FRANKHAM

Tilbury, Riverside Business Park Expansion
Energy Statement

THURROCK COUNCIL

Frankham Consultancy Group
Building Services
Tilbury, Riverside Business Park Expansion

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THURROCK COUNCIL

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1.0 Executive Summary

This report has been produced by Frankham Consultancy to support the planning application for the proposed expansion at Tilbury, Riverside Business Park.

The production of the Energy Strategy has been set out to comply with the Building Regulations Part L 2013, and the Building Research Establishment Assessment Method (BREEAM), to achieve a 'very good' rating.

Thermal modelling was carried out by a suitably accredited person to investigate the proposed strategies, to allow the project to be assessed.

The Building Research Establishment Assessment Method (BREEAM) is the environmental assessment tool adopted and currently used by many local authorities and Government agencies, to ensure the overall environmental performance of the development is achieved and carbon emissions reduced.

This Energy Statement outlines the key features and strategies adopted to deliver an energy efficient building.

The first step is to reduce energy demand from the buildings. To do so, enhanced building fabric specification and careful construction detailing will be used. (passive energy efficiency measures)

The second step is to design efficient building services, delivering heating, ventilation, lighting and effective controls. (active energy efficiency measures)

Should an on-site renewable energy system be installed. The third step is the application of on-site renewable energy technologies to offset CO_2 emissions.

It was found that steps 1 and 2 alone met compliance with Building Regulations Part L 2013, due to the Building emission rate (BER) being equal to the Target emission rate (TER), this was achieved by reducing the energy demand significantly via passive and active energy efficiency measures.

The following table summarises the total baseline carbon emissions in the form of $kgCO_2/m^2$ for the development, the savings achieved by the proposed scheme following the application of passive and active energy efficiency measures and the implementation of a Solar Photovoltaic array should one be installed, however, it is believed that a Solar Photovoltaic array will not be installed for this project.

	Annual Carbon Emissions
Baseline Scheme	33,278.8 $kgCO_2/yr$
Proposed Efficiency Measures	33,278.8 $kgCO_2/yr$
Final Proposed Scheme	28,138.24 $kgCO_2/yr$
Total Annual Savings	**5, 140.56 $kgCO_2/yr$**
Total % Reduction	**15%**

Table 1.Summary of CO_2 savings below the Target emission rate (TER)

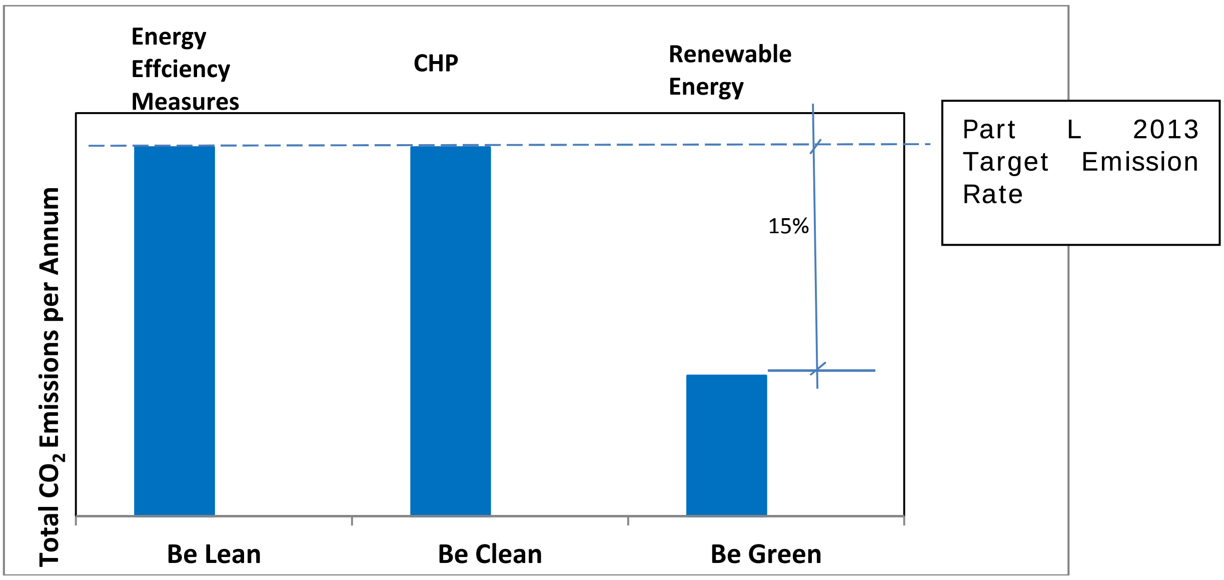

Fig.1. Graph showing reduction in CO_2 emissions against baseline

As can be seen from the table and figure above, the proposed measures achieve a 15% reduction in annual CO_2 against the 2013 Building Regulations Part L target should a Solar Photovoltaic array be installed, however, it is believed that a Solar Photovoltaic array will not be installed for this project.

