

Kingmoor Industrial Development, Wrexham

BREEAM ENE 04
LZC Report

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Appendix A – BRUKL

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1 EXECUTIVE SUMMARY

The proposed development Kingmoor Wrexham, is targeted for BREEAM 2018 Excellent rating, to contribute towards this achievement this Low Zero Carbon Energy Report has been produced in order to identify credits to be awarded under BREEAM ENE04. This study ultimately concludes that 2 out of 3 credits can be awarded, these include the Passive Design and LZC Feasibility credits.

This report will assess the feasibility of various low/zero carbon technologies in accordance with BREEAM ENE04. As such this report will follow the structure as dictated by BREEAM ENE04 which is described as follows:

- Passive Design Analysis
- Free Cooling
- Low Carbon Feasibility Study

The Passive Design section of the analysis has adopted a fabric first approach incorporating passive measures such as performance building fabric in addition to strategic building layout/orientation, amongst other features, to assist in obtaining this credit.

Regarding Free Cooling, BREEAM ENE04 requires passive free cooling measures to meet the total cooling demand of the building, while some free cooling features are present, they are unable to meet the cooling demand without supplement from an active cooling solution therefore the Free Cooling credit cannot be achieved.

Finally, various LZC technologies have been assessed for suitability and incorporated into the design as appropriate, this combined with passive design measures has resulted in a reduction in CO₂ emissions and Primary Energy Demand when compared against "standard" versions of the building model that exclude these benefits and use only notional inputs for fabric performance and systems.

The building will utilise efficient building fabric and incorporate low carbon, VRF heat pump technology, efficient lighting design and control systems to achieve a meaningful reduction in CO₂ emissions and primary energy demand over Part L, as required by BREEAM ENE04.

The proposed fabric specification is described in the table below:

Table 1 Building Fabric Specification

Building Fabric			
Element	L2A: 2014 Limiting U-values (W/m ² .k)	L2A: 2014 Notional U-values (W/m ² .k)	Proposed U-values (W/m ² .k)
Floors	0.25	0.22	0.18
External Walls	0.35	0.26	0.24
Roof	0.25	0.18	0.16
Windows	2.20	1.80	1.60
External Doors	2.20/1.5	2.20/1.5	2.20/1.5
Air permeability (m ² /h.m ² @ 50 pa)			
Full Building	10.0	3.0	3.0

2 INTRODUCTION

2.1 PURPOSE

NOVO Integration Ltd has been appointed as energy consultants to produce an assessment of Low/Zero Carbon Technologies for the non-domestic development known as Kingmoor.

This is to support the scheme design process and acquire BREEAM ENE04 credits. In a separate calculation, the development is required to meet Part L2A Building Regulations. The result of this calculation is presented as a BRUKL document, an energy model is required to produce this document; BREEAM ENE04 requires multiple comparisons between a "standard building" and the "proposed building", this report uses the original Part L Energy model to facilitate the ENE04 results tables presented in each summary section of this report. These results pertain only to ENE04 and do not represent the formal Part L Results, please refer to the Part L BRUKL issued separately for those results.

This report has been prepared solely for the use of FI Real Estate Management and NOVO Integration Ltd accept no responsibility for its use by any third parties.

This report will outline the following as required by BREEAM ENE04:

1. Passive design measures implemented to reduce total energy demand and ensure thermal comfort levels in occupied spaces.
2. Consideration of "Free Cooling" solutions to reduce cooling energy demand.
3. Assess the proposed development site's estimated CO₂ emissions and look into the feasibility of Low Zero Carbon technologies, examining the following aspects relative to LZC/renewable technologies:
 - Energy generated by Renewable/Low Zero Carbon Technologies (LZC)
 - Feasibility assessment for each Renewable/Low Zero Carbon Technologies (LZC)
4. Conclude by summarising the key Passive Design, Free Cooling and LZC Technology measures included and provide confirmation of eligible credits under BREEAM ENE04.

2.2 BACKGROUND POLICY DOCUMENTS

The following statements and regulatory guidelines form the policy background to this LZC Report:

- The Kyoto Protocol at the United Nations.
- Framework Convention on Climate Change as negotiated in December 1997 has come into effect on 16 February 2005 following the ratification of the agreement by Russia on 18 November 2004. The Burden Sharing Agreement of the EU mandates a 12.5% reduction in greenhouse gas emissions for the UK by 2008 - 12.
- The Department of Transport and Industry White Paper, titled "Our Energy Future - Creating a Low Carbon Economy", spells out a target for 10% of electricity to be from renewable sources nationally by 2010 and twice this by 2020.
- National Policy Objectives regarding renewable energy Planning Policy Statement 22: Renewable energy guidance for local governing bodies concerning implementation of renewable energy technologies through appropriate planning.

