IN2
ENGINEERING DESIGN PARTNERSHIP

D1846
East Wall Road
Residential Development

ARROW | ASSET MANAGEMENT

Sustainability & Energy Efficiency Report

IN2 Project. No. D1846

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1.0 INTRODUCTION

IN2 Engineering Design Partnership has been appointed by Arrow Asset Management to complete a Planning Stage Energy Analysis Study for the proposed East Wall Road residential project to demonstrate the strategy required to ensure the development meets the requirements of Part L of the Building Regulations.

2.0 EXECUTIVE SUMMARY

This report summarises the Energy Analysis undertaken for the proposed development of 337no. residential units located at East Wall Road, Dublin 3.

The report first outlines the background to the NZEB standard and it's application in Irish regulations. The NZEB standard is included in the Building Regulations Technical Guidance Document (TGD) Part L 2019, which sets out the methodology to demonstrate compliance.

The regulations are described including the requirement for reductions to primary energy and the inclusion of an element of renewable technology, set at 20%, in all new dwellings. Suitable strategies to achieve this standard are described and assessed for the East Wall Road project.

The proposed solution is detailed incorporating a centralised plant solution with Air Source Heat Pump and Combined Heat and Power as the primary energy sources, supplemented by modulating gas fired boilers.

The standards required to achieve compliance are set out including building fabric, mechanical and electrical systems and renewable technologies.

Finally the utilities infrastructure to the surrounding areas is assessed and confirmed adequate for the proposed development.

3.0 DEVELOPMENT OVERVIEW

The proposed development is to be situated on the corner of East Wall Road and Merchants Road, Dublin 3 within the site context as illustrated below in Figure 3.1.

Figure 3.1 - Development Site

The proposed development comprises of the demolition of the existing buildings on site (excluding Unit 11, 15 and 16) and the construction of 337 no. residential apartment units and a range of commercial uses, including café, retail, office at the IDA Business Park, East Wall Road, Dublin 3. The proposed development will range in height from 4 no. to 10 no. storeys (c. 35.2m) and will be laid out in 6 no. residential blocks and 2 no. existing commercial blocks. The propped development will also include public open space, residential amenities, hard and soft landscaping, basement car and bicycle parking and all other ancillary works necessary to facilitate the development

4.0 BUILDING REGULATIONS

4.1 NZEB Standard

Building energy has been long understood as a major contributor to greenhouse gas emissions. This was acknowledged within the 2030 Communication published by the European Commission (2014) which states that "the majority of the energy-saving potential (for the EU) is in the building sector."

Primary Energy consumption in Ireland is reducing as figure 4.1 below illustrates however average Irish CO2 emissions per household remains 60% above the EU average (SEAI 2015).