2.0 Introduction and Context

2.1 Introduction

This report is intended to demonstrate the energy efficiency measures that will be employed within the construction of the proposed development, in order to minimise its lifetime energy consumption and the associated production of carbon dioxide. The report also aims to outline low or zero carbon technologies which are technically and financially feasible to incorporate, in addition to the application of the passive and active sustainability measures.
The final report will demonstrate the following:

- The baseline CO_2 emissions & energy demand associated with the development.
- The energy efficiency measures employed to reduce the energy demand.
- The feasibility of connecting to an existing district heating network.
- The feasibility of employing CHP and on-site renewable technologies.
- The type, location and capacity of those renewable technologies deemed feasible to reduce the building's annual CO_2 emissions.
- Final design proposals and predicted annual carbon emissions

The regulated and unregulated carbon emissions and energy consumption have been calculated using approved SBEM software, such as IES Virtual Environment.

2.2 Site Information

The proposed Tilbury Riverside business Park site is to be accessed via Fort Road, Tilbury. The surrounding area is predominantly made up of various industrial units. The proposal is to utilise land that is currently used as car parking space to accommodate the proposed expansion, consisting of ground floor and mezzanine.

The proposed development will include a mix of 20 light commercial and business industrial units, with associated staff and visitor car parking. The floor area for the new development is approximately 1,300m^2.

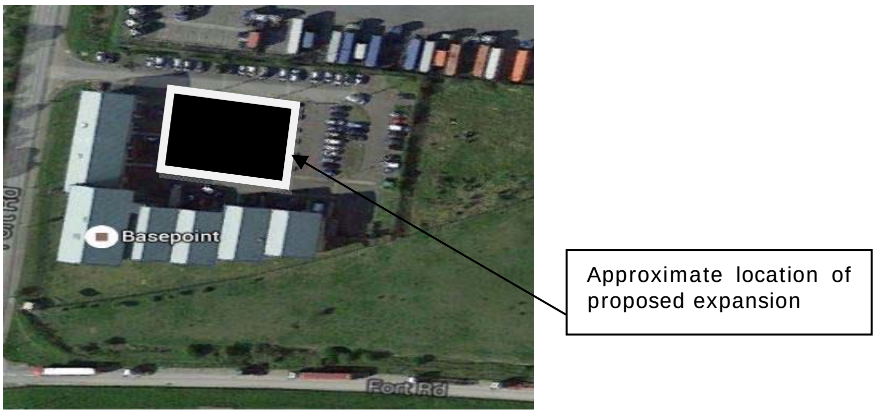

Fig.2. The proposed site location

2.3 The Building's Geometry

The shape and orientation of the proposed buildings has a significant impact upon potential energy consumption. For example, should the majority of the glazing be south facing and exposed to direct sunlight, a greater amount of energy may be required in the form of cooling to prevent over-heating when compared to a building with glazing that predominantly faces north.

Conversely, concentrating a larger proportion of the glazing on the south façade of the building will capture a greater amount of natural daylight and reduce the usage of the indoor lighting, offering a significant reduction in energy consumption for lighting in comparison to an overshadowed building.

The key to a successful design is to balance these conflicting requirements to minimise the net annual carbon emissions whilst still providing a comfortable internal environment.

In the case of this particular development, the size and shape of the site place constraints on the orientation and form of the buildings. However, there are still passive energy efficiency measures which can be feasibly employed within the design, and these are being reviewed.

To comply with criterion 3 of the Building regulations Part L, the spaces in the building should have appropriate passive control measures to limit solar gains.

This has been addressed by providing internal blinds in the following industrial units, 2,3,4,5,6,8,9,12,13,14,15,16,17,18 and 19.

2.4 The Building Fabric

The choice of materials selected to build the structure have a dramatic effect upon the energy required to heat and cool the building. By improving the U-values (a measure of insulation, the lower the number the better) and thus reducing the heat lost from the building, less energy will be consumed with a resultant reduction in annual CO_2 emissions.

Most building users will be aware of the benefit of reducing heat loss in a winter scenario, and will understand the principle of achieving this through increased insulation performance.

However, careful selection of the building fabric is equally important to the performance in summer conditions, and is usually manifested in the cooling and lighting loads. One area where this is extremely important is the specification of the glazing. There are three key parameters which have been considered;

i) The amount of insulation provided by the window (u-value).

ii) The amount of solar heat energy able to pass through the window (g-value).

iii) The amount of visible light able to pass through the window (visible light transmittance).

