RENAISSANCE ENGINEERING

Energy Statement

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Executive Summary

This report prepared by Renaissance Engineering demonstrates the strategy for the mechanical & electrical systems including the energy performance and the sustainability of construction for Greenleaf Homes Ltd. of the proposed development as described in the planning report.

The energy strategy has been approached in a holistic manner using the energy hierarchy “Be Lean, Be Clean, Be Green” in order to comply with Technical Guidance Document Part L – Conservation of Fuel and Energy Buildings Dwellings 2018, and South Dublin County Council Regulations.

The design will place high emphasis on passive solar design, combining external local shading with high performance glazing in order to minimise solar heat gain in accordance with the Part L solar overheating criteria while maximising natural daylight access.

Key features of the energy efficient design of Greenleaf Homes Ltd. include enhanced building fabric performance, mechanical ventilation heat recovery, hot water heat pump systems, electric radiators and high efficacy lighting with occupancy and daylight control where applicable. The proposed energy strategy as detailed in this report is compliant with the requirements of Part L and achieves NZEB.

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1 Introduction

The proposed design will comply with national building regulations for energy performance and carbon emissions set out in the 'Technical Guidance Document Part L - Conservation of Fuel and Energy 2018 Draft - Dwellings' (referred to in this document as 'Part L'). A provisional Building Energy Rating (BER) will also be produced in line with the EU Directive on Energy Performance in Buildings (EPBD).

The overall energy strategy of the proposed design has been approached in a holistic manner using the adopted energy hierarchy "Be Lean, Be Clean, Be Green". Energy performance has been assessed in accordance with the Domestic Energy Assessment Procedure (DEAP) methodology to demonstrate the systematic improvement in energy performance.

2 Renaissance Engineering's Approach

2.1 Energy Strategy Methodology

The proposed development will aim to exceed where feasible the requirements of Part L and achieving Nearly Zero Energy Building (NZEB) performance.

2.2 Energy Hierarchy

In order to achieve these objectives, the following energy hierarchy (referred to as "Be Lean, Be Clean & Be Green") has been used to identify and prioritise effective means of reducing carbon emissions.

Be Lean
Energy efficiency through design and use

Be Clean
Optimise energy supply infrastructure for efficiency through 'Low Carbon' strategies

Be Green
Utilise renewable energy resources where appropriate

Renaissance Engineering considers the above a hierarchy proposed and/or endorsed internationally 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 CO_2 savings at each stage are maximised before strategies at the next stage are considered.

3 Legislative and Planning Requirements

Any new developments need to comply with two things;

1. National Legislation to meet requirements of the EU Directive on Energy Performance in Buildings (EPBD).
2. Local planning requirements as determined by the local authority.

3.1 Building Regulations Technical Guidance Document Part L

The Technical Guidance Documents Part L – Conservation of Fuel and Energy 2018 Draft – Dwelling stipulates the following requirements on new dwelling:

1. Limitation of Primary Energy Use and CO_2 Emissions.
2. Renewable Energy Technologies.
3. Building Fabric.
4. Building Services.
5. Construction quality and commissioning of services.

3.2 Nearly Zero Energy Buildings (NZEB)

Directive Recast 2010 (EPBD), stipulating all new buildings to be nearly zero energy buildings by the 31st of December 2020 and all buildings acquired by public bodies by 31st December 2018.

The definition for Nearly Zero Energy Buildings in the Energy performance in Buildings Directive (EPBD) is "a very high energy performance, as determined in accordance with Annex 1, 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".

NZEB is not separate to the building regulations, it is merely a term used to define the targeted performance of building regulations in the near future. Each member government has discretion in how the standard is applied nationally, and to comply with the NZEB requirement, the Irish government has issued the revised Building Regulations in the form of:

1. Technical Guidance Document Part L – Conservation of Fuel and Energy Dwellings (2018).
2. The Technical Guidance Document Part F – Ventilation (2018).

3.2.1 Domestic Energy Assessment Procedure (DEAP)

For new buildings, it is proposed that NZEB will be equivalent to a 25% improvement in energy performance on the 2011 Building Regulations and have a renewable energy ratio of 20%.

In order to demonstrate that an acceptable primary energy consumption rate has been achieved for NZEB, the ratio between the calculated Energy Performance Coefficient (EPC) should not be greater than the Maximum Permitted Energy Performance Coefficient (MPEPC), with a value of 0.30. Similarly, the ratio between the calculated Carbon Performance Coefficient (CPC) should not be greater than the Maximum Permitted Carbon Performance Coefficient (MPCPC), with a value of 0.35.