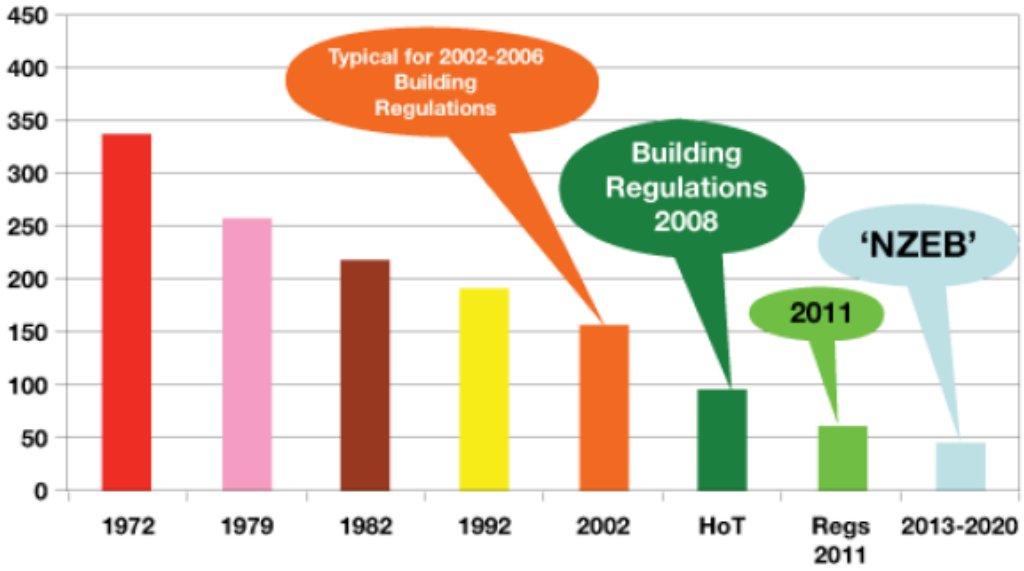

Figure 4.1 - Primary Energy Consumption in Irish Housing 1972-2020

The EU Energy Performance of Buildings Directive established a target for all new developments in Europe to achieve Nearly Zero-Energy Building (NZEB) standard by the end of 2020, with all new Public buildings achieving compliance by the end of 2018.

A Nearly-Zero Energy Building is defined as having "very high energy performance", with Article 2 of the EPBD outlining that "the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby"; the latter is understood to refer to district heating systems and centralised plant arrangements.

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

4.2 NZEB in Ireland

For new dwellings in Ireland, NZEB has been principally defined under the following targets:

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

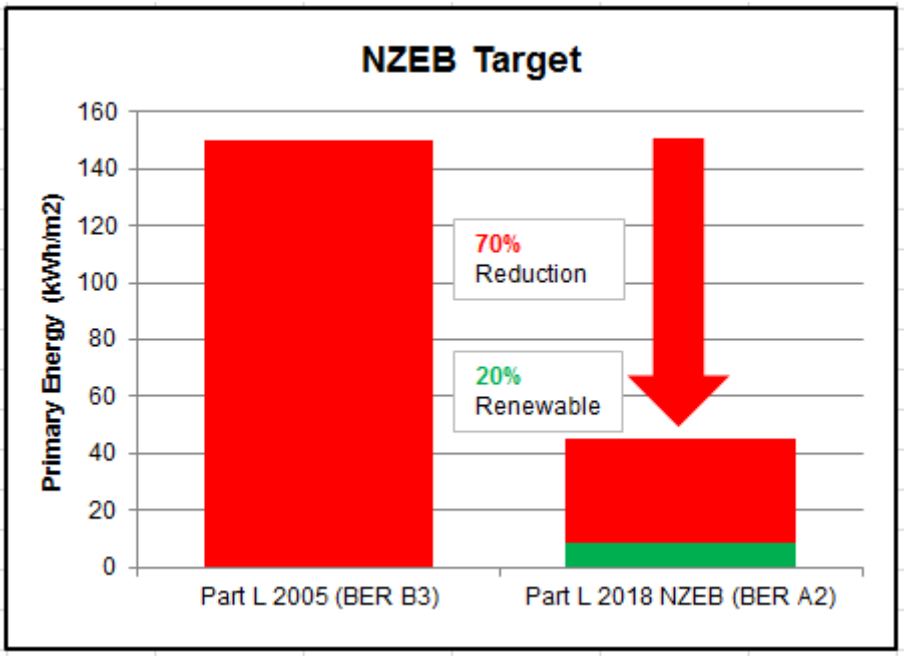

Figure 4.2 - NZEB Part L 2019 Targets

Figure 4.2 above illustrates the NZEB targets for Primary Energy (and Carbon Emissions) and Renewable Energy. The Part L 2005 benchmark above would achieve a B3 BER, by comparison the same NZEB compliant building would achieve an A2 BER.

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

4.3 Part L 2019

Technical Guidance Document (TGD) Part L Conservation of Fuel and Energy – Dwellings outlines how compliance can be demonstrated through the utilisation of the Dwelling Energy Assessment Procedure (DEAP) software version 4.2, which analyses comparative energy usage for a particular residence.

The energy assessment is determined annually on a floor area basis (kWh/m2.ann) for the following usages, known as “regulated loads”:

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

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

4.3.1 Energy Co-efficients

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

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

4.3.2 Thermal Transmittance (U-Values)

In addition to the Energy Co-efficients minimum Fabric Performance is defined as follows in Part L 2019:

- Roofs: 0.16 W/m2K
- External Walls: 0.18 W/m2K
- Ground/ Exposed Floors: 0.18 W/m2K
- Windows/ Doors/ Rooflights: 1.40 W/m2K

4.3.3 Air Permeability

- Maximum Air Leakage: 5 m3/hr.m2 @ 50Pa

In terms of apartments or other terraced residential buildings, Part L allows that the compliance can be demonstrated based on the average of all dwellings for each of the parameters associated with Part L, namely Primary Energy (EPC), Carbon Emissions (CPC) and Renewable Energy (RER). Therefore, for the purposes of analysis, all apartments were assessed to determine an average result for compliance.