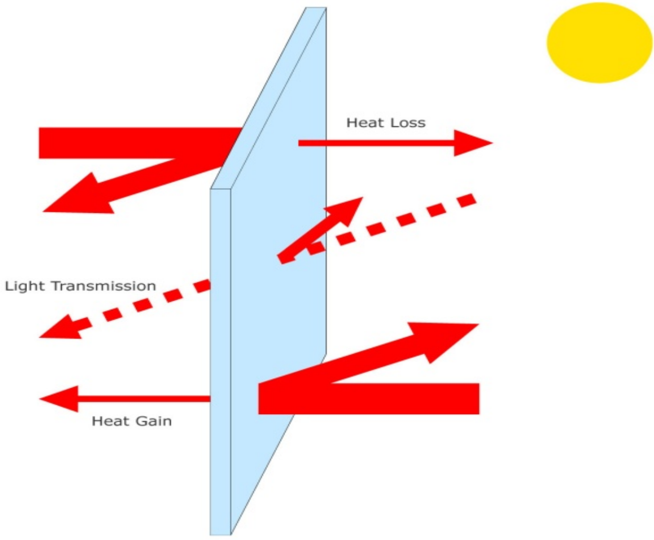

Fig.3. Energy flow through glazing

These three parameters have been carefully reviewed to select a glazing specification that minimises heat loss and therefore heating loads (u-value), reduces the risk for potential overheating through controlling solar heat gain (g-value) and minimises the amount of artificial lighting that will be required through day-lighting (visible light transmittance).

Table 2 indicates the proposed performance specification that the fabric of the proposed development will achieve. The proposed U-values are shown against the current minimum requirements of the Building Regulations.

Construction Element	**ADL2A U-Value W/m²K**	**Proposed U-Value W/m²K**	**Proposed *G-Values**
Walls	0.35	0.15	-
Ground/exposed floors	0.25	0.15	-
Roofs	0.25	0.10	-
Window (incl. roof windows, roof lights etc).	2.2	1.4	A transmittance of 0.8 for Units 2-3-4-5-6-8-9. A transmittance of 0.65 for Units 19-18-17-16-15-14-13-12
Pedestrian doors and high usage entrance doors	2.2	2.25	0.57

Table 2. Summary of proposed building fabric values.

2.5 Air Permeability / Thermal Bridging

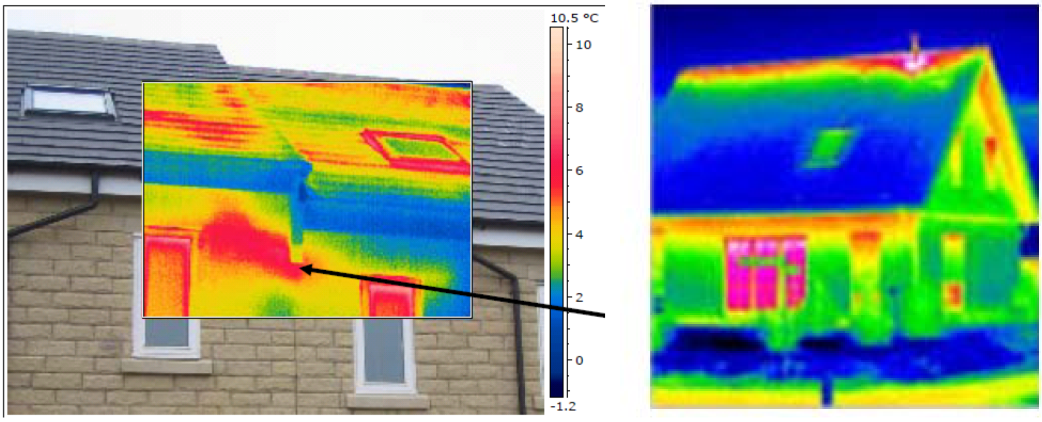

Fig.4. Thermal image from a typical House

The Air Permeability rating of a building (a measure of uncontrolled air infiltration) has become as important an issue as the improvement of the building's insulation. More heat is lost through poor building construction and resulting air leakage, than through the fabric in modern buildings.

The development will be designed to achieve an air permeability rate of $5m^3/m^2$/hour at 50 Pa.

The air tightness of the new build areas of the development shall be tested by an accredited assessor upon practical completion of the building in accordance with Approved Document L2B.

The second area that will be achieved through careful detailing will be the reduction of heat lost across non-repeating thermal bridges. The building will also be designed and constructed to accredited construction details to ensure that thermal bridging is minimised.

3.0 Heating & Cooling Infrastructure including CHP

In accordance with the energy hierarchy, having incorporated measures to reduce energy demand within the design of the proposed development, the next stage is to investigate measures to supply the required energy efficiently.

This section of the report addresses these requirements, and discusses how it applies to the proposed development.

3.1 Considerations

Consideration to encourage developers to utilise or connect to existing heat networks, or to consider where feasible constructing new networks where they do not already exist.

Major development proposals should select energy systems in accordance with the following hierarchy;"

1. *Connecting to Existing District Networks*

2. *Site wide Combined Heat & Power network*

3. *Communal Heating and Cooling*

The feasibility includes questions of financial and technical viability" which "*will ensure that requirements are not imposed on the development that could lead to uneconomic costs on occupiers*."

