# Potato Wharf – Blocks 3 & 4

# Energy Statement

## May 2015

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## 1.0 Introduction

This report addresses the deliverables as part of the proposed Potato Wharf Blocks 3 & 4 development, consisting of two eight story residential blocks containing 191 units within Manchester's city centre, by using SAP analysis on each of the individual dwellings in order to produce an Energy Statement for the whole development.

In accordance with Manchester City Council regulation, as set out in Appendix A: Energy Target Explanation, an energy statement must be produced for any development with more than 10 residential units in order to demonstrate the total regulated energy that the final completed development would use and the equivalent carbon emissions that this would generate.

Against this baseline the developer is asked to consider renewable and decentralised energy technologies which will reduce the predicted carbon emissions by 15%.

In addition to this, there is a further requirement for the proposed Potato Wharf development to achieve Code for Sustainable Homes (CfSH) Level 4. In order to do this, the development must achieve a 25% reduction in carbon emissions relative to the calculated target emissions.

In accordance with Document L1A, Section 1, Paragraph 23 which states; *'Where a building contains more than one dwelling (such as in a terrace of houses or in a block of flats), an average Target Emission Rate (TER) can be calculated for all the dwellings in the building. In such cases, the average TER is the floor-area-weighted average of all the individual TERs, and is calculated according to the following formula:*

*{(TER$^1$ x floor area$^1$) + (TER$^2$ x floor area$^2$) + (TER$^3$ x floor area$^3$) + …)} ÷ {(floor area$^1$ + floor area $^2$ + floor area $^3$ + …)}'*

Thus the whole building TER and similarly total Dwelling Emission Rate (DER) have been calculated through the use of SAP calculations to demonstrate compliance with the regulations set out in Part L1A. The SAP analysis gives the total regulated energy and the equivalent carbon emissions associated with this for the development as a whole. The energy hierarchy approach can then be applied in order to identify opportunities for carbon emission reductions to facilitate the required 15% reduction. Further improvements to the energy strategy can then be applied in order to achieve the 25% reduction on carbon emissions required by Code for Sustainable Homes (CfSH) Level 4.

## 2.0 Energy Hierarchy

When producing an energy strategy for a development, the energy hierarchy provides the most practical and cost effective methodology for minimising energy demand and minimising associated $CO_2$ emissions. A three stage process is set out by Manchester City Council guidance as detailed below:

1. Minimise Energy Demand – This first tier in the energy hierarchy aims to reduce the amount of energy required on site by, for example, minimising the building fabric u-values, optimising building air tightness or installing low energy light fittings.

2. Minimise Fuel Consumption – The second tier in the energy hierarchy aims to reduce the fuel consumed by the development by optimising central plant efficiencies and installing intelligent controls to optimise the efficiency of the relevant systems (e.g. installing a boiler with weather compensation control).

3. Provide On-site Renewables – The third and final tier of the energy hierarchy aims to generate energy through the use of on-site low or zero carbon technologies (LZCTs), these include combined heat and power generators (CHP), Photovoltaics (PVs) and ground/air/water source heat pumps.

## 2.1 Passive Design Elements

Passive design elements will satisfy criteria 1 and 2 of the Energy Hierarchy, these will involve;

| | |
|---|---|
| Building Fabric | • Maximise building air tightness<br>• Minimise building fabric U-Values<br>• Minimise Cold Bridging |
| HVAC Plant | • Maximise plant efficiency<br>• Minimise distribution heat loss through specification of insulation<br>• Maximise heat recovery |

## 2.2 Low and Zero Carbon Technologies

Criterion 3 of the Energy Hierarchy will require the use of Active Low Zero Carbon Generating Technologies (LZCGTs)

The following section presents a high level summary review of Active Low Zero Carbon Generating Technologies which have been considered at the initial feasibility stage for Potato Wharf, Blocks 3 & 4.

The benefits and any perceived risk associated with each LZCGT should be carefully considered relative to appropriate reference documents prior to being incorporated into the proposed building design.

### 2.2.1 Combined Heat and Power

A Combined Heating & Power (CHP) Plant is an electricity generator situated at the point of use. It consists of an engine that generates electricity with the waste heat used for heating. The units range from large industrial units to small domestic size units.