4.4 Primary Energy

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

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

- Electricity: 2.08
- Natural Gas/ LPG/ Oil/ Biomass: 1.10

It can be seen from the above that the Primary Energy conversion for Electricity is twice that of Natural Gas (as well as other fossil fuels and biomass); therefore a direct electric heater would consume double the Primary Energy of a LPHW radiator. However, as can be seen from Figure 3.3 below, the underlying trend over time has been that the Primary Energy of electricity with respect to Natural Gas (and other fuels) has been reducing. This reduction is due to the increased "greening" of the ESB grid by Wind and Solar renewables and more efficient plant operation. As the grid Primary Energy factor reduces the technology solutions required to achieve NZEB compliance are changing as follow:

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

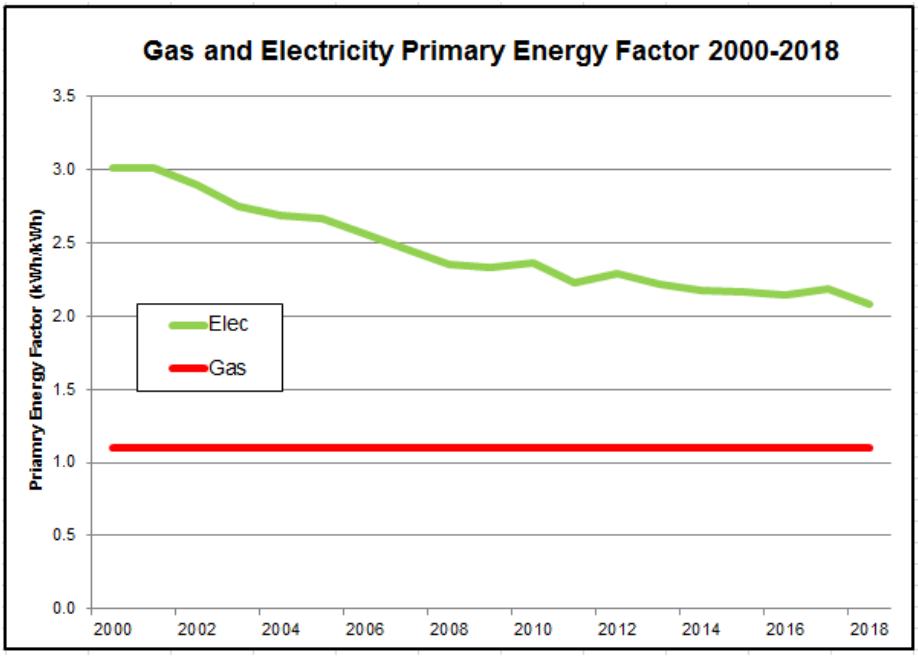

Figure 4.3 - Primary Energy Factors for Gas and Electricity 2000-2018

4.5 Renewable Technologies

Renewable technologies can be utilised to significantly reduce Primary Energy requirements (in addition to ensuring the renewable energy percentage is achieved). Figure 4.4 below indicates how, for a typical apartment (notional 100m2) designed to ensure NZEB compliance, 4 no. (250W) PV panels would offset the excess energy within the gross consumption. This extent of renewable energy must be at least 20% of the overall Primary Energy (RER =0.20+).