We have set out an assessment of the feasibility of these energy systems.

3.2 Connecting to Existing District Networks

The London Heat Map (www.londonheatmap.org.uk) is an online tool which exists to enable information relating to large heat loads and energy supplies within the Greater London area to be collated and searched. By using the tool to search the areas adjacent to a site, local authorities and developers can locate within a given area; areas of high heat demand, major heat supply plant that may have surplus capacity, and existing and proposed district heating networks. Therefore, it is possible to identify any opportunities that may exist for connecting a proposed development to an existing network, proposals for future networks that could be connected to the proposed development, or identify centres of significant energy demand which could help the viability of a proposed new heat network.

The proposed site does not appear on the London Heat Map, therefore, connection to an existing heat network is not feasible.

The creation of a new heat network for the proposed development would not be a viable option, as there is no requirement for significant quantities of low temperature hot water. As such, the creation of, or connection to, a district heating network is not viable in this case.

3.3 Site Wide Combined Heat & Power

Combined heat and power (CHP) can provide an effective means of generating heat and electricity on site. However it requires careful consideration. If installed in the wrong application, i.e. in a building where there is not a relatively constant heating and electricity demand, it will not deliver the energy and carbon emissions reductions, and place uneconomic costs on the operators for the lifetime of the system.

The following table is based on the CIBSE TM38 "Reset method" for analysing the feasibility of Low or Zero Carbon Technologies;

Will the CHP plant operate for more than 4,500 hours per year?	No
Will the buildings have a year round demand for heat? (E.g. Swimming pool heating, canteen, washroom, or process use).	No
Is there a reliable base load for electricity between 7:00am and midnight?	Yes
Is there a requirement for heating distribution systems to operate at temperatures in excess of 80^{o}C	No

Table 3: CIBSE TM38 Feasibility Analysis Checklist

To encourage development proposals to evaluate the feasibility of decentralised energy supply methods. Generally, this means combined heat and power units (CHP) fired by natural gas, biomass or municipal waste, serving individual buildings, groups of buildings or entire development sites by means of a heat network. By generating electricity on-site rather than at distant power stations, more efficient use is made of the primary energy source. If the fuel is biogas or biomass then the opportunity exists for very high levels of carbon reduction to be achieved.

Given the benefits of CHP, it is understandable why its use is encouraged where practical. However, it is a technology with very specific requirements, and is not suitable in every development. Being heat-led, CHP needs a year-round demand for heating and hot water to be viable. This pattern of demand will not be experienced in the proposed development, but is more often associated with developments such as swimming pools and hospitals, which help provide the necessary demand profile.

For this reason, CHP is considered unsuitable for this particular development.

3.3.1 The Proposed Heating System

Electric heaters complete with thermostats and timers are proposed for the new development.

Heating System Summary	
Heating Source	Electric heaters

Table 4. Proposed Heating System

3.4 Hot Water Services

Hot water services will be provided by point of use electric storage water heaters to serve the new development.

All pipe work will be thermally insulated to reduce system losses. There will be no pumped secondary return.

3.5 Mains Water Services

There will be 20 No. separate utility water meters to serve each industrial unit and an additional landlords water meter serving 2No. External hose union taps via a break tank and booster set.

Energy efficient fittings will be used throughout the design including dual flush toilets, wash hand basins complete with flow restrictors, leak detection systems to monitor and raise an alarm if a leak occurs between the utility meter at the boundary and an internal check meter and an automatic shut off system for all sanitary areas.

3.6 Ventilation

Provision will be included within the design for inlet and exhaust louvres for future tenant fit out. Inlet louvres are to be located above the pedestrian door and the exhaust louvre to be located at high level on the opposite side of the unit.

The toilet areas and kitchenette will be mechanically ventilated and discharged to atmosphere via exhaust louver.

Toilet extract fans will be controlled via operation of the lighting circuit as an energy saving measure. The fans will have the facility for 15 minute run-on.

Kitchenette extract fans will be controlled via wall mounted controller.

3.7 Lighting

The use of electrical energy for lighting is a major element of the site's total energy usage. The fixed lighting shall utilise low energy fittings throughout.
The use of natural day-lighting will be maximised throughout the scheme to minimise the quantity of energy consumed by lighting.

Low energy fixed lighting will be installed in all rooms.

3.8 Results – Energy Efficiency Saving

The building was modelled using IES accredited software to analyse the CO_2 emissions of the building with the various energy strategies in comparison with "notional" building, which produces the "Target" rate against which the emissions are compared.

The table below shows the baseline emissions and the resultant emissions of the proposed scheme following the application of the passive and active energy efficiency measures.

As can be seen from the table below, the improvements made to the building fabric and the efficiency of the building services are equal to the Target Emission Rate, therefore, comply with Building Regulations Part L 2013.