CHP provides Carbon Dioxide savings because both heat and electricity are produced. The system uses significantly less primary energy than traditional generation because power distribution losses (via the national grid) are eliminated and the waste heat is utilised to provide a portion of the building heating demand, giving an energy output efficiency of around 80%, compared to grid supplied power efficiency of between 35 and 50%.

We have assessed the application of mains gas fired CHP system to supply the building base heating and domestic hot water load. This CHP installation would work in conjunction with other heat generating technologies, such as central mains gas fired boiler plant.

In order for CHP to be effective in terms of $CO_2$ emission reduction and payback, the annual run-time must be maximised. As such CHP plant should be sized to the base domestic water load and a proportion of the base heating load. If CHP is intended to meet the entire building heating and hot water demand, a number of smaller modular units should be considered. A summary is presented below;

| **Combined Heat & Power Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Space Heating<br>Domestic Hot Water<br>Building Electrical Supply |
| **Practicality** | High | CHP is extremely practical and is an ideal technology to incorporate into large multi-story residential buildings, when used in conjunction with centralised boiler plant and LTHW flat heat exchanger units.<br><br>No additional fuel store is required, however consideration should be given to unit size, plant space requirements and associated noise attenuation measures. |
| **Cost Effectiveness** | Medium | Capital cost can be significantly greater than traditional boiler plant, however payback can be in the order of 5 to 10 years where appropriately sized.<br><br>Systems do not qualify for Feed in Tariff or Renewable Heat Incentive |
| **Reliability** | High | CHP engines will require annual maintenance and will incur downtime as a result. |
| **$CO_2$ Emission Reduction** | High | CHP can offer a significant reduction in $CO_2$ emissions provided that Central plant is sized to maximize run time. |
| **Additional Planning Constraints** | | CHP plant may require greater noise attenuation measures than would be required for traditional boiler plant. |

### 2.2.2 Embedded Photovoltaic Panels - PV

Photovoltaic technology generates electricity from light. Photovoltaic panels are distinct from other renewable energy technologies since there are no moving parts to be maintained and they are silent.

The typical efficiency of a PV panel is 17%, with 1m2 of PV panels typically generating 140kWh annually. As such, in order to reduce building $CO_2$ emissions to a significant degree, large arrays are required. For multi-storey buildings, where the useable roof area is significantly less than the gross internal floor are, PV panels offer a very limited scope to reduce $CO_2$ emissions.

It is possible to mount PV panels to the building façade, however this can present a number of practicality issues associated with access and maintenance.

A summary is presented below;

| **Photovoltaic Panels Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Building Electrical Supply |
| **Practicality** | High | PV panels are extremely practical, in that they are essentially passive in nature and require limited maintenance associated with cleaning.<br><br>Require large areas to contribute significantly to building $CO_2$ emission reduction. |
| **Cost Effectiveness** | Low | Capital cost can be high, in the order of £500/m2. Payback can be lengthy, however PV Panels will qualify for the Feed in Tariff, with payments designed to provide a payback in the order of 10 years. |
| **Reliability** | High | PV Panels are simple in their operational nature and are typically reliable. Some panel types may experience time dependency degradation. |
| **$CO_2$ Emission Reduction** | Low | Within residential buildings, where energy consumption is more heavily clustered during evening and night time, PV panels offer a very low $CO_2$ emission reduction compared to alternative LZCTs |
| **Additional Planning Constraints** | | The installation of PV Panels on new buildings may require the consent of the local planning authority. |

### 2.2.3 Biomass Boilers

We have assessed the application of Biomass wood fuel systems on supplying the building base heating load.

A biomass boiler would work in conjunction with conventional mains gas fired boiler plant which would provide the building peak winter heating loads. A buffer vessel would be installed to accommodate low summertime loads.

Modern wood fuel boilers are efficient, reliable and relatively clean in terms of fuel storage and handling. There can be issues with the smoke and flue gas produced as wood fuel will produce low level NOx emissions.