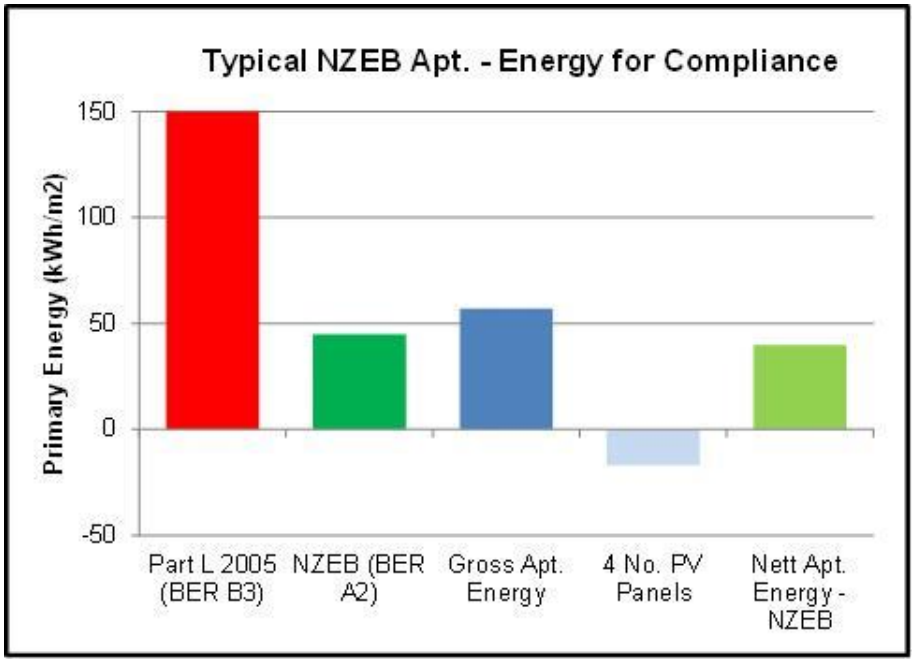

Figure 4.4 - EPC Compliance for Typical Apartment

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

4.5.1 Air Source Heat Pumps (ASHP)

Reduces Primary Energy associated with both Heating and Hot Water compared to gas boilers. Can be implemented on either a centralised or decentralised basis (see Section 4.6 below).

4.5.2 Combined Heat and Power (CHP)

Offsets Primary Energy associated with Hot Water (and potentially some Heating) where used in conjunction with centralised plant/ district heating. Viable for larger (300+ unit) apartment developments where may be integrated with an ASHP to avoid any requirement for PV.

4.5.3 Photovoltaics (PV)

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

4.6 Centralised –v- Decentralised Plant

4.6.1 Decentralised Plant

This solution provides each apartment with individual heating units (generally floor-standing air source heat pump or wall-mounted condensing gas fired boiler) and hot/ cold water storage in "hot press" area, in a conventional manner.

Figure 4.5 – Decentralised Plant Components: Boiler, Calorifier and PV panel

In addition, localised Heat Recovery Ventilation (HRV) units would be provided (typically located in store areas within apartments). Each individual apartment would also have its own separate ESB meter, located in a Ground Floor switch room.

Pro's

- All apartments would have autonomous services provision, with only utilities of ESB, gas and mains water being outside direct responsibility of individual units.

Con's

- Reduced space availability within apartments due to provisions for boiler/ heat pump, hot and cold water storage.
- Inflexible – no potential to add new sustainable solutions in the future
- Potential noise issues related to heat pumps
- Localised gas boilers would require individual flues to each apartment unit, with associated vents for combustion air.
- Gas boilers would require pipework to be routed throughout development incurring additional venting/ fire compartmentation.
- Localised storage tanks result in low pressure availability for hot and cold water; unless localised pumps installed which require more space and have inherent noise impact to individual apartments.

4.6.2 Centralised Plant

This option would consist of a centralised plant area with ASHP and or CHP as the primary heating source with modulating gas-fired condensing boilers supplementing the peak load. Centralised cold water storage and booster pumps would serve all apartments. Each apartments would be provided with an individual Heat Interface Unit (HIU) to provide domestic hot water and heating. These are a small encased heat exchanger unit with piped manifold arrangement, typically wall mounted within Utility room space.

Figure 4.6 – Centralised Plant Components: Modulating Boiler Plant, CHP and HIU

Individual ESB meters (in switchroom/ sub-station arrangement), would still be retained for each apartment.

Pros

- Increased physical space available within apartments due to absence of boiler/ heat pump/ hot and cold water storage.
- Single point of maintenance for development at central plantrooms.
- Flue requirements and associated vents for combustion localised to central plant boilers and CHP only, as opposed to throughout individual units.
- Avoids routing gas pipework through apartment complex with associated venting/ fire compartmentation.
- Centralised nature allows future connection of renewable technologies as and when they become viable.
- Entire hot and cold water system may be pressurised.
- Potential for small ASHP to provide most of the heat through the year by meeting the base load requirements.
- Potential for CHP to provide “free” hot water to apartments throughout the year; subject to extent of Landlord electrical load requirements.

