

KGA (UK) Ltd

Chartered Building Services Consulting Engineers



Ene04 Low Zero Carbon Report

Project:
Knowsley East Hub

Date: 22 November 2022

Trinity Chambers
10 Ivy Street
Birkenhead
Merseyside
CH41 5EF

Telephone	0151 647 5021
Facsimile	0151 647 6955
Web	www.kga.co.uk
Email	eng@kga.co.uk

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1.0 EXECUTIVE SUMMARY

This report identifies a number of low or zero technologies for the new development which have been investigated, a number of the technologies have been rejected and the reasons explained. The technology which is most suited for the development is Photovoltaic's for the building. The building and photovoltaic technology has been modelled using Version 2022.1.2.0 of the Virtual Environment Software by IES Ltd to calculate the building CO2 emissions with and without PV, and also energy contribution by the proposed PV Panels. The results are as summarised below:-

Unit Reference	BER Baseline U (kgCO2/m2)	BER Improved U (kgCO2/m2)	% Reduction
Unit 1	1.51	1.39	8.8%

2.0 INTRODUCTION

This report has been undertaken to investigate the feasibility of incorporating Low and Zero Carbon Technologies at Knowsley East Hub.

The following technologies have been considered and investigated as to their suitability for the proposed development.

- Biomass Boilers
- Ground Source Heat Pumps
- Solar Thermal Panels
- Photovoltaic Panels
- Wind Turbines
- Air Source Heat Pumps
- CHP

Additionally, the feasibility of utilising an existing CHP system, local power or waste heat locally, also the potential to provide a CHP or other technology to export waste heat and/or power.

This report is a high-level concept study which describes the above technologies, local planning criteria, site limitations, feasibility of exporting heat/electricity and any available grants.

There is a strong commitment from the client that should a low and zero carbon technology is economically feasible and a genuine contribution to reducing CO₂ emissions if possible then it will be seriously considered.

The assessment has been undertaken by Mr Aled Williams of KGA (UK) Ltd, a CIBSE accredited Low Carbon Consultant and CIBSE accredited Low Carbon Energy Assessor, accreditation number LCEA182170.

The intended site is located off Gale Road/South Boundary Road, Knowsley.

To the all surroundings there are existing industrial units. Noise is not an issue due to the industrial/retail location. There is very limited external space at ground level so all renewable technologies would either need to be on the roof or within the building.

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4.0 BACKGROUND

The Climate Change Act 2008 aims to improve carbon management and help the transition towards a low-carbon economy in the UK.

New Construction will need to play its part in meeting national targets for carbon reduction. To this end the Building Regulations set target emission rates. These emission rates are calculated utilising a government approved calculation engine referred to as the Simple Building Energy Model (SBEM).

There are different Carbon intensities between Electricity and Gas. Grid supplied electricity has a much higher Carbon intensity due to Power Station efficiency being much lower and distribution energy losses being much higher than using mains gas.

Displacing electricity with Low or Zero Carbon technologies therefore generally is better, as it costs more per kWh and has greater carbon intensity, brings bigger financial and environmental benefits.

5.0 BUILDING FABRIC

The building will be clad with a unitised curtain walling system.

At this stage it is anticipated that an overall U-value for the curtain walling system of around 1.3W/m²K or better will be achieved. For the purposes of this assessment this value has been used, though solutions will be sought to reduce the U-value further where possible in order to realise further carbon reductions.

Glazing to the units will be specified to achieve a g-value of around 0.4. This is considered to provide an appropriate year-round balance between maximising daylighting and beneficial wintertime solar gain, and minimising summertime solar gains to reduce the overheating risk and need for comfort cooling.

The current proposals for the enhanced building fabric performance for the Proposed Development are summarised in Table 5-1.

