Sustainability Report

Strategic Housing Development at Mill Road, Saggart, County Dublin

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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 of the proposed development as described in the planning report.

The proposed development shall consist of a combination of houses and apartments. Two blocks of apartments ranging from five to eight storeys in height will contain a mix of primarily 1-bed and 2-bed units and a total of 185 apartments. 38 duplexes and 51 houses make up the remaining units for a total of 274 dwellings on the overall site.

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 2019, and Dublin City Council Regulations.

Key features of the energy-efficient design of the Strategic Housing Development at Mill Road, Saggart, County Dublin include enhanced building fabric performance, local electricity production by solar photovoltaic, electric radiators and high-efficacy lighting with occupancy and daylight control where applicable. Consideration will be given to hot water heat pumps and mechanical ventilation with heat recovery as part of Domestic Energy Assessment Procedure analysis.

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 2019 - 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 hierarchy, proposed and/or endorsed internationally by many local authorities, to be an appropriate set of principles for adherence to in tackling climate change. Adoption of this hierarchy as an overarching philosophy for design shall enable maximisation of CO_2 savings at each stage of the design process from early concept selection through to detailed design and realisation at later stages.

3 Legislative and Planning Requirements

Any new developments need to comply with two criteria:

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 2019 – Dwellings stipulates requirements in the following areas (applicable to new dwellings):

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) stipulates all new buildings shall 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 (2021).
2. The Technical Guidance Document Part F – Ventilation (2019).

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	2019 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/m^2/annum energy use for domestic hot water heating, space heating / cooling; or
- 4 kWh/m^2/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 Guidance 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.

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.

Disadvantages

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

4.2 Centralised System (apartments) utilising Gas Boilers and CHP

Combined Heat & Power (CHP) increases the efficiency of energy generation from internal combustion of either natural gas, LPG, oil or bio-diesel.

CHP or cogeneration is the simultaneous generation of heat and electricity from the one piece of equipment. Heat that is usually lost in the power generation process is captured and used to heat water.

By capturing heat that is usually wasted, the much higher running efficiencies (in some cases greater than 99%) achieved can generate significant carbon and energy savings for the user. These savings are recognised in TGD L - Buildings other than Dwellings 1.2.5 as making CHP an acceptable alternative to renewable technology:

"As an alternative to providing the RER (Renewable Energy Ratio) as outlined in sub-section 1.2.1 the use of a combined heat and power (CHP) system which contributes to the space and water heating energy use would be acceptable.

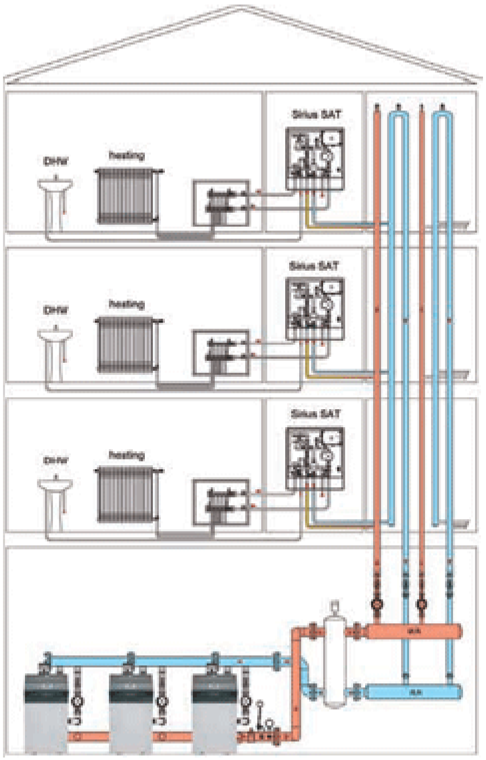
The primary energy savings due to the use of CHP should be equivalent to the RER of 0.20 or 0.10 as applicable contributing to the thermal energy use within the building. The calculation methodology for the primary energy saving contribution is provided in the NEAP calculation.