3.2.2 Achieving Compliance

The table below gives guidance on the acceptable levels of provisions required to ensure that heat loss through the fabric of the building is limited.

Fabric Elements	2011 Part L	2018 Part L (NZEB)
Pitched Roof	0.16	0.16
Flat Roof	0.20	0.20
Walls	0.21	0.18
Ground Floors	0.21	0.18
Other Exposed Floors	0.21	0.18
External Personnel Doors, Windows and Rooflights	1.6	1.4

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

3.3 Renewable Energy Technologies

New developments are obligated to install some form of renewable energy technologies in the premise to comply with regulations. The permissible technologies refer to equipment that supply energy derived from renewable energy sources, e.g. solar thermal, on-site solar photovoltaic, heat pumps, combined heat and power and other on-site renewable energy systems.

The minimum level of energy provision required to satisfy regulations are presented below. For developments with more than one dwelling, every individual dwelling or the average of the development would collectively be required to contribute:

- 10 kWh/m²/annum energy use for domestic hot water heating, space heating / cooling; or
- 4 kWh/m²/annum of electrical energy; or
- a combination of these which would have equivalent effect.

3.4 Building Fabric

Building Regulations Part L outlines the acceptable levels of provisions necessary to ensure that heat loss through the fabric of a building is minimised. The technical document discusses various aspects, including:

- Insulation levels to be achieved by the plane fabric elements.
- Thermal bridging.
- Limitations of air permeability.

3.4.1 Fabric Insulation

The new development will be designed and constructed to limit heat loss and where appropriate, limit heat gains through the fabric of the building. In order to limit the heat loss through the building fabric the thermal insulation for each of the plane elements of the development will meet or exceed the area weighted average elemental U-Values as specified in Part L.

3.4.2 Thermal Bridging

To avoid excessive heat losses and local condensation problems, consideration will be given to ensure continuity of insulation and to limit local thermal bridging, e.g. around windows, doors and other wall openings, at junctions between elements and other locations. Heat loss associated with thermal bridges is considered in calculating primary energy use and CO_2 emissions using DEAP methodologies.

Acceptable Construction Details will be adopted for all key junctions where appropriate (i.e. typical/standard junctions). For all bespoke key junctions, certified details which have been certified by a third-party certification body will be used.

The default values for thermal bridging as set out in table D2, Appendix D of TGD – Part L, will be used or the certified details for any bespoke key junctions.

3.4.3 Air Permeability

In addition to fabric heat loss, reasonable care will be taken during the design and construction to limit the air permeability (Infiltration). High levels of infiltration can contribute to uncontrolled ventilation. Part L requires an air permeability level no greater than $5m^3/h/m^2$ at 50 Pascals for NZEB. Where lower levels of air permeability are achieved, it is important that purpose provided ventilation is maintained. The design intent will be to achieve an air permeability of $3m^3/h/m^2$ @ 50Pa (TBC) which represents a reasonable upper limit of air tightness.

4 Energy Efficient and Sustainable Technologies Considered

4.1 District Heating Network

District heating systems deliver heat for both space heating and water heating needs to buildings through a network of insulated pipes. Heat is produced centrally in large plants and delivered through the district heating network. The usage is transferred to each user via a Heat Interface Unit and then metered.

South Dublin City Council has launched the Tallaght District Heating Scheme. This scheme will supply low cost heat with a low carbon footprint to the area. The system will harness waste heat from a local data centre.

District heating systems offer advantages in terms of higher energy efficiencies, reduced consumption of energy resources and are fully compatible with European and National policies and objectives for carbon dioxide reduction, energy efficiency, security of energy supply, sustainability and competitiveness. District heating can also offer capital cost savings and reduced operating and maintenance costs to commercial and residential customers.

Advantages

- Multiple sources of heat generation can be utilised: Condensing boilers, biomass, CHP and heat pumps.
- Reduces labour and maintenance costs associated with individual systems.
- Hot water available around the clock.
- Helps to manage the supply and demand of heat to avoid unnecessary production while still meeting needs.

Disadvantage

- If a major issue occurs, the entire site will lose heat.
- Large capital investment required.
- Responsibility for consumer billing.

4.2 All Electric

4.2.1 Electric Radiators

In the past electric heating was considered by many as one of the most inefficient heating systems on the market. This was primarily due to certain types of heaters like night rate storage heaters and panel heaters. Today however, electric radiators made with high thermal ceramic heating elements with digital thermostat controls are very efficient with low running costs. Electric radiators are 100% efficient, meaning all the electricity used is converted into heat unlike conventional wet systems where there are losses in several areas of the system. There are losses in the boiler itself, the flue connecting to the boiler has its losses where wasted energy is exhausted into the atmosphere and then there are the losses in the heating pipes that travel around from radiator to radiator. On average a conventional wet system would incur losses of around 20%, making the system only 80% efficient.