Table 5-1 Fabric performance targets (Passive design measures)

ELEMENT	MINIMUM BUILDING REGULATIONS FABRIC PERFORMANCE	ENHANCED FABRIC PERFORMANCE
External Wall U-value (W/m ² K)	0.26	0.18
Office Party wall U-value (W/m ² K)	0.26	0.18
Ground floor U-value (W/m ² K)	0.18	0.15
Roof U-value (W/m ² K)	0.18	0.18
Curtain Wall / Glazing U-value (W/m ² K)	1.6U / G0.4 / LT 0.7	1.3U / G0.4 / LT 0.7
Roof Lights / Glazing G-value	2.2U / G0.55 / LT 0.6	1.5U / G0.55 / LT 0.6
Air permeability (m ³ /hr.m ² @ 50 Pa)	8.0	4.0

From the thermal model, the BRUKL documents attached to this report details building annual energy consumption and annual energy consumption from incorporating the passive design measures are as follows:-

Unit Reference	BER Baseline U (kgCO ₂ /m ²)	BER Improved U (kgCO ₂ /m ²)	% Reduction
Unit 1	1.51	1.39	8.8%

6.0 LOW OR ZERO CARBON TECHNOLOGIES

6.1 BIOMASS BOILERS

Energy from biomass is produced by burning organic matter. Biomass products such as trees, crops or animal dung are harvested and processed to create bio-energy in the form of electricity, heat, steam, and solid fuels. Biomass is the solid form of 'bio-energy', but liquid fuels can also be generated from plant matter and this is referred to as 'bio-fuel'.

Biomass is carbon-based so when used as fuel it also generates carbon emissions. However, the carbon that is released during combustion is equivalent to the amount that was absorbed during growth, and so the technology is carbon-neutral (the fuel generally requires treatment and transport, with associated carbon emissions). Unlike fossil fuels, biomass can be replaced relatively quickly.

The factors that influence the feasibility of Biomass installations are as follows:-

- Location - Locations with convenient transport access to suppliers of biomass, and with sufficient space for storage. Design and operation fuel handling/storage can require as much consideration as the biomass plant itself.
- Building - The technology is appropriate to all building occupation types, however additional space is required to accommodate the boiler, buffer tank and fuel storage.

The potential for biomass in the UK is good, although a reliable and reasonably local supply of fuel from forestry, farming or industrial sources is required. The Government is committed to biomass because it is a low carbon energy source and because of its potential to boost rural economies. Consideration should be given to maintenance, in particular to the availability of personnel and the time required maintaining biofuel systems.

Operation and Safety

There are no particular health and safety concerns associated with the technology. Guidelines for the operation of biomass systems are generally as for other solid fuel appliances, especially in regards to fuel storage and handling, as well as operating stoves and boilers. There is a requirement to dispose of ash, but this is a minor concern in well-commissioned equipment. Further information is available from Clear Skies (www.greenbooklive.com) and the Renewable Energy Association (www.r-e-a.net).

Fuel Delivery

The strategy for fuel delivery must also be considered at the design stage. The solution for fuel delivery will impact significantly on the shell construction. There are options of either a hopper/bag to contain the fuel or an underground store.

Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Fuel Supply	Is there a supply chain within 25 miles	Mixed and pellet suppliers within 25 miles.	S
Delivery	Is there space for delivery vehicles?	Access is available	S
Storage	Can space be allowed for storage?	Limited storage space	U
Boiler Plant	Can space be allowed for boiler and ancillary equipment?	The plantroom required would be too large	U
Exhaust Flue	Is there location for a flue?	Flues can be accommodated	S
Maintenance	Maintenance to be carried out by a qualified HEATAS installer.	A suitable maintenance contractor can be provided.	S
Noise Level	Are higher noise levels acceptable.	No, domestic properties nearby	S
Available Heat Load	Good low grade heating system must be available such as underfloor heating.	Building heat load equates to circa 10% of the predicted building energy usage – no low grade heating	U

The biggest disadvantage is space for both the biomass plantroom and storage which ideally need to be in close proximity to each other and also on the ground floor, with all ground floor required for commercial storage there is no space. Due to the space requirements of the technology the biomass boilers have been rejected as a viable option.