-
- The United Kingdom has made commitments that extend beyond this requirement. National Targets are for a reduction to 20% below 1990 CO₂ levels by 2010 and a 60% reduction by 2050.
 - Integrating renewable energy into new developments: Toolkit for planners, developers and consultants, September 2004.
 - The Building Regulations 2014 Welsh - Approved Document L - Conservation of Fuel and Power in new buildings other than dwellings.
 - National Planning Policy Framework (July 2021).
The National Planning Policy Framework is a key part of our reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

3 DESIGN PARAMETERS

3.1 ARCHITECTURAL DRAWINGS ISSUED BY MCAU

Table 2 Schedule of Drawings used for Analysis

Drawing Number	Drawing Contents
1204-03	Unit 1 Plans
1204-03	Unit 2 Plans
1204-03	Unit 3 Plans
1204-05	Proposed Elevations

3.2 CONSTRUCTION ELEMENTS

Table 3 Building Fabric Specification

Building Fabric			
Element	L2A: 2014 Limiting U-values (W/m ² .k)	L2A: 2014 Notional U-values (W/m ² .k)	Proposed U-values (W/m ² .k)
Floors	0.25	0.22	0.18
External Walls	0.35	0.26	0.24
Roof	0.25	0.18	0.16
Windows	2.20	1.80	1.60
External Doors	2.20/1.5	2.20/1.5	2.20/1.5
Air permeability (m ² /h.m ² @ 50 pa)			
Full Building	10.0	3.0	3.0

3.3 ENVIRONMENTAL CRITERIA

As the Part L2A of the Building Regulations (2014) require, the environmental criteria of the occupied spaces have been set to the National Calculation Method Standards.

3.4 STANDARD BUILDING

The standard building displays the energy efficiency results for the development without passive design measures such as improved fabric performance included in the calculation. This will then be compared against the Proposed Building which will include passive design measures as per the methodology of BREEAM ENE04.

The IES thermal modelling software has generated the following results based on the notional u-values as stated in table 3 above, all other elements described in table 6.3 in the BREEAM UK New Construction 2018 document have also been set to notional values:

Table 4 Standard Building Results

Criteria (CO ₂ / Energy Demand	Standard Building	Proposed Building	Reduction	% Reduction
Building Emission Rate (BER) kgCO ₂ /m ² /Year	13.7	-	-	-
Primary Energy Demand kWh/m ² .yr	69.73	-	-	-

3.5 ENERGY EFFICIENT DESIGN SUMMARY

This section outlines the design energy efficient measures taken to minimise the building's energy demand and therefore reduce energy use and CO₂ emissions further than the Baseline (Building Regulations 2014 Part L2A compliance). Often referred to as the 'Fabric First' approach.

The energy efficient measures include:

- Inclusion of performance building fabric to achieve an improved air permeability result.
- Utilising highly efficient heating and hot water systems.
- Utilising low energy efficient lighting such as LED lighting.
- Utilising low SFP supply and extract ventilation.

The table below outlines the improvements made to the building fabric elements compared against both the Building Regulations limiting U-values and the 'Notional Dwelling' U-values which the Standard Building is derived from. As can be seen, the fabric is designed to achieve an improved air leakage target and all proposed values surpass the limiting values.

Table 5 Proposed Building Fabric Specification

Building Fabric			
Element	L2A: 2014 Limiting U-values (W/m ² .k)	L2A: 2014 Notional U-values (W/m ² .k)	Proposed U-values (W/m ² .k)
Floors	0.25	0.22	0.18
External Walls	0.35	0.26	0.24
Roof	0.25	0.18	0.16
Windows	2.20	1.80	1.60
External Doors	2.20/1.5	2.20/1.5	2.20/1.5
Air permeability (m ² /h.m ² @ 50 pa)			
Full Building	10.0	3.0	3.0

3.6 HEATING DEMAND

The heating energy demand will be reduced by providing good insulation of the building envelope in order to minimise heat losses.

The development will utilise a highly efficient Electric Air Source Heat Pump (ASHP) technology to provide heating and limited comfort cooling.

To support the objectives of BREEAM ENE04 the use of active cooling is minimal, limited only to the office areas which is required in order to meet acceptable temperatures in BREEAM HEA04 (see Appendix B Thermal Report issued separately).