If the sourcing of wood fuel is managed on a sustainable basis, biomass (wood fuel) is harvested as part of a constantly replenished crop. This theoretically maintains a closed carbon cycle with no net increase in atmospheric $CO_2$ levels. As such biomass is essentially a carbon neutral fuel and has been given a $CO_2$ emission factor of 0.013kgCO2/kWh. This is to take account of energy consumed in wood fuel production and regular transport for deliveries. The relatively low $CO_2$ emissions of biomass fuels compared with conventional fossil fuels can be seen below.

| | |
|---|---|
| **Grid Supplied Electricity** | **0.517 kg.$CO_2$/kWh** |
| **Biomass** | **0.013 kg.$CO_2$/kWh** |
| **Natural Gas** | **0.198 kg.$CO_2$/kWh** |

It should be noted that biomass wood fuel can only be considered carbon neutral if the fuel is sourced from sustainable sources.

The capital costs of installations are higher and the space requirements are significantly greater than alternative fossil fuel systems but running costs will be low compared to oil, gas or electric heating. The price of wood chips is, at best, 1p/kWh less than that of mains supplied gas. The price of wood pellets follows the price of mains supplied gas in urban areas, however in rural areas, or where transportation costs are higher the cost of wood fuel can be higher.

Concrete underground fuel storage bunkers enable easy delivery of the wood fuel, and ensure minimal visual impact. The fuel is tipped directly into the bunker through access lids with a tipping trailer. Filling takes minutes, rather than the hours required to fill an above ground silo via a blower. From the bunker, the wood chip fuel is conveyed upwards, to the boiler via a screw auger. Underground concrete storage bunkers tend to be more expensive than above ground steel containers, as in addition to the fuel feed mechanisms and container fabrication, underground silos would incur excavation costs. In most instances underground bunkers will need to be tanked to avoid the ingress of ground water. Lids will have to be manufactured in such a way that they prevent the ingress of rainwater and rainwater run off. A summary is presented below;

| **Biomass Boiler Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Space Heating<br>Domestic Hot Water |
| **Practicality** | Low | Biomass boiler systems are not generally practical for urban environments due to a number of constraints<br>• Access roads for Fuel delivery and sufficient maneuvering space for HGV delivery vehicles<br>• The requirement for above below ground storage<br>• The NOx and other particulates in wood fuel smoke<br>• The size and height of biomass boiler flues, and their presence in a conservation area skyline |
| **Cost Effectiveness** | Medium | Capital cost can be high compared with traditional boiler plant. In addition to increased plant capital cost, consideration should be given to the cost of fuel storage areas, fuel feed mechanisms and additional flue filtration systems to minimize particulate emissions.<br>Biomass would qualify for the Renewable Heat Incentive (RHI), with payments designed to provide a payback in the order of 5 years. |
| **Reliability** | Medium | Biomass boilers are typically reliable, however fuel feed mechanisms and wood fuel storage will require regular maintenance |
| **$CO_2$ Emission Reduction** | High | Biomass boilers can offer significant $CO_2$ emission reductions when compared with other fuels. |
| **Additional Planning Constraints** | | • Access roads for Fuel delivery and sufficient maneuvering space for HGV delivery vehicles<br>• The requirement for above ground/below ground storage<br>• The NOx and other particulates in wood fuel smoke<br>• The size and height of biomass boiler flues, and their presence in the skyline |

### 2.2.4 Ground Source Heat Pumps

Ground source heat pumps replace or supplement fossil fuelled boiler plant and produce low grade hot water (45 degrees Celsius approximately) for use in building heating systems.

Ground source heat pumps use heat extracted from the ground, which, at depths below 10m, is unaffected by seasonal change & remains constant throughout the year, to drive the evaporation side of a refrigerant compression cycle. A fluid is circulated through lengths of cross linked polyethylene pipes buried in trenches, or bore holes, adjacent to the building. This fluid extracts heat from the ground and is then circulated through an evaporator within the heat pump, this increases the refrigerant temperature within the heat pump. The refrigerant is then mechanically compressed raising the temperature further. The refrigerant then passes into a heat exchange plate which transfers this heat to the building heating system.

Pipe configurations for ground loops are either horizontal or vertical. Horizontal ground loops require large surface areas, and these cannot be covered with tarmac, ie these systems cannot be installed underneath building car parks. Vertical U Loops are installed in boreholes of between 45 and 150M in depth depending on particular ground conditions and spaced approximately 5m apart. The vertical U Loop is normally the best choice as it offers high capacity and a high quality installation at reasonable cost. However, a geological investigation may be required to minimise risk of failure and improve cost certainty.