6.2 GROUND SOURCE HEAT PUMPS

Ground source heat pumps provide a new and clean way of heating buildings in the UK. Ground Source Heat Pumps make use of renewable energy stored in the ground, providing an extremely energy-efficient way of heating buildings. They are suitable for a wide variety of building types and are particularly appropriate for low environmental impact projects.

They do not require hot rocks (geothermal energy) and can be installed in most of the UK, using a borehole or shallow trenches or, less commonly, by extracting heat from a pond or lake. Heat collecting pipes in a closed loop, containing water (with a little antifreeze) are used to extract this stored energy, which can then be used to provide space heating and domestic hot water. In some applications, the pump can be reversed in summer to provide an element of cooling, but these systems are not currently eligible for UK grants.

The only energy used by Ground Source Heat Pump systems is electricity to power the pumps. Typically, a Ground Source Heat Pump will deliver 3 or 4 times as much thermal

energy (heat) as is used in electrical energy to drive the system. For a particularly environmental solution, green electricity can be purchased.

Ground Source Heat Pump systems have been widely used in other parts of the world, including North America and Europe, for many years. Typically, they cost more to install than conventional systems; however, they have very low maintenance costs and can be expected to provide reliable and environmentally friendly heating for in excess of 20 years. Ground Source Heat Pumps work best with heating systems which are optimised to run at a lower water temperature than is commonly used in UK boiler and radiator systems. As such, they make an ideal partner for underfloor heating systems.

Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Ground Conditions	Is ground suitable for bore holes or loops?	There is no ground information available, Trial hole would need to be completed and insufficient surrounding space for loops.	U
Plant Room	An area for the heat pumps and pipework distribution point is required.	Area for heat pumps can be accommodated.	S
Available Heat Load	Good low grade heating system must be available such as underfloor heating.	Building heat load equates to circa 10% of the predicted building energy usage.	U

Ground source heat pumps are considered to suitable for buildings in which there is a large demand for heat and in which a low grade heating system is available such as underfloor heating. There is no low grade heating in the building and there is no space for the shallow loop installation and the ground conditions are unknown for 200m bore hole installation. This renewable option have been rejected for the above reasons.

6.3 SOLAR THERMAL PANELS

Solar water heating utilises the energy from the sun to heat water; in the UK this is commonly used for hot water needs. A heat collector is generally mounted on a roof or south facing façade (south-east/south-west is also acceptable) and the sun heats the fluid within it.

There are two main types of collectors, these are flat plate collectors and evacuated tube collectors, see Figure 5. The predominant of the two is the flat plate collector for domestic systems due to the fact that it tends to be the cheaper option. Evacuated tube collectors are more complex in the manufacturing process and are therefore more expensive than flat plate collectors. It is claimed that evacuated tube collectors have better winter performance.

There can be a large difference in the costing of the installation of a commercial solar water heating system. The costs are dependent upon installation labour, pipework and fittings which vary down to site-specific issues. An important issue when installing in solar water heat are the locations of the collectors and the storage relative to each other. The arrangement and length of pipe-runs from collectors to storage facilities can provide complication and affect the cost of the installation.



Solar Water Heating: Flat Plate collector, and Evacuated Tube collector
Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Roof Orientation	The collectors need to be orientated from SE to SW or mounted flat	Roof Space available	S
Roof Space	Panels should not be shaded at any time.	Both main roofs should give uninterrupted view of the sky and at an inclination of 30 Deg	S
Available HWS Load	All year hot water demand	Building HWS load equates to circa 15% of the predicted building energy usage.	U

Although Solar Thermal is a technology that could be sited on the building the all year hot water demand is very low, circa 15% of the building energy demand. For this reason the installation of Solar thermal panels have been rejected.

6.4 PHOTOVOLTAIC PANELS

The word photovoltaic is a marriage of the words 'photo', which means light, and 'voltaic', which refers to the production of electricity. Photovoltaic technology generates electricity from light.

All PV cells have at least two layers of such semiconductors: one that is positively charged and one that is negatively charged. When light shines on the semi-conductor, the electric field across the junction between these two layers causes electricity to flow - the greater the intensity of the light, the greater the flow of electricity.