The design of the CHP system should take account of the output rating of the appliance and the design thermal profile for the development for which it is designed. It should be suitable for the building application (simultaneous electrical and thermal profile requirements) and not oversized."

The heating system comprises a combination of gas boilers and a CHP unit, sized appropriately to meet the objective of Part L and to optimise the cost of installation and operation. Water is heated in the plantroom and circulated throughout the building, via one or more buffer vessels, to each apartment. The heat is transferred to the apartment circuit via a heat exchange device termed a Heat Interface Unit (HIU).

A HIU is an integrated solution for delivering and recording the heat consumed by an individual dwelling served from a centralised heating plant or district heating scheme. HIUs provide localised control and metering in a self-contained package, allowing simple integration of individual dwellings into a larger heating and hot water system. These units can be installed either internally within each dwelling, or recessed into the dividing wall between dwelling and landlord space, allowing ease of access for inspection and maintenance.

An example of a system utilising heat interface units and centralised heating plant is shown below (Source: https://www.cibsejournal.com/cpd/modules/2011-03/)



Advantages

The use of a centralised boiler and CHP system incorporating HIUs has many advantages versus installation of boilers in individual apartments; among them:

- Improved safety due to elimination of gas distribution pipework to apartments
- Individual flue terminals (with associated plumbing) in each apartment are not required
- Gas safety inspections are typically restricted to the plant room;
- Reduction in operating costs owing to reduced boiler service;
- If installed facing into landlord areas, HIUs reduce maintenance access issues;
- Meter reading and energy billing can be carried out remotely from a central location – this can be very attractive to councils and those with a large portfolio of buildings;
- Effective integration of low to zero carbon technology can be far simpler with a central scheme, versus a combination of individual apartment boilers with a technology such as solar photovoltaic, which is potentially complicated to install and offers reduced benefits for the building owner or occupants.

Disadvantages

However, compared with alternative options for meeting the Energy Performance Coefficient (EPC), Carbon Performance Coefficient (CPC) and Renewable Energy Ratio as required by Part L, this system may be considered disadvantageous for the following reasons:

- High efficiencies in heat generation are reduced by high circulation losses due to the need to transport hot water throughout the building, as opposed to other systems where the source of hot water is local to the demand. Overall heating system efficiencies may be as low as 65%.
- These circulation losses may lead to overheating in landlord areas, as hot water circulation is required 24/7 to serve instantaneous hot water demand in each apartment.
- Equally, lower efficiencies may mean a large gas connection is required.

- Installation is expensive compared with alternative systems capable of meeting the requirement, as a result of centralised plant, associated plantroom and civil works and pipe distribution network.
- This system requires the landlord to set up and operate an energy supply and metering system and manage payment from tenants.
- Centralised plant is more expensive to design and maintain.

4.3 All-Electric Systems

4.3.1 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, such as 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, in fact, 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 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 such as boilers, pumps, valves and associated accessories.
- There are low maintenance costs associated with an electric heating system unlike a conventional wet heating system.
- Electric heaters with built-in, sensitive, thermostatic controls allow the radiator to quickly adapt to changes in room temperature.
- The future is electric and electric heating. By integrating a renewable energy source such as photo voltaic panels (PV) into the heating system, the dwelling can produce its own power to use for heating.

4.3.2 Air-to-water heat pump for heating and hot water

Air-to-Water or Air-Source 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. Houses typically utilise either a “split” refrigerant system, with external unit installed in the garden acting as an evaporator and a pre-plumbed heat pump cylinder containing the interface to transfer heat to the water circuits, or a monobloc unit, where all refrigerant is contained in the external unit and a primary hot water circuit links it to the internal unit containing the hot water storage.

Dwellings may avoid the need for the external unit by installing an exhaust air heat pump, which uses extract (waste) air from the wetrooms as its heat source rather than the outdoor air.