Ground source systems can offer a coefficient of performance (heat output to electrical energy Input) of between three and four achieving good savings on energy when compared with traditional fossil fuels. Ground source systems are deemed to be low carbon, because they rely partly on electrical power to

- Circulate the brine or alternative refrigerant
- Drive the heat pump compressor,
- Further heating the domestic hot water to prevent legionella growth

Several practicality issues need to be considered;

- The size and configuration of the borehole array is dependent on the local bedrock type and its respective thermal conductivity.
- In order to mitigate the risk of deterioration of the ground condition (cooling) the array should be split into smaller areas within the site
- Coordination of ground boreholes with other site services would need to be developed at an early stage if this strategy was adopted.

A summary is presented below;

| Ground Source Heat Pump Summary Table | | |
|---|---|---|
| **Energy Addressed** | | Space Heating |
| **Practicality** | Low | GSHP systems are not practical for sites with a constrained foot print. In order to make a significant contribution to building heat load, and to reduce building $CO_2$ emissions an array of bore holes would be required. Bore holes may be 150m deep<br><br>GSHP systems may not be feasible within the site due to the tight nature of the site and the proximity to the Bridgewater canal basin.<br><br>In order to utilize the low grade heat generated by such systems would require the use of underfloor heating. This is not the most practical heating solution for multi-story residential buildings |
| **Cost Effectiveness** | Medium | Capital cost can be high compared with traditional boiler plant. In addition to increased plant capital cost, consideration should be given to the cost of bore holes.<br><br>GSHP systems would qualify for the Renewable Heat Incentive (RHI), with payments designed to provide a payback in the order of 5 to 10 years. |
| **Reliability** | High | GSHP systems are generally reliable, however careful consideration would need to be given to time dependent degradation of the bore-hole (Ground Cooling) |
| **$CO_2$ Emission Reduction** | Medium | GSHP systems can offer significant CO2 emission reductions when compared with other fuels, this is however dependent on the ground condition and SCoP of the heat pump unit. |
| **Additional Planning Constraints** | | Significant ground works required to create the bore-hole array. |

### 2.2.5 Centralised Air Source Heat Pumps (Air to Water)

Centralised Air source heat pumps replace or supplement fossil fuelled boiler plant and produce low grade hot water (45 degrees Celsius approximately) for use in building heating systems.

Centralised Air source heat pumps use heat extracted from the ambient air to drive the evaporation side of a refrigerant compression cycle. A refrigerant system extracts heat from the air and is then circulated through an evaporator within the heat pump, this increases the refrigerant temperature within the heat pump. The refrigerant is then mechanically compressed raising the temperature further. The refrigerant then passes into a heat exchange plate which transfers this heat to the building heating system.

Centralised Air source systems can offer a coefficient of performance (heat output to electrical energy input) of between three and four achieving good savings on energy when compared with traditional fossil fuels. Air source systems are deemed to be low carbon because they rely partly on electrical power to circulate refrigerant & drive the heat pump compressor.

A summary is presented below;

| **Centralised Air Source Heat Pump Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Space Heating |
| **Practicality** | Medium | Centralised ASHP systems are not practical for sites with a constrained sites due to the size of plant and due to the associated noise<br><br>In order to utilize the low grade heat generated by such systems would require the use of underfloor heating. This is not a practical heating solution for multi-story residential buildings |
| **Cost Effectiveness** | Medium | Capital cost can be high compared with traditional boiler plant.<br><br>Centralised ASHP systems would qualify for the Renewable Heat Incentive (RHI), with payments designed to provide a payback in the order of 10 years. |
| **Reliability** | High | ASHP systems are generally reliable, however careful consideration would need to be given to the SCoP. Quoted efficiency figures do not often reflect UK weather conditions and systems may under perform as a result. |
| **$CO_2$ Emission Reduction** | Medium | ASHP systems can offer comparable $CO_2$ emission reductions when compared with other fuels, this is however dependent on the ambient condition and SCoP of the heat pump unit. |
| **Additional Planning Constraints** | | Location of plant would need to be considered. |

#### 2.2.5.1 Decentralised Individual Exhaust Air Source Heat Pumps (Air to Water)

Exhaust air source heat pumps are a similar technology to air source heat pumps as described above. The difference is that exhaust air source heat pumps extract warm internal air from the dwelling to drive the evaporation side of a refrigerant compression cycle. Using warm internal air gives a benefit in terms of heat recovery making the system even more efficient.