Heat Pump VRF systems are extremely efficient with respect to the amount of heat output versus the amount of energy inputted, therefore less energy is wasted in the heating process. Please note the final design may differ from this report.

3.7 HOT WATER DEMAND

The hot water demand will be met through instantaneous electric water heaters which have a 100% delivery efficiency providing a low carbon hot water solution that also this ensures there is no hot water piping running through the building which would emit heat and effect thermal comfort.

Please note the final design may differ from this report as the design progresses. For the full details please refer to the Building Services report.

3.8 VENTILATION

Mechanical ventilation heat recovery will be limited to the office areas, as part of the Passive Design process the supply SFP will be 1.2 w/(l/s) which is an improvement upon the Part L2A notional SFP value which is 1.8 w/(l/s). The heat recovery efficiency will also be improved from the notional value of 70% to 85% therefore making more efficient use of waste heat. Mechanical ventilation is required to support the thermal comfort of the occupants and support the acquisition of credits under BREEAM HEA04.

Please note the final design may differ from this report as the design progresses. For the full details please refer to the Building Services report.

3.9 LIGHTING

The proposed light fittings will be low energy efficient fittings. This will be provided via LED fittings.

4 PASSIVE DESIGN ANALYSIS

4.1 SITE LOCATION, ORIENTATION AND WEATHER

The development site is located within an industrial estate on Bryn Lane, Wrexham. The area surrounding the site is predominately commercial in its use with industrial units to the South and West and an industrial development to the North. As the site is not located in a dense urban area the Albedo level will be low with few dense building/infrastructure surfaces present to reflect heat onto the development. Furthermore, there will be little to no micro-climate present, as such this will passively reduce the cooling load on occupied spaces compared to a dense urban city centre location.

Figure 1 Aerial Site View



The proposed development consists of 3nr new warehouse units with office space comprising an overall total floor area of approximately 93,5775m².

The general orientation based on entrance is Northwest-Northeast, occupied office areas also follow this orientation. The primary benefit of this orientation is that, unlike a south facing orientation, solar gains will be reduced therefore reducing the cooling load and accompanying CO₂ emissions and Primary Energy demand.

In a separate issue to this report, a Thermal Modelling study has been carried out to assess thermal comfort and comply with BREEAM HEA04 and TM52 Criteria. The analysis conducted using IES approved software utilised the present-day and future Cardiff weather files as this was deemed the most appropriate to the site location, therefore local weather data including future scenarios has been considered as per the requirements of ENE04.

4.2 BUILDING FABRIC, LAYOUT AND THERMAL MASS

As per the Building Fabric Specifications in the earlier Design Parameters section of this report, the proposed u-values for the building fabric exceed the notional values. All proposed u-values (summarised below) are also improved beyond the limiting values as dictated by Part L2A 2014:

Table 6 Proposed u-values:

Construction Element	U-Value
Floors	0.18
External Walls	0.24
Roof	0.16
Windows	1.60
External Doors	2.20/1.5

The main passive benefit of the building fabric lies in its ability to retain the heat emitted by the heating system therefore reducing the heating load and associated CO₂ emissions and Primary Energy demand.

The building layout takes advantage of natural ventilation by ensuring occupied spaces are located around the perimeter of the overall building and have access to external walls and windows which can provide natural infiltration and reduce the energy required for mechanical ventilation. In addition, the building layout places heated circulation areas such as staircases and the entrance lobby directly adjacent to the office spaces therefore reducing the amount of internal wall in contact with heat loss spaces. This will contribute a reduction in heating energy demand as the heat retention of the offices is slightly improved.

The building layout ultimately cannot fully negate the requirement for active cooling and ventilation as the potentially high occupancy of the offices requires these systems to achieve the thermal comfort requirements of BREEAM HEA04.

The Thermal Mass of the building is anticipated to be lightweight; the thermal capacity of the construction will therefore be average and provide minimal passive heating/ cooling benefits. One minor benefit of the thermal mass would be that it will allow the spaces to purge any stored heat at faster rate during unoccupied hours essentially helping to pre-cooling the building to a certain degree therefore reducing reliance on the active cooling system in the earlier hours of the day.