Advantages

- One of the cheapest forms of heating systems. There is no requirement for expensive equipment like boilers, pumps, valves and accessories to operate.
- Low maintenance costs associated with an electric heating system unlike a conventional wet heating system.
- Electric heating with built in sensitive thermostatic controls allows the radiator to quickly adapt to changes in room temperature.
- The future is electric and electric heating. By integrating a renewable energy source like of photo voltaic panels (PV) into the heating system, the dwelling can produce its own to use for heating.

4.2.2 Hot Water Heat Pump Cylinder

Air to Water Heat Pump (ASHP) Systems are a standalone system suited for any dwelling. The system works on a lower operating temperature which drastically reduces running costs. Throughout the year, the heat pump will run at efficiencies of 250-450% depending on ambient temperature. The system works best in conjunction with underfloor heating and aluminium radiators but can also be installed with suitably sized steel radiators. By integrating the heat pump directly into the water cylinder, however, a hot water heat pump can be formed which will cater for the hot water requirements of a dwelling while the heating requirements can be met by electric radiators. This drastically reduces the need for pipes, pumps, valves and accessories required in the traditional wet system.

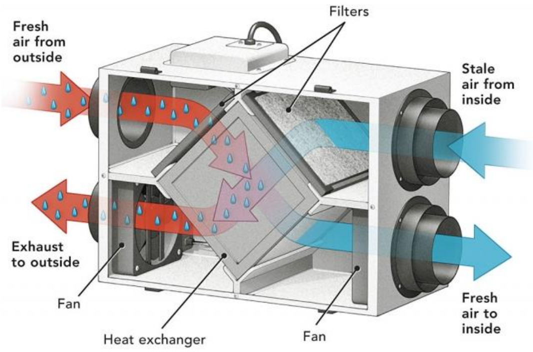
4.2.3 Solar Photovoltaic

Solar Photovoltaic (PV) systems generate electricity from sunlight. The panels produce electricity in the form of direct current (DC). As this form cannot be utilised by household electronic equipment, an inverter is used to convert the electricity to alternating current (AC).

Advantages

- Solar PV is a proven technology that, once installed, will provide free electricity for decades.
- Since there are no moving parts, PV panels require minimal maintenance. PV panels also generally have 25 years' performance warranties and a life expectancy in excess of 30 years.
- Annual solar irradiation can be estimated using historical weather data. Therefore, the electricity generated is predictable.
- Solar PV is versatile, offering multiple methods of roof, ground installations, as well as car ports, awnings, facades, etc.
- Prices of PV panels have fallen by 40% since 2014, and 75% since 2009.
- With a feed-in tariff (FiT), excess electricity can be sold back to the grid. FiT is yet to be adopted.
- Solar PV systems can be coupled with battery technology to store electricity for night-time usage. However, the overwhelming majority of systems are 'grid connected' and not battery systems.

4.2.4 Mechanical Ventilation Heat Recovery



Mechanical ventilation with heat recovery (MVHR) is a whole-house ventilation system which supplies fresh air to dry rooms and extracts stale air from wet rooms. Both air flows are ducted and driven by two fans, one on the supply side and one on the extract side. The key element of this system is that it uses a heat exchanger to transfer heat from the warm exhaust air to the fresh air, achieving up to 85% heat recovery. The reduction in heat losses due to ventilation is significant and occupants' comfort is also increased as the air supply is warmed before entering the rooms. The MVHR unit which houses the heat exchanger and the fans is also equipped with filters which prevent outside dust entering the system and internal air particles depositing within the unit.

Advantages

- Waste heat from extract air is recovered, reducing the heating load.

Disadvantages

- Increased capital outlay in comparison with mechanical extract, passive supply systems.
- Central systems will require larger than normal ceiling voids and riser space to distribute ductwork.

5 Mechanical and Electrical Services Strategy

With the current insulation levels associated with NZEB standards, amalgamated by the modern efficiencies and simplistic M&E designs associated with electric technologies, choosing an all-electric solution is more cost effective to install and operate for a large development predominantly comprised of residential units.