Integrated Panels – This system involves placing panels into the roof during roof building, as shown below. It is most suitable for application where high output is desirable or where the roof area is limited.

Protection from the environment is required for PV cells, and they are usually packaged behind a glass sheet. Cells may be connected together to form photovoltaic modules, or solar panels to provide for a higher electrical demand. For a large building the modules must be arranged in arrays.

The EPIA/Greenpeace Advanced Scenario shows that by the year 2030, Photovoltaic systems could be generating in the region of 2,600 TWh of electricity worldwide. This means that there is the possibility that enough solar power may be produced globally in twenty-five years' time to satisfy almost 14% of the electricity needs of the world's population.

Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Roof Orientation	The PV panels need to be orientated from SE to SW or mounted flat	Roof Space available	S
Roof Space	Panels should not be shaded at any time.	Both main roofs should give uninterrupted view of the sky.	S
Adequate building electrical load	All year (particularly) summer electrical load	The annual electrical consumption predominantly lighting and auxiliary equipment equates to circa 75% of the building energy demand	S

Photovoltaic is a technology that should be considered and can be mounted south facing, the building energy demand is predominantly electrically led and therefore PV is a viable option.

6.5 WIND TURBINES

Wind Energy is a fast growing renewable energy sector, with more and more people successfully making use of wind power for both domestic and commercial projects. Sunlight falls on oceans and continents, causing air to warm and rise. This in turn generates surface winds that spin wind turbine blades to produce electricity.

Wind Turbines have the benefit of:-

- Helping the environment, as wind turbines produce no air pollution.

- Reducing energy dependence on the national grid.
- Reducing costs.

Wind Turbines have financial benefits:-

- Lowering of electricity bills, due to the reduction in reliance on the national grid.
- Set up costs for off-grid power are minimised.
- Expenditure on fossil fuels is reduced
- An under-utilised location or resource can become a source of energy generation and revenue.

Systems utilising wind energy can help to reduce the amount of electricity purchased from utility providers. They can also cut down dependence on non-renewable energy resources.

Wind Energy can be an efficient and effective means of providing renewable power generation. Turbines can produce electricity without producing Carbon Dioxide emissions and can therefore be an excellent way of achieving the 10% renewable energy target.

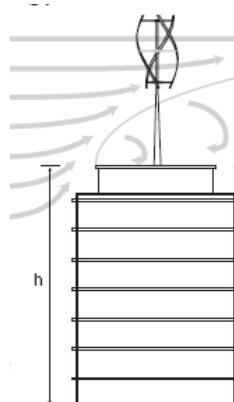
Wind turbines provide a visual statement for any development but inappropriate siting can result in disappointing outputs.

Wind is an intermittent resource. However, wind turbines are not unreliable technology. Modern wind turbines are able to capture more than 90% of the available energy from the wind, compared with a fuel efficiency of between 35 and 40% for a conventional coal fired station, which tends to lose a significant proportion of energy through heat loss and pollution.

System Description

Wind turbines generally have 3 blades (see below) and they rotate at 10-30 revolutions per minute. The blades face into the wind, the wind forces them to go round, which then spins a shaft inside the turbine, which is connected to a generator, which produces the electricity.

Typically, reasons for wind turbines causing disruption or being refused planning permission include its visual impact, noise and vibration. Modern design is geared towards adding visual appeal to its surroundings, and the aerodynamics of the horizontal axis design mean that noise and vibration is reduced to near silence.



Wind Turbines in Action

Attention is required to ensure that wind paths remain unrestricted to ensure optimum performance

Wind speed at 45m agl (in m/s)

6.1	6.1	6.1
6.1	6.1	6.2
6.1	6.1	6.1

Wind speed at 25m agl (in m/s)

5.6	5.6	5.6
5.6	5.6	5.6
5.5	5.6	5.6

Wind speed at 10m agl (in m/s)

4.9	4.9	4.9
4.9	4.9	4.9
4.8	4.9	4.9

The above table shows the results from the wind speed at various highs from the national wind speed database on DECC (Department of Energy and Climate Change).

Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Wind Speed	Free Standing wind speed to be above 5.5 m/s	DECC wind speed database indicates average wind speeds of 4.9 m/s	U
Obstructions	Free area around the turbine required to avoid turbulence	There are a number of tall building on the site that would create turbulence including trees	U

Due to the predicted wind speeds estimated in the location provided by DECC wind turbines have been rejected as a viable technology for this development.

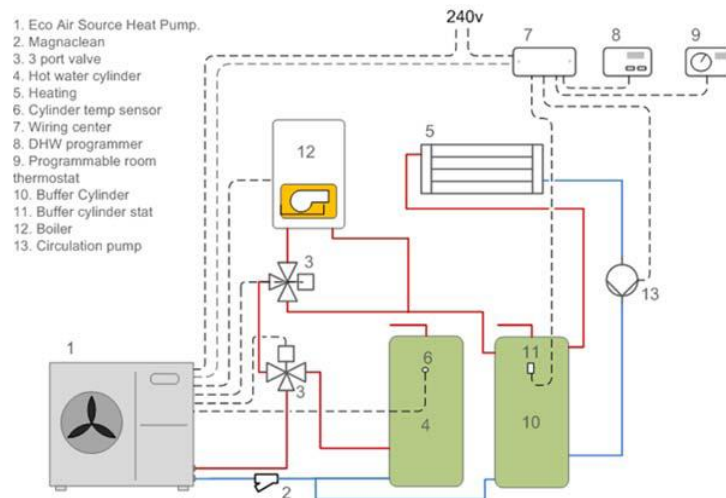
6.6 AIR SOURCE HEAT PUMPS

These systems use similar principles to ground source heat pumps to extract heat from air instead of the ground. A COP above 3.0 is required to be more efficient than an equivalent gas boiler.

Some manufacturers claim to be able to achieve 65°C water temperatures but this depends on many factors – not the least of which is the outside ambient temperature 40- 45°C is more realistic.

An additional feature with the heat pump is that during summer the cycle can be reversed to give cooling (usually with underfloor systems) and the rejected heat can be used to generate hot water.

Below is a typical system schematic which shows some of the system components but will depend on the final system design.



Air source heat pumps can be fitted outside and generally perform better at slightly warmer air temperatures.

Suitability of Technology

Item	Requirements	Comments of Suitability	Suitable (S) Unsuitable (U)
Plant Space	An external area for the heat pumps and pipework distribution point is required.	Possible to allocate an area for the plant	S
Available Heat Load	Good low grade heating system must be available such as underfloor heating.	Building heat load equates to circa 10% of the predicted building energy usage.	U

There is limited space externally however it could house the air source heat pumps. There is no low grade heating such as underfloor heating and the building heating load equates to only 10% of the building energy demand and therefore this option has been rejected.

6.7 CHP / WASTE HEAT / ELECTRICITY

Due to the limited heating demand of the building and especially during the summer periods whereby the heating load is nominal there is no scope for a considerable period of the year to recover the waste heat from the CHP. A CHP is suitable only when an all year round heat demand is available. For that reason the CHP option has been rejected.

The closest district heating network is approximately 10 miles away within Sheffield city centre which is unsuitable.

With regards to generating heat and electricity to export into a local network, there is no community heating or electricity network to feed into.

6.8 SUMMARY

The following table summaries the technologies which have been rejected and those which are to be investigated further financially.

Technology	Suitable (Yes / No)
Biomass Boilers	No
Ground Source Heat Pumps	No
Solar Thermal Panels	No
Photovoltaic Panels	Yes
Wind Turbines	No
Air Source Heat Pumps	No
CHP	No

7.0 GOVERNMENT SCHEMES

7.1 GRANTS AND PROCUREMENTS

The Low Carbon Buildings Programme has now come to an end and grants for low or zero carbon technologies are no longer available. The Government funding for Renewable Technology has now been replaced by Feed in Tariffs and the Renewable Heat Initiative.