A separate option involves integration of the heat pump directly into the water cylinder to create a hot water heat pump, which is dedicated to hot water production and ignores space heating, which can be provided by electric radiators. The radiators in turn may be supplied by solar photovoltaic (PV) or alternative energy source. This drastically reduces the need for pipes, pumps, valves and accessories required in the traditional wet system.

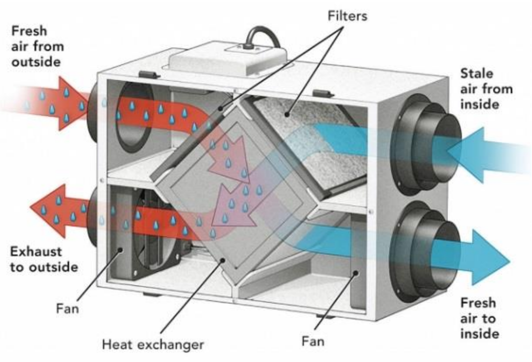
4.3.3 Solar Photovoltaic

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 to be implemented by the Electricity Supply Board (ESB) in 2021.
- Solar PV systems can be coupled with battery technology to store electricity for night-time usage and the intention for this site is to improve solar potential via the installation of batteries for the benefit of residents and landlord systems.

4.3.4 Mechanical Ventilation Heat Recovery in combination with Exhaust Air Heat Pump



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 units as well as losses in the radiators' ability to dissipate heat. This is a similar issue to that encountered with a centralised system, which may use gas boilers supplemented with a source of renewable energy (ground/water/air-source heat pump/solar PV) or high-efficiency energy (CHP as discussed in the previous section).

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 unit's thermal losses. This characteristic is one feature which makes electric systems cost-effective to operate even though electricity rates are higher than natural gas prices.

Further cost-effectiveness within an all-electric system can be achieved by installation of local electricity generation in the form of solar PV. Maximum retention of site-generated electricity during off-peak usage times can be ensured by incorporating a form of electricity storage – this could include a combination of the hot water store (heated via electrical immersion element) the battery of an electric vehicle connected to a charging unit and installation of dedicated domestic solar batteries. Efficiency of water heating could be further maximised by installation of a hot water heat pump.

The dwellings will contain continuous mechanical ventilation. BER analysis in DEAP will guide the selection of mechanical ventilation system with consideration of the inclusion of heat recovery.

5.1 Mechanical Services

- Each dwelling shall be fitted with electric radiators.
- The overall system shall be suitably sized to overcome heat losses.
- The bathrooms shall be fitted with appropriately sized electric towel radiators.
- Hot water heating shall be electrically-generated. Multiple options are available for this, such as dedicated hot water heat pumps or direct electric heating via immersion, fed by the solar PV system when generation capacity is available.
- A Building Energy Rating (BER) preliminary report shall be carried out for each dwelling and shall guide the strategy for hot water heating in detail, when combined with the amount of solar photovoltaic which can be installed to serve the dwelling.
- Each dwelling shall be fitted with mechanical ventilation and its associated duct work.
- The centralised ventilation unit shall extract air via grilles or valves positioned in the wet rooms of the dwellings such as bathrooms, kitchens, and utility rooms.
- Thermostatic control of at least two space heating zones and one hot water zone shall be provided in accordance with the requirements of Technical Guidance Document L 2019.
- Mains water will be supplied to each dwelling from a suitably-sized storage tank.
- Cold water storage and supply requirements shall be maintained by the cold-water storage tank.
- Hot and cold water shall be boosted via a booster pump to all sanitary ware items.
- 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 of each house and apartment.
- 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.
- Houses shall be provided with interconnected mains-operated smoke detectors with battery backup.
- Each room within the dwelling shall have a mains smoke/heat detector installed, with coverage of stores and ancillary areas as appropriate and required by the fire strategy.
- An 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 wiring for future electric vehicle charging stations.
- Solar photovoltaic panels and accompanying battery storage will be provided to houses and apartments.