Renaissance Engineering is currently consulting on a 3rd Generation District Heat Network in Liverpool consisting of 540 No. apartments, 7,000m^2 of commercial space, a 180-bed hotel and a 200-bed aparthotel under development for future connection. The heating scheme operates at a flow and return temperature of 80°C and 60°C respectively, feeding each unit via a Heat Interface Unit or a heat exchanger. The heat consumed is metered and then distributed around each unit via a hydronic system and its associated ancillary equipment such as pumps and valves. These items will drastically increase the installation costs associated with the development as well as introduce additional complexity in the design and increase the maintenance costs pertinent to each unit in the development

As district heating schemes operate on the basis of ensuring hot water availability around the clock, high temperature water is continuously circulated throughout the extensive pipe network of the development. This results in thermal losses throughout the year, being predominantly higher during the summer months when the thermal demand is lower due to the lack of space heating requirements. There will also be losses through the pipework in the apartments as well as losses in the radiators' ability to dissipate heat. On the other hand, electrical radiators do not suffer the same compounded effect of losses from a hydronic system. Aided by their ability to reach temperature quickly, the 100% efficient electric radiators can modulate their output / turn on and off with ease and on short notice to ensure the radiators are active to combat the dwellings thermal losses. This characteristic enables the electric system of being cost effective to operate even though electricity rates are higher than natural gas prices.

Glen Dimplex have conducted an in-depth analysis comparing a 3rd generation centralised district heating scheme with an all-electric system. Their analysis is summarised in the tables below.

M&E Costs	70 Apartments	100 Apartments	190 Apartments
District Heating	€863,100	€1,189,684	€2,252,000
Dimplex e-heat	€455,000	€650,000	€1,235,000
Savings	**€408,100**	**€539,684**	**€1,017,000**

Table 2: Residential installation cost (Source: Glen Dimplex NZEB Solutions for Apartments)

Running Costs	70m^2 Ground Floor Apt.	50m^2 Middle Floor Apt.	100m^2 Top Floor Apt.
District Heating	€313.92	€170.64	€333.09
Dimplex e-heat	€248.78	€113.86	€233.40
Savings	**€65.14**	**€56.78**	**€99.69**

Table 3: Residential operating cost (Source: Glen Dimplex NZEB Solutions for Apartments)

Table 2 highlights a gradual increase in the amount of savings obtainable by installing an all-electric system with increasing development size. For Greenleaf Homes Ltd., with 544 residential units, the forecasted savings by installing an electric development is €4,187,805. This figure doesn't account for savings from the commercial areas.

With a world evolving to becoming more electric and renewable dependent and as electricity prices continue to stabilise in the future with the rollout of wind generation farms across the country that will contribute to 40% of the demand on the grid, an all-electric development appeals to masses for being future proof.

The possibility of connecting the development to Tallaght's District Heating Scheme instead of an independent DHS is also being considered. The Tallaght DHS promises to supply hot water by reclaiming heat from a local data centre. This option promises low carbon heating to a residential market. However, we are currently awaiting further information regarding Tallaght's DHS from Codema to complete the assessment.

5.1 Mechanical Services

- Each apartment shall be fitted with electric radiators.
- Each room shall be fitted with electric radiator(s) suitably sized to overcome heat losses.
- The bathrooms shall be fitted with appropriately sized electric towel radiators.
- DHW for the apartment shall be generated from an aptly sized hot water heat pump cylinder.
- Each apartment shall be fitted with a mechanical ventilation heat recovery (MVHR) unit and its associated duct work.
- The MVHR unit shall extract air via ventilation ducts positioned in the wet rooms of the apartments such as bathrooms, kitchens, and utility rooms.
- Horizontally mounted PV panels shall be fitted to generate the renewable energy contribution required to comply with NZEB standards.
- All rooms will be controlled by a thermostat on the electric radiators.
- Mains water will be supplied to each apartment from a suitably sized break tank located on the ground floor, individually terminating at an isolation value located under the sink, and continuing to serve the cold-water storage tank.
- Hot water shall be generated by the cylinder.
- Cold water shall be generated by the cold-water storage tank.
- Hot and cold water shall be boosted via a booster pump to all sanitary ware items with the exception of the toilet.
- Soils and waste pipework shall be installed to all sanitary ware items.
- There will be pressurised water services throughout the dwelling including all showers and taps.

5.2 Electrical Services

- A suitably sized distribution panel shall be located in the utility room.
- Electrical sockets / outlets with USB ports and dimmable light switches will be strategically installed throughout the dwelling. Shaver sockets shall be supplied in the bathrooms.
- All socket outlets & light switches shall be White Plastic Type MK Logic or equal throughout.
- Lighting will be energy efficient LED throughout.
- Each apartment shall be supplied with a fire alarm system via the landlord system which shall be independent of the apartment fire alarm system.
- Each room within the apartment shall have a mains smoke/heat detector installed.
- An audio and visual intercom system shall be linked from each apartment to the entrance.
- Complete CAT6 cabling installation for use with telephone/data services shall be provided.
- The development will be provided with electric vehicle charging stations.