4.3 OCCUPANCY TYPE AND VENTILATION STRATEGY

The Occupancy and Ventilation strategy have been detailed in the previously issued Building Services and Thermal Modelling reports however here is a short summary of these two elements:

Occupancy:

- Includes only spaces that would be occupied for more than 30mins as per BREEAM HEA04
- Heat gains per person has been set to 130W (75W sensible and 55W latent)
- The occupancy profile of the spaces has been set to 8:00 – 18:00 Mon – Fri weekends have been excluded.
- Number of occupants per space detailed in the table below:

Table 7 Preliminary Room Occupancies

Room	Occupancy (people)
Office Spaces	1 per 10m ² floor area

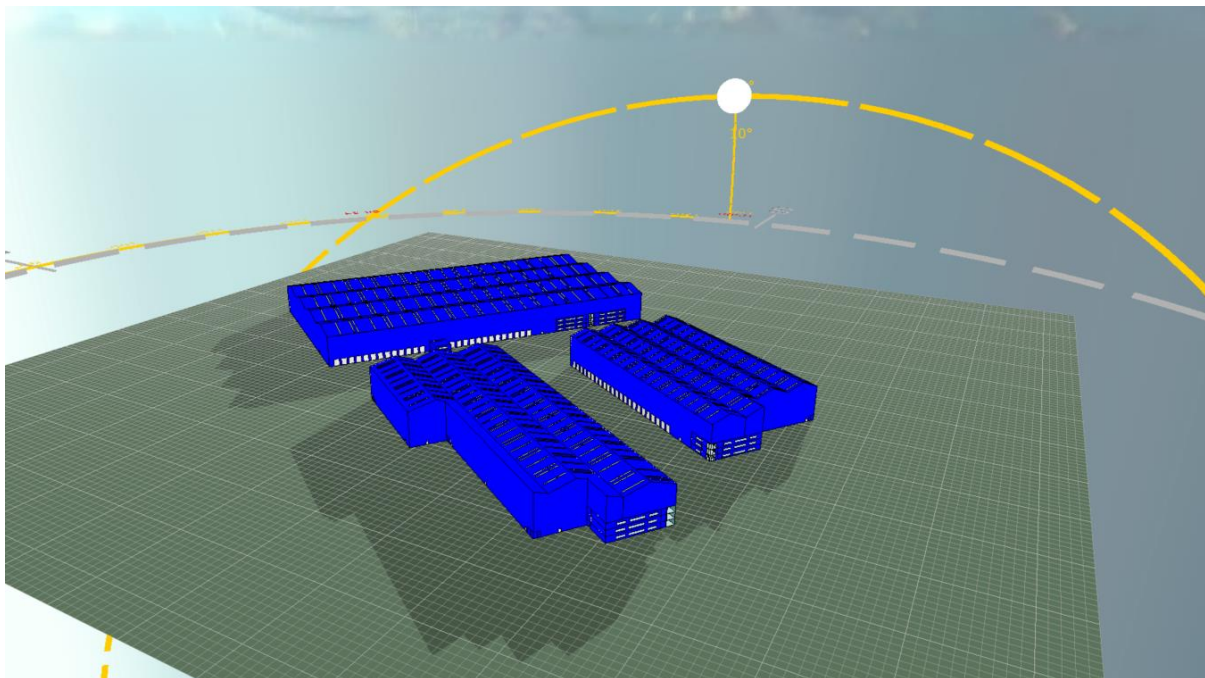
Ventilation Strategy:

- Mechanical Ventilation with Heat Recovery, SFP improved beyond notional from 1.8 w/(l/s) to 1.2 w/(l/s) and heat recovery efficiency improved from 70% to 85%

4.4 DAYLIGHTING AND ADAPTION TO CLIMATE CHANGE

The design incorporates a predominantly Northwest / Northeast facing orientation which therefore receives a moderate amount of natural daylight whilst minimising any solar gain issue that may occur with a fully south facing orientation. The figure below displays the sun path and shade during the mid-day.

Figure 2 Sun Path Arc Daylighting Strategy



As shown above, Northwest-Northeast facing façades of the occupied office areas are not in view of the sun during this time with shadows cast to the North. North facing office windows will receive less natural light however this also means there will be less solar gain, this balances the equation to an extent as the increased demand for artificial lighting is off set by the reduced cooling/mechanical ventilation load. The windows themselves will assist in providing natural lighting via a good light transmittance value of around 0.7 which has ultimately led to a reduction in energy used for artificial lighting overall.

Regarding climate change adaption, a test has been carried out measuring the BER performance of the buildings using different climate scenarios.

Table 8 Building Emission Rate Performance Climate Scenarios

Building Type	Present Day	DSY 2 2020 high 50	DSY 3 2020 high 50
Notional	12.4 kgCO ₂ /m ² .yr	12.4 kgCO ₂ /m ² .yr	12.4 kgCO ₂ /m ² .yr
Proposed	11.9 kgCO ₂ /m ² .yr	11.8 kgCO ₂ /m ² .yr	11.8 kgCO ₂ /m ² .yr

As shown in the table above a test was carried out using 2nr climate scenarios against the present day. DSY 2 represents a longer less intense summer where DSY 3 represents a short but more intense summer period. There are no differences in the BER result between the 2nr different scenarios therefore showing that the building has good adaptability against potential future climates. A slight decrease can be seen between the present-day climate and DSY's 2 and 3 to account for changes in the heating demand.

