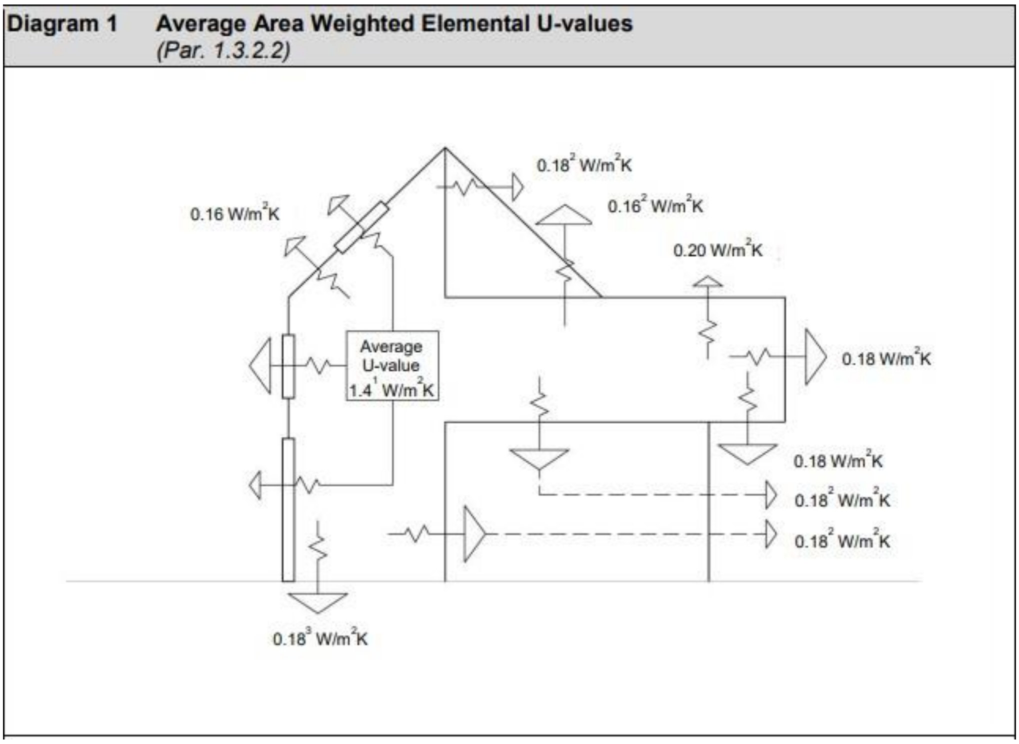


Image above Showing Average Area Weighted U-Values from Diagram 1 of TGD L 2019

7.6 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 (Glebe 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

<u>Thermal Bridging</u>

The key purpose of minimising thermal bridging coefficients is to avoid excessive heat loss and potential condensation issues at critical junctions and details, including, Wall to wall, Wall to Roof, Windows and Doors along with other penetrations for Services fixings. DEAP calculation methodology considers thermal bridging and 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 and air Infiltration – Acceptable Construction Details”.

Limitation of air permeability

Further to limiting fabric heat loss and thermal bridging, the reduction of air permeability in a given dwelling can have significant reductions in primary energy consumption and 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 and ceiling joints,

service openings, doors and 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 and purge ventilation functions can offer reductions in thermal gains in dwellings however these are reactive measures, and the selection of building fabric elements will have the most beneficial impact in limiting heat gains.

Passive solar design is the aim for a 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 daylighting 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 daylighting for overall energy use.

7.7 Building Services Compliance

7.7.1 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

7.7.2 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 and storage.
b. Intelligent control systems to optimise efficiency and provide the end-user with appropriate energy usage information.
c. Mechanical ventilation systems with heat recovery and SFPs in compliance with TGD L 2019
d. Renewable heat sources and or incorporation of Solar PV systems

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

8 Heating and Hot Water Production: Distribution and 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 and frost protection shall be utilised where pipework crosses unheated or external spaces.

Control systems shall be capable of providing automatic control of space heating based on room temperature and 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 and 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 and 3 of TGD L 2019 and as per "achieving compliance with Part L" document yet to be published.

<u>Mechanical Ventilation</u>

All ductworks will be appropriately sized and service routes shall be optimised to minimise fan power requirements and improve system efficiency. All SFPs will be in compliance with TGD L 2019 and DEAP minimum requirements and 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 and 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 and efficient solution.

<u>Renewable Heat Sources or Incorporation of Solar PV</u>

There are many readily available technologies that can provide renewable heat such as Air source and 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 and 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 and 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 and 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.

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.

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 MandE systems and their operation, A comprehensive and easy to interpret building user guide will help to prevent these unnecessary energy losses.

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 (35^{O}C to 55^{O}C) can be used to heat DHW or internal spaces via radiators or underfloor 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, 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 and 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's 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 and pressure, which then re- enters the evaporator to absorb more free energy from the atmosphere and continue the cycle.