7.2 FEED IN TARIFFS

The Feed-in Tariffs (FIT) scheme is a government programme designed to promote the uptake of renewable and low-carbon electricity generation technologies.

Introduced on 1 April 2010, the scheme requires participating licensed electricity suppliers to make payments on both generation and export from eligible installations.

Please be aware that the FIT scheme has closed to new applicants from 1 April 2019, barring some exceptions.

7.3 EXPORT TARIFFS

The export tariff is a bonus payment for every kWh of surplus electricity you generate but and export to the electricity grid. The payment has a set 'floor price' see below per kWh, which can be opted out of to negotiate a new price with your energy supplier, that you export back and the electricity supplier then delivers the electricity to another customer.

The tariff has been designed as an extra incentive to encourage people that they will still receive money for any surplus electricity they generate

The published tariff rates for PV systems are as follows:

Export Tariff	Technology Type	Tariff
April 2010 to 30 November 2012	Non- PV	3.95
On or after 1 December 2012	Non- PV	5.57
April 2010 to 30 July 2012	PV	3.95
On or after 1 August 2012	PV	5.57

7.4 RENEWABLE HEAT INCENTIVE

The Renewable Heat Incentive (RHI) is a government initiative to encourage more people to use renewable energy. The scheme was announced in March 2011 and will offer quarterly payments to those with renewable heat installations – including solar thermal.

The tariffs levels that will be available at the introduction of the scheme are set out in the table below:-

Eligible Technology	Eligible Sizes	Date of accreditation	Tariff Rate 2021/22 (p/kWh)
Small Biomass	Less than 200 kWth	before 1 July 2014	10.26
			2.69
		between 1 July and 30 September 2014	9.79
			2.59
		between 1 October and 31 December 2014	8.87
			2.33
		between 1 Jan and 31 March 2015	7.91
			2.09
		between 1 April and 30 June 2015	6.73
			1.80
		between 1 July and 30 September 2015	5.05
			1.34
		between 1 October and 31 December 2015	4.80
			1.28
		between 1 January and 31 March 2016	4.32
			1.14
		between 1 April and 30 June 2016	3.94
			1.05
		between 1 July and 30 September 2016	3.55
			0.94
		between 1 October and 31 December 2016	3.37
			0.89
		between 1 January and 31 March 2017	3.21
			0.85
		between 1 April and 30 July 2017	3.06
			0.80
		between 1 July and 19 September 2017	2.91
			0.76
		on or after 20	3.17

		September 2017	2.22
Medium Biomass	200 kWth and above & less than 1MWth	before 1 July 2013	6.29
			2.69
		between 1 July 2013 and 31 March 2016	5.94
			2.59
		between 1 April 2016 and 31 June 2017	5.70
			2.47
		between 1 July and 19 September 2017	5.13
			2.22
		on or after 20 September 2017	3.17
			2.22
Large Biomass	1MWth and above	before 21 January 2013	1.16
		between 21 January 2013 and 31 March 2016	2.33
		between 1 April 2016 and 19 September 2017	2.22
		after 20 September 2017	3.17
			2.22
Solid Biomass CHP Systems	All capacities	before 1 April 2016	4.79
		on or after 1 April 2016	4.60
Small water/ground-source heat pumps	Less than 100Kwth	before 21 January 2013	5.72
		between 21 January 2013 and 31 March 2016	10.15
			3.03
		between 1 April 2016 and 1 April 2020	9.74
			2.91
		on or after 1 April 2020	9.74
			2.91
Large water/ground-source heat pumps	100kWth and above	before 21 January 2013	4.20
		between 21 January 2013 and 31 March 2016	10.15
			3.03
		between 1 April 2016 and 1 April 2020	9.74
			2.91
		between 1 April 2020 and 30 June 2020	8.77
			2.62
		between 1 July and 30 September 2020	7.02
			2.09
		between 1 October 2020 and 31 December 2020	5.61
			1.67