4.5 CREDIT 1 PASSIVE DESIGN ANALYSIS SUMMARY

The building orientation and layout will assist in reducing the buildings energy consumption for heating and ventilation by taking advantage of natural infiltration through the exposed external wall construction and by having heated spaces adjacent to the occupied office areas which reduces the amount of internal heat loss walls.

Further to this, consideration has been given to the local weather and microclimate. Present and future DSY weather files for Cardiff have been deemed the most appropriate weather file for the site. It has been deemed that as the site is not located in an urban city centre there will therefore be no micro-climate affecting internal thermal conditions, the location therefore passively reduces the cooling load.

Further contributing to the Passive Design Analysis is the improved building fabric performance which improved over notional values in all instances. The fabric will therefore be able to better retain heat and reduce the heating demand than the standard building which uses notional values.

Although mechanical ventilation is required on this project, the specific fan power and heat recovery efficiencies have been improved in the Proposed Building Calculation beyond that of the Standard Building calculation. The consideration of all passive design features above has ultimately resulted in a reduction in CO₂ emissions and Primary Energy demand as shown in Table 9 below.

Table 9 Passive Building Results

Criteria (CO ₂ / Energy Demand	Standard Building	Proposed Building	Reduction	% Reduction
Building Emission Rate (BER) kgCO ₂ /m ² /Year	13.7	11.9	1.8	13.14
Primary Energy Demand kWh/m ² .yr	69.73	60.46	9.27	13.30

The results in the above table isolate the impact of the passive design features discussed, in order to do this the system technology (i.e. heat pump) used has been kept consistent in each calculation. Later in Section 6 Low Carbon Feasibility Study of this report, the impact of applying L2C Technology will be isolated and compared. Please note that as per the BREEAM 2018 Technical Manual some Passive features such as orientation are fixed for both standard and proposed building calculations.

4. PASSIVE DESIGN ANALYSIS



It is the conclusion of this section of report that the consideration and implementation of passive design measures support the acquisition of ENE04 Credit 1 without compromising systems put in place to support the thermal comfort of the occupants and meet BREEAM HEA04 criteria. Table 9 displays the Passive Building Results which can be compared against the Standard Building which uses only notional values, it is therefore recommended that the first credit of the BREEAM ENE04 Criteria be awarded.

5 FREE COOLING ANALYSIS

This aspect of the 2nd credit available within ENE 04 requires detailed consideration to identify and utilise appropriate technologies in which free cooling can meet the entirety of the buildings cooling demands.

As per the ENE04 04 criteria, various options as listed below should be investigated and their feasibility determined.

1. Night-time cooling (which could include the use of a high exposed thermal mass)
2. Ground coupled air cooling
3. Displacement ventilation (not linked to any active cooling system)
4. Ground water cooling
5. Surface water cooling
6. Evaporative cooling, direct or indirect
7. Desiccant dehumidification and evaporative cooling, using waste heat
8. Absorption cooling, using waste heat

The free cooling should apply to all occupied spaces in the building. In the case of this project occupied spaces include Office areas.

A feasibility study has been carried out on all the above options and the most appropriate option would be Night-time cooling.

Taking advantage of the low thermal mass and amount of exposed wall construction throughout the evening in the Summer months to reduce the cooling requirements and pre-cool the spaces for the following day.

However, as the spaces have a potentially high occupancy and additional heat gains will be emitted from equipment such as computers, the free cooling methods available are unable to match the cooling demand on their own, as such this space requires comfort cooling to achieve HEA04 criteria.

As it cannot be demonstrated that the free cooling can meet the buildings cooling demand the second credit for ENE04 cannot be achieved therefore no additional analysis will be reported.

6 LOW CARBON FEASIBILITY STUDY

This section of the report will examine various low carbon technologies with respect to their appropriateness to this development. Some of the low carbon systems are intrinsically unsuitable due to the development type and location whereas others are potentially viable.

6.1 CLEANER ENERGY - CHP & DECENTRALISED ENERGY NETWORKS

6.1.1 On-site CHP

The Energy Hierarchy identifies combined heat and power (CHP) as a method of producing heat and electricity with much lower emissions than separate heat and power. Also, it encourages the creation of district heating systems supplied by CHP.