	Annual Carbon Emissions
Baseline Scheme	33,279 kgCO_2/yr
Proposed scheme	33,279 kgCO_2/yr
Annual Savings	0 kgCO_2/yr
% Reduction	0%

Table 5 Proposed energy efficiency measures against 2013 Part L compliant baseline.

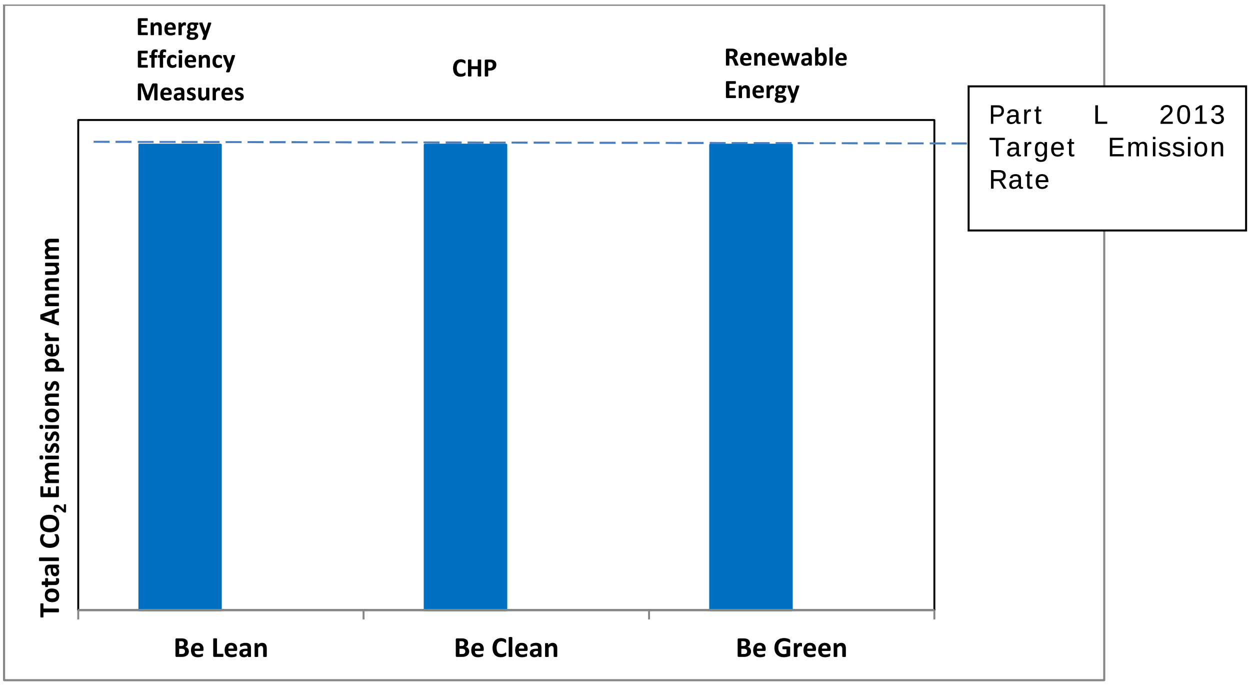

Fig.5. Graph showing reduction in CO_2 emissions against baseline after energy efficiency measures.

4.0 Renewable Energy

This section of the report will discuss on-site renewable energy generating technologies.

4.1 Initial Site Assessment

The proposed site has been assessed for the suitability of installing on-site renewable technologies for the purpose of on-site energy generation. The technologies considered are as follows:

- Solar Thermal Hot Water;
- Solar Photovoltaic Electricity;
- Biomass Boilers;
- Air Source Heat Pumps;
- Ground Source Heat Pumps;
- Wind Turbine Electricity.

Water driven technologies, such as tidal & wave power, have been dismissed due to the site's geographical location.

Having conducted an initial assessment utilising the CIBSE RESET method, figure 7 provides a visual indication of which technologies are deemed to be technically feasible. Further explanation is included for each technology under the appropriate headings.