		on or after 1 January 2021	4.49
			1.34
Air source heat pumps	All capacities	before 1 April 2016	2.90
		on or after 1 April 2016	2.81
Deep geothermal	All capacities	before 1 April 2016	5.83
		between 1 April 2016 and 31 December 2021	5.59
		on or after 1 January 2021	5.03
Solar collectors	Less than 200 kWth	before 21 January 2013	10.95
		between 21 January 2013 and 31 March 2016	11.66
		on or after 1 April 2016	11.19
Biomethane injection	All capacities	before 1 January 2015	8.73
	First 40,000 MWh	before 1 July 2015	8.73
	Next 40,000 MWh		5.12
	remaining MWh		3.96
	First 40,000 MWh	between 1 July and 30 September 2015	8.31
	Next 40,000 MWh		4.87
	remaining MWh		3.76
	First 40,000 MWh	between 1 October and 31 December 2015	7.49
	Next 40,000 MWh		4.39
	remaining MWh		3.39
	First 40,000 MWh	between 1 January 31 March 2016	6.73
	Next 40,000 MWh		3.96
	remaining MWh		3.05

	First 40,000 MWh	between 1 April 2016 and 30 June 2016	5.82
	Next 40,000 MWh		3.42
	remaining MWh		2.63
	First 40,000 MWh	between 1 July and 30 September 2016	4.95
	Next 40,000 MWh		2.91
	remaining MWh		2.24
	First 40,000 MWh	between 1 October and 31 December 2016	4.70
	Next 40,000 MWh		2.78
	remaining MWh		2.13
	First 40,000 MWh	between 1 January and 31 March 2017	4.24
	Next 40,000 MWh		2.49
	remaining MWh		1.91
	First 40,000 MWh	between 1 April and 31 June 2017	3.82
	Next 40,000 MWh		2.25
	remaining MWh		1.72
	First 40,000 MWh	between 1 July 2017 and 21 May 2018	3.43
	Next 40,000 MWh		2.03
	remaining MWh		1.55
	First 40,000 MWh	between 22 May and 31 December 2018	5.82
	Next 40,000 MWh		3.42
	remaining MWh		2.63
	First 40,000 MWh	on or after 1 January 2019	4.95

	Next 40,000 MWh		2.92
	remaining MWh		2.25
Small Biogas combustion	Less than 200 kWth	before 1 April 2016	8.73
		between 1 April and 30 June 2016	7.56
		between 1 July and 30 September 2016	6.42
		between 1 October and 31 December 2016	4.83
		between 1 January and 31 March 2017	3.61
		between 1 April and 30 June 2017	3.43
		between 1 July 2017 and 21 May 2018	3.09
		on or after 22 May 2018	4.83
Medium biogas combustion	200 kWth and above & less than 600 kWth	before 1 April 2016	6.86
		between 1 April and 30 June 2016	5.95
		between 1 July and 30 September 2016	5.03
		between 1 October and 31 December 2016	3.79
		between 1 January and 31 March 2017	2.84
		between 1 April and 30 June 2017	2.69
		between 1 July 2017 and 21 May 2018	2.42
		on or after 22 May 2018	3.79
Large biogas combustion	600 kWth and above	before 1 April 2016	2.59
		between 1 April and 30 June 2016	2.21
		between 1 July and 30 September 2016	1.88
		between 1 October and 31 December 2016	1.42

	between 1 January and 31 March 2017	1.07
	between 1 April and 30 June 2017	1.02
	between 1 July 2017 and 21 May 2018	0.93
	between 22 May and 31 December 2018	1.42
	on or after 1 January 2019	1.21

APPENDIX – BRUKL DOCUMENTS

Project name

Knowsley East Hub**As designed****Date:** Tue Nov 22 10:06:16 2022

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name**Telephone number:** Phone**Address:** Street Address, City, Postcode

Certification tool

Calculation engine: Apache**Calculation engine version:** 7.0.17**Interface to calculation engine:** IES Virtual Environment**Interface to calculation engine version:** 7.0.17**BRUKL compliance module version:** v6.1.c.0**Foundation area [m²]:** 222.05The CO₂ emission and primary energy rates of the building must not exceed the targets