The implementation of a CHP strategy should be decided per good practice design. Key factors for the efficient implementation of the CHP system are:

- Development with high heating load for most the year, in this case the requirement for hot water.
- CHP operation based on maximum heat load for minimum 10 hours per day
- CHP operation at maximum capacity of 90% of its operating period

The implementation of a CHP unit is not to be considered for this development due to its relatively low heating and hot water demand and as such, should it be installed would be extremely inefficient and effectively would have to dump a considerable amount of the heat which it would generate.

As a result, it is inappropriate for this development.

6.1.2 Decentralised Energy Network

The feasibility of connecting into an existing heating network or providing the building with its own combined heat and power plant has been assessed through the use of UK CHP Development Map.

At the moment, there is no decentralized energy network available and in particular a district heating network in the proximity of the proposed development site that would allow the development to connect to such a network.

As such any benefit from connecting to this system is not possible. As there are no plans to extend the current district heating network to within the vicinity of the development, there is no benefit for including any future provision of connection.

6.1.3 Micro - CHP

Micro CHP has not been considered further for this project for the following reasons:

Micro-CHP is a relatively new concept. Since they were released, issues have been raised in relation to unproven technology, inefficiency for shorter run cycles and lack of technical knowledge that can limit the practical application of micro-CHP at present.

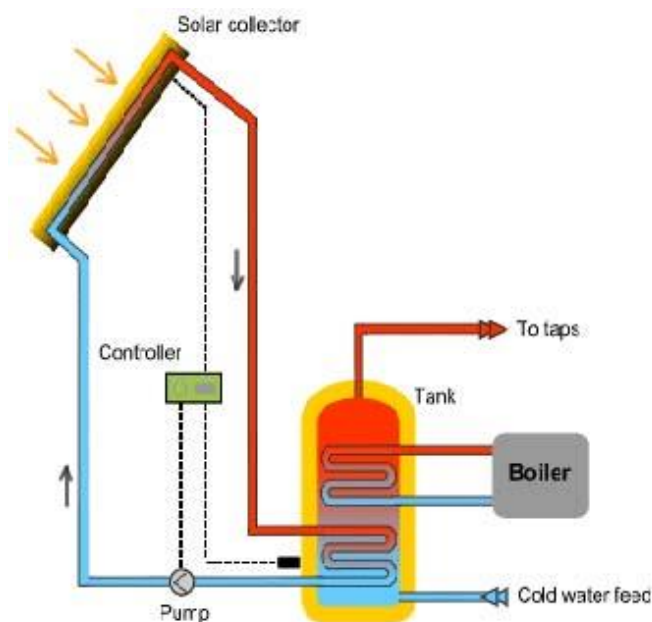
In addition, these are a fossil fuel, of which reliance on should be reduced where possible

7 ZERO CARBON FEASIBILITY STUDY

This section of the report will examine various renewable technologies with respect to their appropriateness to this development. Some of the LZCs are intrinsically unsuitable due to the development type and location whereas others are potentially viable.

7.1 SOLAR WATER HEATING

Figure 3 Solar Thermal Diagram



Solar thermal panels utilise the sun's energy to generate hot water for use within the building. The panels are commonly provided in either flat plate or evacuated tube arrangements. The panels are ideally located facing south at an approximate 30° inclination angle in areas where they are not subjected to shade.

The use of solar thermal will introduce further pipework which emits heat into the building which will therefore increase the internal gains and reduce the effectiveness of the passive design discussed previously in this report and increase the cooling load.

As such this technology has been discounted.

7.2 WIND TURBINES

Wind turbines generate electrical energy derived from kinetic energy provided by the local wind resource. The performance of wind turbines depends greatly on the wind speed and turbulence that in turn is influenced by the terrain and installation height.

Figure 4 Typical 6kW Wind Turbine Example



As the site does not lend itself to the installation of a wind turbine given its proximity to other commercial units this has been discounted.

7.3 PHOTOVOLTAIC CELLS (PV)

Photovoltaic (PV) panels utilise the sun's energy to generate electricity. The optimum location for PV panels is south facing at an approximate 30° inclination angle in areas where they are not subjected to shade.

Figure 5 PV Examples



Photovoltaics would be an appropriate renewable technology that this project can take advantage of. However, it would come at the expense of reducing available space for roof lights and therefore passive natural lighting. Furthermore, the development can meet the requirements of Part L, Planning and BREEAM ENE04 through passive design and low carbon technology alone. Photovoltaics have therefore not been included in the current design.