Introducing individual heat pumps into each dwelling replaces the need for a centralised boiler plant. The only requirements for the dwellings are an air supply, either directly from an exterior wall or through a duct, and an energy supply. Dwelling space constraints also need to be considered as units are typically 0.6x0.6m and are around 2m in height.

Decentralised Individual exhaust air source heat pumps are versatile in that they are able to be connected to the optimal low temperature hot water distribution systems whether it be radiators, convectors or underfloor heating. They also provide for the domestic hot water demand containing a dedicated DHW vessel within the unit. Exhaust air source systems can offer a coefficient of performance (heat output to electrical energy input) of between three and four achieving good savings on energy when compared with traditional fossil fuels. These systems are deemed to be low carbon because they rely partly on electrical power to circulate refrigerant & drive the heat pump compressor and also because they utilise recovered heat from warm internal air.

A summary is presented below;

| **Decentralised Air Source Heat Pump Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Space Heating<br>Domestic Hot Water |
| **Practicality** | High | EASHP systems are not practical for sites with a constraints on dwellings dimensions due to relatively large unit sizes<br><br>The low grade heat generated by such systems are able to utilise a number of LTHW distribution systems suitable for most applications |
| **Cost Effectiveness** | Medium | Capital cost can be high compared with traditional boiler plant.<br><br>EASHP systems would qualify for the Renewable Heat Incentive (RHI). |
| **Reliability** | High | EASHP systems are generally reliable, however careful consideration would need to be given to the SCoP. Quoted efficiency figures do not often reflect UK weather conditions and systems may under perform as a result. |
| **$CO_2$ Emission Reduction** | Medium | EASHP systems can offer comparable $CO_2$ emission reductions when compared with other fuels, this is however dependent on the ambient condition and SCoP of the heat pump unit. |
| **Additional Planning Constraints** | | Sufficient external air supply to dwellings would have to be considered |

### 2.2.6 Solar Hot Water Heating

Solar Thermal Hot Water Systems generate hot water through absorption of solar radiation. The technology works best with a south facing aspect and can be installed on both flat and pitched roofs with an appropriate framing system.

Solar thermal hot water systems must be sized relative to a base heat demand. Most system types will continue to heat water even when there is limited or no demand, resulting is elevated system temperatures, as such oversizing a system will lead to stagnation and system overheating.

A summary is presented below;

| **Solar Hot Water Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Domestic Hot Water |
| **Practicality** | Medium | Systems are practical on a small scale provided that a steady base heat load exists during the day time when panels are exposed to the sun. |
| **Cost Effectiveness** | Medium | Capital and Installation costs are in the order of £500/m2, however the technology can qualify for the RHI, such that payback will be in the order of 5 to 10 years |
| **Reliability** | High | Systems can be reliable, due to their simplicity, however problems can arise if systems are oversized relative to base heat load |
| **$CO_2$ Emission Reduction** | Medium / Low | Systems can reduce $CO_2$ emissions, however impact could be low relative to other heat generating technologies as only a proportion of the base heat load can be met. |
| **Additional Planning Constraints** | | The installation of solar thermal hot water panels on new buildings may require the consent of the local planning authority. |

### 2.2.7 Wind Turbines

In a suitable location wind energy can be an effective source of renewable power generation. The most common arrangement is for a machine with a 3 blade rotor connected to a generator which is mounted on a tower or increasingly in city areas on top of a building. Average site wind speeds of 4m/s can produce useful amounts of electricity from a small generator.

Wind turbines operate at peak efficiency in areas of Laminar flow (unidirectional steady state flow). When placed in areas of turbulent flow (circulating, multidirectional flow) turbines will operate at a much reduced efficiency and will provide a fraction of their rated out-put.