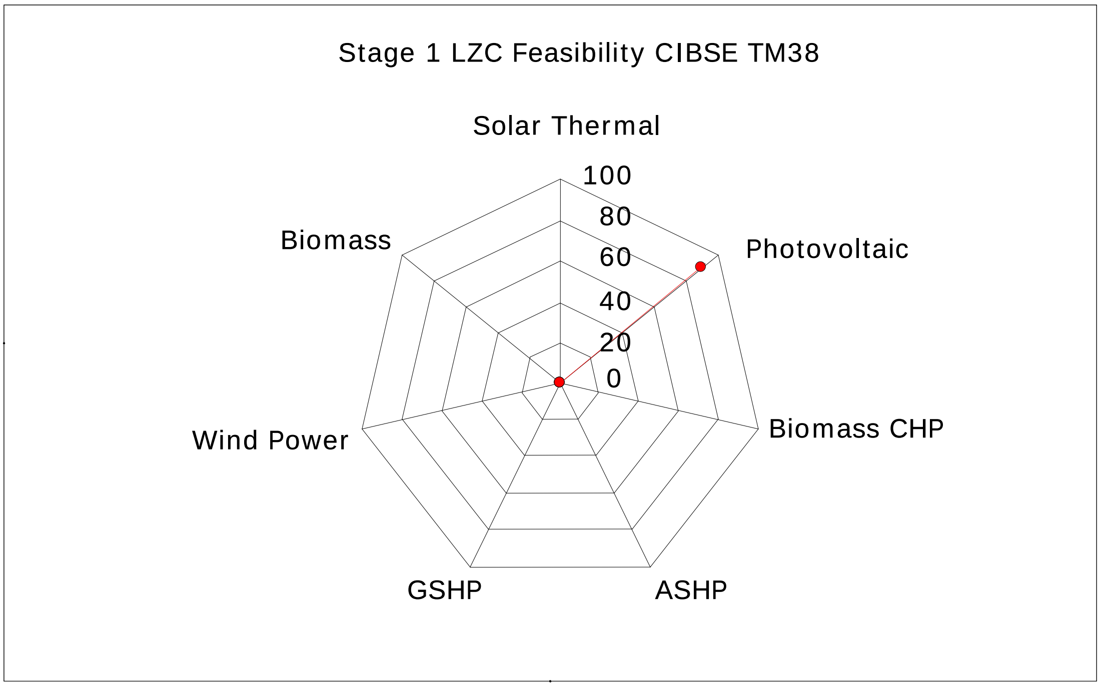

Fig 6.TM38 tool Spidergram showing feasibility of renewable technology options

4.2 Solar Thermal Hot Water

Will the building have either a flat roof or a roof facing within 45° of south available for use?	Yes
Will the building have a year round demand for hot water (e.g. for swimming pool heating, canteen, washroom, showers, or ('process use')?	No
Is there space for hot water storage adjacent to the collectors?	No

Solar Thermal Hot Water systems operate by passing cold water through a roof-mounted solar collector, which is designed to absorb heat from solar radiation, and transfer that to the water passing through it. This warm water is distributed back to a hot water cylinder, where it is used to raise the temperature of the water required for use in wash hand basins and showers for example. The domestic water may need further heating to reach the desired temperature with the assistance of traditional water heating plant.

Such a system does not generate noise, and doesn't require the use of any additional land, as it would be located upon the roof of the building.

The hot water demand for the building is very low and no showers, baths are proposed.

For these reason a Solar Thermal Hot Water system is not considered feasible.

4.3 Solar Photovoltaic Electricity

Will the building have either a flat roof or a roof facing within 45° of south available for use?	Yes
Are high quality cladding materials proposed for the building, which could be replaced with photovoltaic materials?	No
Will the building be free from overshadowing for most of the day from other buildings, structures and other objects (e.g. trees)?	Yes

Solar Photovoltaic electricity generation is a widely recognised form of renewable energy generation, generating electrical current (DC) when sunlight hits a semi-conductor material (Silicon crystals). This DC current is then converted to a usable AC current via an inverter, from where a connection to the building's electrical distribution system will be made.

PV is a clean and silent form of renewable energy generation and as such would cause no disturbance to the occupants and neighbouring buildings. With the roof space available, the system would not require the use of any additional land.

PV requires little maintenance, and with the panels set at 30° they are effectively self-cleaning, requiring an annual clean and inspection. They also have a lifespan of 50 years, in comparison to solar thermal panels that may need replacement within 15 years (with the exception of the inverters, which have a 15 year lifespan).

Therefore, Photovoltaic electricity generation is considered a feasible option.

4.4 Combined Heat and Power

Is there a reliable base heating load over a 12 month period?	No
Is there a reliable base load for electricity between 7:00am and midnight?	No
Will the CHP plant operate for more than 5000 hours per year?	No
Is there a requirement for heating distribution systems to operate at temperatures in excess of 80°C	No

There is insufficient seasonal heat demand over a 24 hour period to maintain this technology, therefore, it is unviable. For CHP plant to be feasible, the system needs to be in operation in excess of 4500 hours per year.
There is no heating load during the summer, and the hot water load is intermittent, so would not provide a suitable base load.

Such a system would require careful consideration to mitigate the noise it generates.

There are alternative systems which are more suitable for the proposed development which will be pursued. CHP has been dismissed as a feasible option for this development.

4.5 Ground Source Heat Pumps

Is the heating system for the proposed building/development served by a low temperature heating circuit?	Yes
Is there sufficient accessible ground space around the building/development to install a horizontal closed loop system?	No
Is the ground free from obstructions such as sewers, tunnels, etc?	No

Due to the compressed nature of the site there will be no suitable space for the location of horizontal or bore hole ground heat exchangers.

The use of ground source heat pumps would significantly increase the area of land affected by the development, as well as adding significantly to the scope of works and construction budget.

For these reasons a ground source heat pump system is not considered feasible.