7.4 SOURCE HEATING AND COOLING

The Air Source Heat Pumps can be linked with indoor units to heat and cool the space. These could be either ceiling mounted cassette units, wall mounted units or floor mounted units. This would have the benefit of also providing cooling to each room in summer months.

The outdoor units can be located anywhere and are not dependant on orientation. They need to be externally mounted and in a local compound to be safe.

This technology has been included in the form of VRF air conditioning units that will provide both heating and cooling. This is required in order to meet BREEAM HEA04 criteria.

7.5 BIOMASS BOILER

Biomass is considered to be a renewable fuel source as the CO₂ absorbed during the growth period is assessed as being approximately equal to the CO₂ emitted during combustion and hence deemed "carbon neutral". Biomass for boilers is typically wood either in chip or pellet form.

Biomass boilers require fuel storage together with associated transportation and delivery to the store location.

Figure 6 Biomass Example



With the minimal plant areas, logistics of deliveries and the proximity to nearby commercial units and domestic areas, it is not considered viable to transport wood pellets or similar to the building.

For the above reasons, the use of a biomass boiler plant is not considered viable for the development.

7.6 FUEL CELL

The fuel cell technology essentially converts chemical energy into both electrical and heat energy. The cell needs to be continually supplied with hydrogen (derived from either a piped or storage source) and oxygen (derived from air) that are combined and the chemical reaction produce electrical energy, heat energy and water vapour.

The fuel cell requires a hydrogen fuel source that can either be from a piped source (not currently available) or from stored gas. However, the more usual approach currently in the UK is to use natural gas in order to generate the hydrogen required to operate the fuel cell.

Fuel cells have various commercial and technical limitations. There is a high initial capital cost together with there being few established suppliers and a very limited specialist design, installation and maintenance capabilities. Certain fuel cell elements require regular replacement imposing a significant on-going cost implication. The fuel cells themselves are generally large, heavy and require fresh air ventilation.

Due to the initial capital cost, space requirements and on-going maintenance costs fuel cells are not considered viable for this development.

8 LZC TECHNOLOGY RESULTS

To achieve the third ENE04 credit, the inclusion of LZC technology must be quantified with a comparison between the SBEM calculation of the proposed building and the SBEM of the same building without the LZC technology.

Given that the chosen LZC technology is VRF Heat Pumps which is the main heating source for the whole development, the comparison will be carried out on a Part L2A gas notional heating system with the passive design measures included as per the ENE04 requirements.

Please note the following applies with respect to the heat pump:

- The Heat Pump can only be used in a single mode (heating or cooling mode) at any one given time, therefore cooling can only be used when there is no heating demand.
- There will be no other heating sources within the office spaces, they will be serviced by the Heat Pump only. The final chosen Heat Pump will have a COP above 2.5.
- For fair comparison the calculations in this report isolate the heating load only

Both the "Notional Technology BRUKL" and the comparison "LZC Technology BRUKL" will be available for review within Appendix A.

Table 10 Passive Building Notional Technology and Proposed SBEM results

Criteria (CO ₂ / Energy Demand)	Passive Building Notional Technology	Proposed Building LZC Technology	Reduction	% Reduction
Building Emission Rate (BER) kgCO ₂ /m ² /Year	12.6	11.9	0.7	5.56
Primary Energy Demand kWh/m ² .yr	63.84	60.46	3.38	5.30

As can be seen from the table above, there is a reduction both CO₂ emissions and Primary Energy solely due to the Heat Pump LZC technology that is to be included within the proposed design. As required by BREEAM ENE04 this calculation includes the passive measures applied in the Passive Design Analysis, therefore the reduction is purely the result of including low carbon Air Source Heat Pump technology.

As a result, it is the recommendation on this report that the 3rd credit under BREEAM ENE04 be awarded.

9 SURFACE WATER RUN OFF

The development will comprise a combination of soft landscaping and permeable paving to mitigate surface water discharge from the development.

A separate analysis has been undertaken by the civil and structural engineer.

10 FUNDING OPPORTUNITIES

10.1 GENERAL

There are three primary funding schemes that are available to encourage the implementation of low and zero carbon technologies. These are the Smart Export Guarantee (SEG), Feed in Tariff (FiT) and the Renewable Heat Incentive (RHI).

10.2 SMART EXPORT GUARANTEE (SEG)

The smart export guarantee (SEG) is an obligation set by the government for licensed electricity suppliers to offer a tariff and make payment to small-scale low-carbon generators for electricity exported to the National Grid, providing certain criteria are met.