Urban developments will, by their very nature, generate high degrees of turbulence as wind moves around and over buildings. Turbulence is difficult to determine and is site specific, a computational Fluid Dynamics (CFD) model would be the most accurate method of determining local turbulence. An accepted rule of thumb however suggests that wind turbines should be situated 10 times the height of the tallest building/landscape feature from that feature and should have an equivalent clearing downstream.

As such wind turbines are often deemed infeasible in urban developments, the rare exception is the sighting of small turbines in school play grounds or playing fields.

A summary is presented below;

| **Wind Turbine Summary Table** | | |
|---|---|---|
| **Energy Addressed** | | Building Electrical Supply |
| **Practicality** | Nil | Wind turbines are not practical in dense urban environments, and a review of the site suggests that such a system would not be feasible. |
| **Cost Effectiveness** | Nil | Such a system would not work within dense urban environments |
| **Reliability** | Nil | Such a system would not work within dense urban environments |
| **$CO_2$ Emission Reduction** | Nil | Such a system would not work within dense urban environments |
| **Additional Planning Constraints** | | Such a system would not work within dense urban environments |

## 2.3 Proposed Low Zero Carbon Generating Technology

Based on the above considerations it is proposed that the building incorporates a centralised gas fired **Combined Heat and Power (CHP)** plant to provide a proportion of the base heating and domestic hot water heating demand.

Another proposal is that the building incorporates individual exhaust air source heat pumps in each dwelling to provide their heating and domestic hot water heating demand.

Both technologies provide the a suitable balance of practicality, cost effectiveness, reliability and opportunity to provide a $CO_2$ emission reduction to satisfy the requirements of the Core Strategy and to satisfy the wider requirements of a Code Level 4 assessment.

Other technologies have been discounted for the following reasons;

| **Discounted Technologies** | |
|---|---|
| **PV Panels** | • A review of the site suggests that there would not be sufficient free area to provide a significant reduction in building $CO_2$ emissions. |
| **Biomass Boilers** | • Access roads for Fuel delivery and sufficient maneuvering space for HGV delivery vehicles<br>• The requirement for above ground/below ground storage<br>• The NOx and other particulates in wood fuel smoke<br>• The potential size and height of biomass boiler flues, and their presence in a conservation area skyline |
| **Ground Source Heat Pump** | • Requires use of underfloor heating<br>• Requires significant ground works |
| **Air Source Heat Pump** | • Requires use of underfloor heating<br>• Requires secondary heating for domestic hot water<br>• Requires plant space with elevation to open air |
| **Solar Hot Water Heating** | • Will provide only small contribution to $CO_2$ emission reduction.<br>• Not suited to working in conjunction with other heat generating technologies that require a steady base heat load such as CHP |
| **Wind Turbines** | • Development in too densely populated an area to achieve laminar flow across rotor blades. |

## 3.0 SAP Analysis

A SAP assessment of the proposed Potato Wharf Development has been carried out in line with the Energy Hierarchy as set out in Manchester City Council's Core Strategy.

The following section presents results from this analysis and builds the case to demonstrate the following relative to this standard;

- Passive energy efficiency improvements have been incorporated into the design such that compliance with Part L1A 2010 can be demonstrated
- Active Low Zero Carbon Generating Technologies are incorporated to an extent that a 15% reduction in $CO_2$ emissions relative to Part L2 2010 can be achieved

Further results are presented to demonstrate what would be required in order to satisfy the Code for Sustainable Homes Level 4 requirement that a 25% reduction relative to Part L2 2010 can be achieved

## 3.1 Calculation Engine

Carbon emission rates have been analysed using JPA Designer software Version 6.01a1 Build 005 and SAP Version 9.90 – relevant for projects that are assessed under 2010 Building Regulations.