4.6 Air Source Heat Pumps

Is the heating system for the proposed building/development served by a low temperature heating circuit?	No
Is there sufficient plant space allowed in the building/development to install the system?	No

Air source heat pumps offer the same advantages as ground-source heat pumps (energy and carbon savings compared to conventional heating systems) but without the need for costly or disruptive ground works. This makes them suited to new developments, particularly for well-insulated buildings.

Air source heat pumps operate on the same principle as ground source heat pumps, with the important difference that they use an outdoor fan unit to collect energy from the ambient air. This low-grade heat is then 'upgraded' into heat suitable for supplying heating and hot water systems, through the use of an electric pump and refrigerant compression circuit. An internal immersion heater is provided to provide a boost to the system on the coldest days.

The outdoor fan unit(s) would be situated discretely within a dedicated enclosure and coupled to an indoor communal hot water storage cylinder. The hot water produced is at a lower temperature compared to a boiler, therefore, underfloor heating should be used instead of radiators – this offers a number of benefits to the occupant, including a more even room temperature and more freedom to locate furniture.

Due to the lower temperature hot water generated by the system, an Air source heat pump system is not considered a suitable option.

4.7 Biomass Boilers

Is there potential for local supply and delivery of biomass fuel?	No
Is the proposed boiler house location such that it can be served by biomass, with adequate facilities for storage?	No

Biomass boilers are widely acknowledged as being a cost effective method of introducing renewable technologies.

However, there are greater operational issues to consider. Fuel must be delivered in bulk, and this has implications in terms of storage and delivery arrangements. Biomass heating in city areas can be undesirable, with local authorities not wishing for buildings to contribute to the already high level of nitrogen oxides present in the air due to traffic pollution.

The advantages of biomass heating, therefore, have to be balanced against the practical issues, particularly in built-up areas where air pollution levels may already be high and opportunities for delivering fuel may be limited.

As such, Biomass boilers have been discounted as a technically viable solution for the proposed development.

4.8 Wind Turbine Electricity

Is the average wind speed on site greater than 7 m/s	No
Is the area free from obstructions which could interfere with the wind flow turbulence?	No
Is the site in or near either of the following? • Conservation area • Area of historic interest • Metropolitan open land • Green belt	No

Small horizontal-axis wind turbines (HAWTs) mounted onto the roofs of buildings are not generally recommended in urban and sub-urban areas as there is a high risk of local and planning opposition, for questionable benefit. Research carried out into the effectiveness of roof-mounted wind turbines has found that their performance in practice falls well short of manufacturers' claims. This is because the wind speeds needed to produce useful amounts of energy are found only in open areas and not in built-up areas.

Furthermore, most turbines are designed to operate in a clear air stream, free of the turbulent airflows that occur around buildings and obstacles. As such, when placed upon a building, their performance is generally poor and less predictable.

For this reason, small wind turbines are not considered to be a feasible option for this development

5.0 CO_2 Offset by on-Site Renewable Energy Generation

Having concluded that a Solar Photovoltaic system is the most technically feasible technology to employ on the site, it is necessary to determine the annual carbon savings that would be achieved by the employment of such a system.

At this stage of the design, it is not possible to give precise sizes for the required Solar Array. However, it has been estimated that 160m2 of monocrystaline type PV array in the order of 25kWp will be required to achieve 15% reduction in annual carbon dioxide through on-site renewable energy generation.

The following table and graph indicate the annual CO_2 emissions savings over and above the energy efficiency measures, should the above system be installed.