Anyone installing a renewable energy system with a capacity of up to 5MW could use SEG. The SEG Licensee is required to put processes in place to pay for the electricity exported by the eligible installation and to report to Ofgem on installations under the SEG arrangements. SEG Licensees determine the rate they will pay, contract length and other terms. However, whilst wholesale electricity prices can sometimes fall below zero, SEG Licensees must always offer a tariff that remains above zero. SEG payments must be calculated by SEG Licensees using Export Meter Readings.

10.3 FEED IN TARIFF (FIT)

The FiT Scheme was replaced in January 2020 by the Smart Export Guarantee (SEG) as described above and has therefore been excluded from this report.

10.4 RENEWABLE HEAT INCENTIVE (RHI)

The RHI scheme is a government programme which is available to individuals and commercial organisations that install technologies that generate heat from a renewable or a low carbon source. This scheme has been available since 2011 and covers solid biomass boilers, solid biomass CHP, ASHP's, GSHP's, WSHP's, solar thermal, deep geothermal, bio methane injection and biogas combustion.

The RHI payment received is dependent on the technology used to generate the heat and size of system installed. Similar to the FiT scheme a fee is paid to the owner of the technology for every kWh of thermal energy generated, the tariff is calculated and fixed for 20 years, however there is no export tariff.

As the development is utilising the VRF Heat pumps for cooling, it is not possible for this development to gain RHI funding in this instance.

11 SUMMARY OF LZC TECHNOLOGIES VERSUS ENE04 CRITERIA



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BREEAM ENE04 Criteria									
Technology	Energy Generated Per Year (kWp)	CO ₂ Savings per year	Life Cycle Cost and payback	Local Planning Criteria	Feasible to export heat/energy	Available Grants	Appropriate to site and energy demand of building	Reasons for excluding other technologies	Connection to CHP
Photovoltaic		N/A	N/A	Allowable	Yes	SEG	Yes	Excluded	Not available
Air Source Heat Pump		0.7 kgCO ₂ /m ² /Year	N/A See Note 1	Allowable	No	RHI See note 1	Yes	Included	Not available
CHP		N/A	N/A	Allowable	Yes	RHI	No	Excluded	Not available
Wind Turbine		N/A	N/A	N/A	Yes	SEG	No	Excluded	Not available
Solar Thermal		N/A	N/A	Allowable	No	N/A	No	Excluded	Not available
Fuel Cells		N/A	N/A	Allowable	No	N/A	No	Excluded	Not available
Note 1. ASHP's are only eligible for the RHI scheme under certain conditions, one such condition is that the ASHP is NOT designed to provide cooling which currently they are owing to the need to meet the thermal comfort criteria of BREEAM HEA04/TM52.									

12 CONCLUSION

The ENE04 Energy Study for Kingmoor, Wrexham has adopted a hierarchical approach of using passive and low energy design technologies to reduce CO₂ emissions and primary energy demand followed by the application of low and zero carbon technologies as appropriate.

The analysis has shown that by incorporating passive and low energy design measures, there is a reduction in the development's annual corrected CO₂ baseline emissions and Primary energy demand utilising the IES energy model assessment method. This is achieved by incorporation of the following elements:

- High performance low thermal mass building fabric to achieve an air leakage rate of 3 m³/h/m² at a pressure differential of 50 Pa with u-values surpassing the requirements of Part L.
- A Northeast/ Northwest orientation combined with a strategic internal layout that takes advantage of heated adjacent spaces, natural lighting and ventilation during the day and supports night-time cooling/purging in the evening through natural infiltration.
- High efficiency VRF Air Source Heat Pump technology for the heating and cooling with electric instantaneous point of use hot water.
- Highly efficient Mechanical Ventilation Heat Recovery with a low specific fan power value of 1.2 w/(l/s) and a heat recovery efficiency of 85%.
- Low energy LED lighting.
- Automatic lighting control system with occupancy and daylight dimming controls in common parts.

The CO₂ and Primary Energy reduction results have been isolated for the passive design analysis and L2C technology study and presented in tables at the end of each analysis. It should be noted the results presented in these tables pertain solely to the requirements of BREEAM ENE04 and do not represent the final Part L2A Compliance results, please refer to the Part L BRUKL issued separately for these results.

This L2C report concludes that the consideration of passive design, free cooling and L2C technology has resulted in a reduction in both CO₂ emissions and Primary Energy Demand.

It is therefore the recommendation of this report the 2 out of 3 credits should be awarded to this development.

13 APPENDICES

Appendix A – BRUKLS (issued separately)

Appendix B – Thermal Report (issued separately)