Cons

- Requires management of heating and hot water distribution with billing through either metering or fixed service charge.
- Larger apartment developments (50 units +) are best suited to Centralised Plant configurations, with higher cost-effectiveness due to economies of scale.
- Decentralised Plant arrangement is most cost-effective and suitable for smaller apartment developments (less than 50 units), or where management of centralised energy systems is not viable.

5.0 ENERGY ANALYSIS

The East Wall Road project was analysed for Part L NZEB compliance based on a central plant solution with the base heating load provided by an Air Source Heat Pump integrated with a Combined Heat & Power unit and condensing gas boiler back up. The

5.1 Building Construction

The following building performance parameters were determined for the East Wall road project, in terms of Thermal Transmittance, Glazing Parameters, Air Permeability and Thermal Bridging respectively:

5.1.1 Thermal Transmittance (U-Values)

- External Walls: 0.18 W/m2K
- Roofs: 0.12 W/m2K
- Ground/ Exposed Floors: 0.18 W/m2K
- Windows: 1.2 W/m2K
- Doors: 1.4 W/m2K

5.1.2 Glazing Parameters

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

5.1.3 Air Permeability

- Air Leakage: 3.0 m3/hr.m2 @ 50 Pa

5.1.4 Thermal Bridging

- Heat Transmission Coefficient: 0.08 W/m2
  In accordance with Acceptable Construction Details (ACD's).

5.2 Mechanical and Electrical Systems

The following low-energy systems have been selected for the mechanical and electrical installations, comprising of heat generators, heating and hot water systems, ventilation and lighting:

5.2.1 Primary Heat Generator

- Type: Air Source Heat Pumps (Centralised)
- Number: 2
- Nominal Capacity: 200 kW
- Fuel: Electricity
- Operational Flow Temperature: 50°C
- Percentage of HTG & HWS delivered:40%

5.2.2 Secondary Heat Generator

- Type: CHP Plant
- Fuel: Natural Gas
- Heating Capacity: 100kW
- Electrical Capacity: 50kW
- Operational Flow Temperature: 70°C
- Percentage of HTG & HWS delivered:20%

5.2.3 Tertiary Heat Generator

- Type: Modulating Condensing Boilers
- Fuel: Natural Gas
- Operational Flow Temperature: 65°C
- Seasonal Efficiency: 95%
- Percentage of HTG & HWS delivered:40%

5.2.4 Heating Installations

- Distribution: Heat Interface Units
- Heat Emitter: Radiators

5.2.5 Hot Water Installations

- Type: Centralised
- Water Use Target: 125 l/person.day
- Bath: Yes
- Shower: 6 l/min (flow restrictor)

5.2.6 Ventilation

- Type: Heat Recovery Ventilation
- Specific Fan Power: 0.5 W/l.s

5.2.7 Lighting

- Luminaire Efficacy: 65 lm/W

5.3 Renewable Technologies

- 2 no. 100 kW Air Source Heat Pumps
- 1no. 100kW CHP plant

5.4 Part L NZEB Compliance

The calculated average NZEB parameters for the proposed Mechanical and Electrical systems achieve the following minimum targets:

- Energy Performance Coefficient (EPC) < 0.30
- Carbon Performance Coefficient (CPC) < 0.35
- Renewable Energy Ratio (RER) > 0.20

6.0 UTILITIES INFRASTRUCTURE

6.1 Natural Gas Services

Initial contact has been made with Gas Networks Ireland (GNI). There is currently no buried or above ground natural gas pipework within the development boundary.

There is local low pressure (25mbar) 90mm pipework below the footpath on the opposite side of Merchants Road to the site.

There are a number of pipes below the footpath at the boundary of the site on East Wall Road as follows:

- Local low pressure (25mbar) 250mm service pipework
- Medium pressure pipework distribution pipework
- High pressure (19bar) 300mm transmission pipework

Gas Networks Ireland will be notified by the contractor prior to the commencement of construction works within the vicinity of the high pressure transmission pipework.

Gas Networks have confirmed there is sufficient capacity in the area to service the new development.