## 3.2 Base Case Parameters

As a base case for the SAPs the following parameters in conjunction with dwelling dimension and layout details have been tested for Building Regulation Compliance with respect to Part L1A 2010. The following table sets out these base case parameters;

| **General** | |
|---|---|
| Orientation | Varies (As per site layout) |
| Sheltered Sides | Varies (As per site layout) |
| Lighting | 100% low energy |
| | |
| **Building Fabric** | |
| External Wall U-Value | 0.20 $W/m^2K$ |
| Ground Floor U-Value | 0.15 $W/m^2K$ |
| Flat Roof U-Value | 0.10 $W/m^2K$ |
| Glazing U-Value | 1.40 $W/m^2K$ |
| Glazing | Double glazed, air filled, 12mm cavity, PVC-u frame |
| Thermal Transmittance | Non accredited details |
| | |
| **Ventilation** | |
| Design Air Permeability | 6.0 $m^3/hr/m^2$ @ 50 Pa*<br><br>* Further to comment regarding frequency of air leakage testing and the associated requirements of Part L1a 4.8b ii |
| Ventilation System | Whole house extract ventilation system |
| | |
| | |

| **Heating** | |
|---|---|
| System | LTHW Radiators via Community Heating Scheme |
| Generator | Gas Boilers (94% efficiency) |
| Controls | Flat rate charging, TRVs, boiler load compensation |
| Other Information | Water Heating also via boiler fed community heating scheme, 0.3 l storage tank with 35mm insulation in each dwelling |
| | |

The base case has incorporated a number of optimisations in attempt to achieve compliance with the regulations. The bullet points below discuss the base case parameters further and give justification:

- All fixed lighting outlets are to have low energy fittings to minimise energy demand.
- Building fabric u-values have been set at better than the best practise values as detailed in Part L1A, again to minimise energy demand.
- Design air permeability is set to **6.0 $m^3$/hr/$m^2$ @ 50Pa** which again is better than the best practise value. This again will minimise energy demand.
- Nuaire's MEVDC-ES whole house extract fan has been specified for the purposes of the calculation. The specific fan power for this unit is 0.35 W/l/s for dwellings with a kitchen + 1 wet room and 0.30 W/l/s for dwellings with a kitchen + 2 wet rooms. These low SPFs will again minimise energy demand.
- Boiler efficiency has been set at an optimum value of 94% and boiler has been specified to have load compensator control, this is to minimise fuel consumption.

### 3.3 Base Case SAP Findings

Whole Development TER = **71.9** $kgCO_2/m^2$
Whole Development DER = **80.0** $kgCO_2/m^2$

DER > TER by **11.2%**, therefore the building **does not** achieve compliance with the energy efficiency requirements of Building Regulations and Building Standards.

Thus, the base case parameters will have to be improved upon to achieve compliance – see following sections.

### 3.4 Energy Hierarchy Application to achieve Manchester City Council Target

As stated above there is a requirement for the proposed Potato Wharf development to achieve a 15% reduction in $CO_2$ emissions relative to the target emissions. Following Manchester City Council's Energy Hierarchy strategy the addition of suitable renewable energy generation is the next step in optimising the design as both energy demand minimisation measures and fuel consumption minimisation measures have been incorporated into the base case to achieve Building Regulations compliance. The initial chosen strategy is to incorporate CHP into the community heating scheme as detailed in the table below.

| **Heating** | |
|---|---|
| System | LTHW Radiators via Community Heating Scheme |
| Generator | Gas Boilers – **50%** of the heating demand<br>CHP – **50%** of the heating demand |

All other parameters remain as per the base case. The tested CHP generator has an efficiency of 85% and a heat to power ratio of 2:1. Results are as follows;

Whole Development TER = **71.9** $kgCO_2/m^2$
Whole Development DER = **60.8** $kgCO_2/m^2$

DER < TER by **15.4%**, therefore the building achieves compliance with the energy efficiency requirements of Building Regulations and Building Standards and also meets the target set out by Manchester City Council of a 15% reduction in carbon emissions.

### 3.5 Energy Hierarchy Application to achieve CfSH Level 4 – 1st strategy

As stated above there is a further requirement for the proposed Potato Wharf development to achieve a 25% reduction in $CO_2$ emissions relative to the target emissions to be eligible for CfSH Level 4. The initial proposed strategy is to incorporate individual exhaust air source heat pumps into the each dwelling meaning a centralised plant is no longer required. The table below gives details of the proposed strategy;

| **Heating** | |
|---|---|
| System | LTHW Radiators |
| Generator | Individual Exhaust Air Source Heat Pumps |

Nuaire whole house extract fans are no longer required with the above strategy as ventilation is incorporated into the exhaust air source heat pump system. All other parameters remain as per the base case. The tested Individual Air Source Heat Pumps are NIBE F370 units which have a COP of 3.06. Results are as follows;

Whole Development TER = **119.3** $kgCO_2/m^2$
Whole Development DER = **74.4** $kgCO_2/m^2$

DER < TER by **37.5%**, therefore the building very comfortably achieve the target set out by CfSH Level 4 of a 25% reduction in carbon emissions.