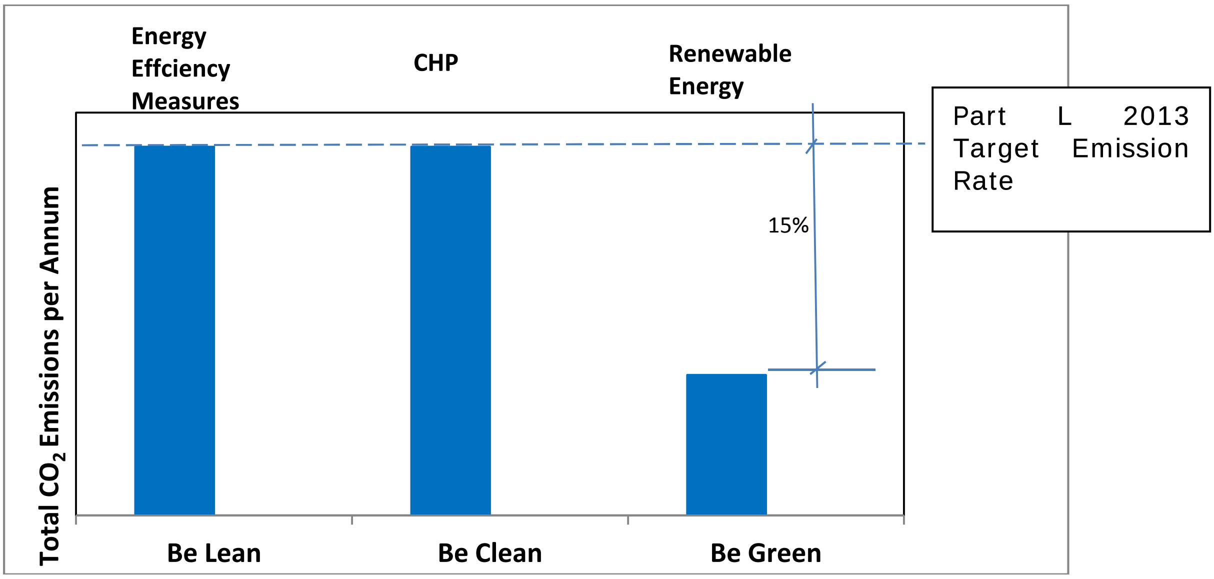

Fig.7 Graph showing reduction in CO2 emissions against baseline after renewable technology was employed.

	Annual Carbon Emissions
Baseline Scheme	33,278.8 $kgCO_2$/yr
Proposed Efficiency Measures	33,278.8 $kgCO_2$/yr
Final Proposed Scheme	28,138.24 $kgCO_2$/yr
Total Annual Savings	**5, 140.56 $kgCO_2$/yr**
Total % Reduction	**15%**

Table 6. CO_2 savings due to solar PV.

6.0 Conclusion

The passive and active energy efficiency measures described in section 3, results in the BER being equal to the TER, achieving compliance with Part L 2013. In addition to the passive and active energy efficiency measures described in section 3, a solar Photovoltaic with a peak output in the order of 25kWp will achieve a 15% reduction in annual CO_2 emissions, should one be installed, however, it is believed that a solar Photovoltaic array will not be installed for this project.

	Annual Carbon Emissions
Baseline Scheme	33,278.8 $kgCO_2$/yr
Proposed Efficiency Measures	33,278.8 $kgCO_2$/yr
Final Proposed Scheme	28,138.24 $kgCO_2$/yr
Total Annual Savings	**5, 140.56 $kgCO_2$/yr**
Total % Reduction	**15%**

Table 7. CO_2 savings due to Solar PV.

As demonstrated in Table 6 above, the energy efficiency measures combined with on-site renewable energy achieve a 15% reduction in annual CO_2 emissions or 5,140.56 $kgCO_2$ per year against a Part L compliant baseline for the development.

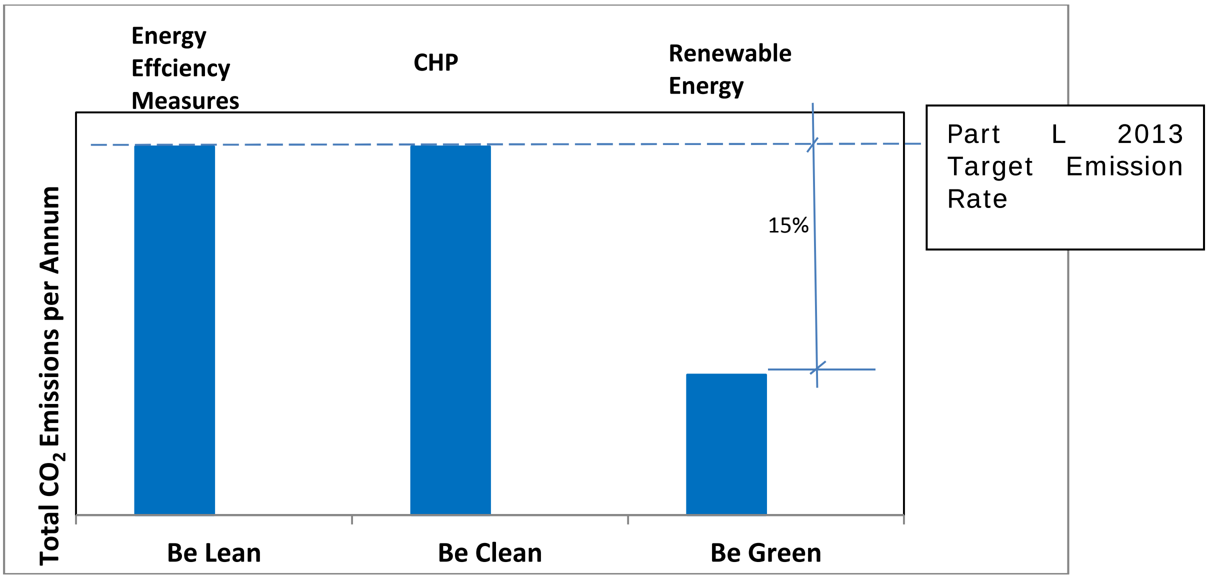

Fig.8. Proposed energy efficiency measures against 2013 Part L compliant baseline.