Figure 6.1 - Gas Networks Ireland Site Map

6.2 ESB Networks Services

It is proposed to install 3No. ESB Network substations to serve the residential development. Capacity and location of the 3No. substation will be agreed with ESB once naming and numbering of the development is agreed with Dublin City Council.

All electrcial substations built as part of the development shall be designed and built to current ESB Networks regulations.

The existing 2no sub-stations to the perimeter of the site and to the single sub-station within the site will be maintained in their current locations.

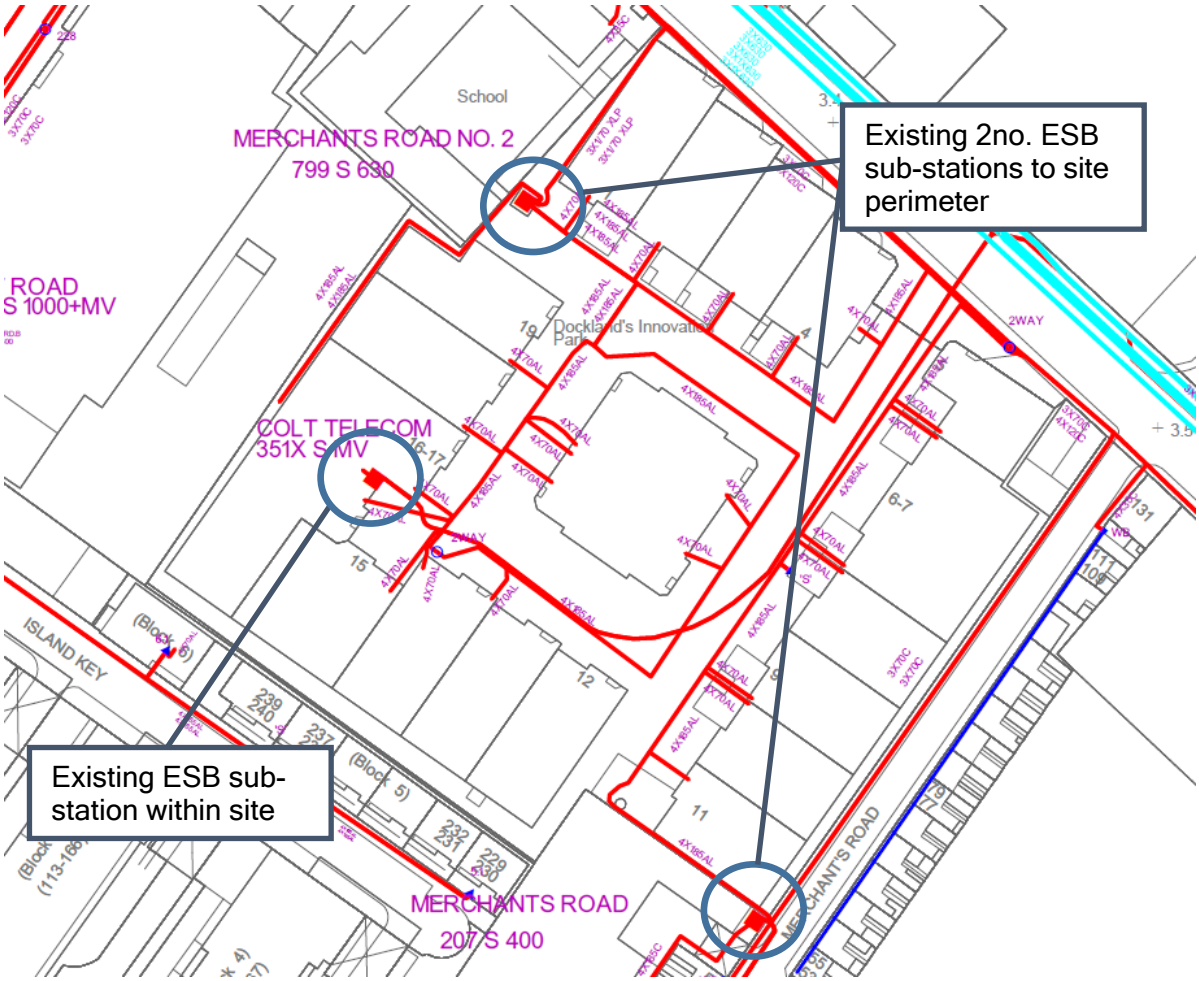

Figure 6.2 - ESB Networks Site Map