A2W Heatpump

ASHPs operate at maximum efficiencies in mild conditions as the free energy available from the atmosphere is dependent on external air temperatures and humidity. The COP also drops of when heating water to a temperature greater than 35^{o}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^{o}C to allow stored DHW to reach at least 50^{o}C. When these two situations are combined, e.g. the external air temperature is below freezing and the desired LTHW setpoint is 55 ^{o}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 and 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 the 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 and Maintenance Costs
b. High equipment lifespan of 20+ years with guarantees often lasting 5-10 years
c. Simple and proven technology with many trained and 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 and becoming more understood and available.
i. Small footprint of unit
j. Large scale ASHPs can be used to supplement LTHW production in large, centralized plant thus effectively replacing the use of CHP units.
k. Effective for heating and 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 and 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 and noise could cause a 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 and aesthetic problems)
e. Must be mounted externally and 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

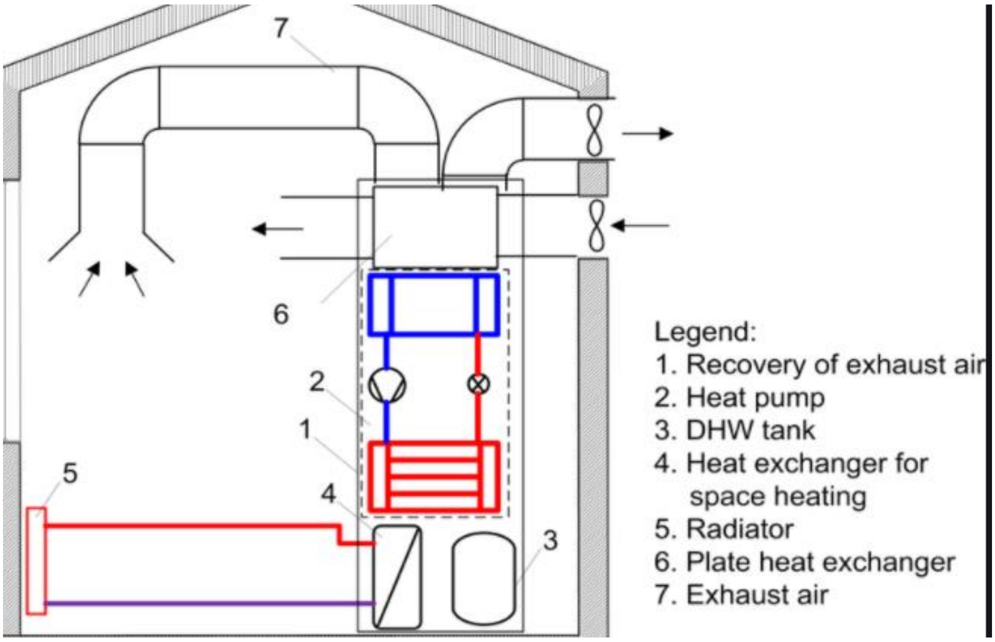
ASHP technology is well suited to this development for many of the advantage highlighted above. The A2W Heat pumps can be located in the back Garden of each unit, the **ECODAN** range offer an **Ultra-Quiet** unit which ensures no interference with the neighbours.

The Mitsubishi range of ASHP can be cascaded to provide suitable heating and hot water for larger projects and this will be utilised for provision to the creche and Nursing Home.

Exhaust Air Heat Pump

These systems 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 and 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 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) and the extract and exhaust air is transferred via a duct network and 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 and 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.



Advantages

a. Extremely high Coefficient of Performance achieves a system efficiency comparable to 535% of a conventional system.

b. Low running and Maintenance Costs

c. High equipment lifespan of 20+ years with guarantees lasting 7 Years.

d. Simple and proven technology.
e. Units are prewired andp re-plumbed and can be installed by plumbers and 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 and there are none of the complications in finding a suitable location as described in section 11.5 above.
n. Effective for heating and 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 and ventilation) is often cheaper than the install of a conventional ASHP alone.
q. Full integrated controls for heating and hot water with wireless connectivity and remote access and control
r. System was invented in 1980s and 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 and apartments may not be suitable for this technology.
b. Low temperature of LTHW network requires oversized radiators or underfloor heating for space conditioning.
c. Low temperature of DHW production of 55 ^{O}C (this is still an acceptable temperature for hot water usage in the home)
d. Not suitable for larger properties ie 3 bed/4 bed houses

Applicability to this Development

EAHP technology is ideally suited to this development for many of the advantages highlighted above. These units will be well suited for the **Duplex and Apartment units** where a back garden may not be best suited for location of A2W units

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9 Conclusion

From the above review of the above report a combination of ASHP and EASHP will work well within this project providing energy efficient hot water and Heating systems in Line with TGD Part L and within the guidelines of NZEB building design.

In addition to the above, these solutions provide the most cost-effective solutions for both developer and owner, ensuring a energy frugal and efficient solution for each type of property.

The EAHP is also the least demanding in terms of space requirements and therefore it will suit duplex units where floor space is at a premium and there is limited space for location external ASHPs and the distribution of central services could cause further complications.

Design of the apartment LTHW system shall be done to ensure that radiators are sizes appropriately for LTHW at 55C with a MWT of no less than 40C. Alternatively and where applicable, UFH shall be utilised to mitigate the need for oversized radiators.

It is our intention to ensure that the proposed MandE design will meet all the requirements of TGD part L 2019 and LCC.