Target CO ₂ emission rate (TER), kgCO ₂ /m ² annum	1.5
Building CO ₂ emission rate (BER), kgCO ₂ /m ² annum	1.39
Target primary energy rate (TPER), kWh/m ² annum	15.9
Building primary energy rate (BPER), kWh/m ² annum	14.72
Do the building's emission and primary energy rates exceed the targets?	BER =< TER BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	U _{a-Limit}	U _{a-Calc}	U _{i-Calc}	First surface with maximum value
Walls*	0.26	0.18	0.18	LB000000:Surf[5]
Floors	0.18	0.15	0.15	LB000000:Surf[0]
Pitched roofs	0.16	-	-	No Pitched roofs in building
Flat roofs	0.18	0.15	0.15	1F000000:Surf[0]
Windows** and roof windows	1.6	1.31	1.31	LB000000:Surf[1]
Rooflights***	2.2	1.3	1.3	0F000001:Surf[1]
Personnel doors^	1.6	1.4	1.4	0F000001:Surf[40]
Vehicle access & similar large doors	1.3	-	-	No Vehicle access doors in building
High usage entrance doors	3	-	-	No High usage entrance doors in building

U_{a-Limit} = Limiting area-weighted average U-values [W/(m²K)]U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m ³ /(h.m ²) at 50 Pa	8	4

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- RAD (E) + NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	-	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

2- RAD (E) + MV(E) Remote

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	-	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

3- VRF1 + MVHR(70)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	4	0	1.4	0.75
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	-
Standard value	1	N/A

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting		General luminaire	Display light source	
Zone name		Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
	Standard value	95	80	0.3
0F01 - Lobby		95	-	-
0F02 - Stair		95	-	-
0F03 - Lift		95	-	-
0F04 - Acc Shower		95	-	-
0F05 - Cleaners		95	-	-
1F01 - Circulation		95	-	-
1F02 - Lobby		95	-	-
1F03 - Lift		95	-	-
1F04 - WC		95	-	-
1F05 - WC		95	-	-
1F06 - WC		95	-	-
1F07 - WC		95	-	-

General lighting and display lighting		General luminaire	Display light source	
Zone name		Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m ²]
	Standard value	95	80	0.3
1F08 - Acc WC		95	-	-
1F09 - Office		95	-	-
1F10 - Meeting Room		95	-	-
1F11 - Void		95	-	-
0F06 - Warehouse		95	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
1F09 - Office	NO (-3.1%)	NO
1F10 - Meeting Room	NO (-14.2%)	NO
1F11 - Void	N/A	N/A
0F06 - Warehouse	NO (-50%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m ²]	5094.4	5094.4
External area [m ²]	12567.5	12567.5
Weather	MAN	MAN
Infiltration [m ³ /hm ² @ 50Pa]	4	5
Average conductance [W/K]	2668.06	4007.82
Average U-value [W/m ² K]	0.21	0.32
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area Building Type

	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
100	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	1.87	2.51
Cooling	0.52	0.19
Auxiliary	0.34	1.12
Lighting	4.14	3.76
Hot water	4.37	3.94
Equipment*	30.67	30.67
TOTAL**	11.25	11.52

* Energy used by equipment does not count towards the total for consumption or calculating emissions.

** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	1.4	0.9
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
<i>Displaced electricity</i>	<i>1.4</i>	<i>0.9</i>

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	15.98	21.3
Primary energy [kWh/m ²]	14.72	15.9
Total emissions [kg/m ²]	1.39	1.5

HVAC Systems Performance										
System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEFF	Cool SSEER	Heat gen SEFF	Cool gen SEER	
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	125.6	80.9	9.4	8.8	5.8	3.69	2.55	4	4
	Notional	188.6	52.3	18.9	3.1	19	2.78	4.63	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	132.8	0	46.1	0	0	0.8	0	1	0
	Notional	348.4	0	68.6	0	0	1.41	0	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	148.1	0	51.4	0	0	0.8	0	1	0
	Notional	249	0	49	0	0	1.41	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type