### 3.6 Energy Hierarchy Application to achieve CfSH Level 4 – 2nd strategy

As stated above the incorporation of CHP into the community heating scheme is another suitable strategy for the Potato Wharf development. In order to achieve the required 25% reduction in $CO_2$ emissions relative to the target emissions to be eligible for CfSH Level 4 the CHP contribution in community heating scheme must be increased. The initial proposal is to increase its contribution to 50% of the building's heating demand as detailed in the table below;

| **Heating** | |
|---|---|
| System | LTHW Radiators via Community Heating Scheme |
| Generator | Gas Boilers – **40%** of the heating demand<br>CHP – **60%** of the heating demand |

All other parameters remain as per the base case including ventilation controlled by the Nuaire's whole house extract fan as previously detailed. The tested CHP generator has an efficiency of 85% and a heat to power ratio of 2:1 as per previous analysis. Results are as follows;

Whole Development TER = **71.9** $kgCO_2/m^2$
Whole Development DER = **57.2** $kgCO_2/m^2$

DER < TER by **20.4%**, therefore the building does not yet achieve the target set out by CfSH Level 4 of a 25% reduction in carbon emissions.

Thus, as the above strategy does not achieve the required target reduction, the next proposal is to increase the CHP contribution even further. The tested strategy is set out in the table below;

| **Heating** | |
|---|---|
| System | LTHW Radiators via Community Heating Scheme |
| Generator | Gas Boilers – **30%** of the heating demand<br>CHP – **70%** of the heating demand |

Again all other parameters remain as per the base case. The tested CHP generator has an efficiency of 85% and a heat to power ratio of 2:1 as per previous analysis. Results are as follows;

Whole Development TER = **71.9** $kgCO_2/m^2$
Whole Development DER = **53.1** $kgCO_2/m^2$

DER < TER by **26.1%**, therefore the building achieves the target set out by CfSH Level 4 of a 25% reduction in carbon emissions.

## 4.0 Conclusions

As per the regulations set out in Part L1A 2010, the whole development must achieve a DER less than the calculated TER. SAP Analysis results show that the building does not achieve compliance with the regulations for the base case as set out in Section 3.1 above. This incorporates better than best practice u-values, better than best practice air permeability and improved central plant efficiencies and controls. The base case must be improved upon in order to comply with the energy efficiency requirements of Building Regulation and Building Standards.

Further to a high level appraisal of potential Low / Zero Carbon generating technologies it is proposed that the building is able to incorporate either of the following technologies;

- Individual Exhaust Air Source Heat Pumps in each dwelling
- A centralised gas fired Combined Heat and Power (CHP) plant to provide a proportion of the base heating and domestic hot water heating demand.

The above technologies both deliver the right balance of practicality, cost effectiveness, reliability and opportunity to provide a $CO_2$ emission reduction to satisfy the requirements of the Core Strategy and to satisfy the wider requirements of a Code Level 4 assessment.

As per the regulations set out by Manchester City Council in Appendix A: Energy Target Explanation, the whole development must achieve a DER of 15% less than the calculated TER. Application of the energy hierarchy not only allows compliance with the regulations but also enables the 15% reduction on CO2 emissions to be achieved. The energy strategy required to achieve this incorporates CHP into the proposed community heating scheme with a **50%** contribution to the annual heating demand (kWh).

As per the further requirements of CfSH Level 4, the whole development must achieve a DER of 25% less than the calculated TER. The development is able achieve the 25% $CO_2$ emissions reduction in order to be eligible for CfSH Level 4 by either of the two following heating strategies;

- Increasing the CHP contribution to **70%** of the annual heating demand (kWh).
- Incorporating Individual Exhaust Air Source Heat Pumps into each dwelling

The optimum strategy will be chosen following detailed design.