



47 Peter Street Manchester

Energy Statement

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1.0 Executive Summary

The energy hierarchy has been adopted for the development to ensure that the correct approach to design is taken to promote an energy-efficient low carbon solution. This has ensured that the benefits of less expensive methods of energy use reduction have been maximised first. The approach adopted is as follows:

- Minimise energy demand – Implement passive design measures and optimise the building envelope in terms of orientation, air tightness, and insulation.
- Meet demands efficiently – Specification of energy efficient plant, heating, ventilation, lighting and system controls to facilitate efficient operation.

This approach responds to Policy EN 4 of the Manchester Core Strategy which seeks to maximise energy efficiency and reduce CO₂ emissions from new developments. The policy requires the application of the energy hierarchy to ensure that passive measures, energy efficiency and low and zero carbon generation options are considered.

The design approach in respect to minimising carbon emissions from the development would also align with the best practise guidelines being adopted by other authorities in Core Strategies Policy necessitating Lean, Clean and Green energy savings to be considered sequentially.

This approach has been implemented in the design for the proposed development in the following ways:

Fabric

The design has applied passive principles and incorporated a 'fabric-first' approach to improve the thermal envelope and reduce primary energy requirements where possible. Given the restrictions with the historic status of the building limited measures can be taken to achieve high levels thermal efficiency.

Heating, Cooling and Ventilation

A variable refrigerant flow system (VRF) with a high coefficient of performance (COP) shall be used as a valid and cost-effective proposal to heat and cool the bedrooms and lounge areas.

Water-efficient fittings (e.g. aerated shower heads and taps) will help to reduce electrical loads for water heating.

The ventilation strategy includes mechanical ventilation with heat recovery via central Air Handling Units.

Lighting

Electrical demand for lighting will be minimised through the use of energy efficient lighting throughout all areas.

Renewable Energy

The potential for renewables and low carbon technologies such as air source heat pumps boilers has been considered as a heat source for domestic hot water and will be evaluated in the design process subject to cost constraints,

CO₂ emissions reduction

The application of passive design principles along with the specification of a high COP Variable refrigerant flow (VRF) system for the heating and cooling, Heat recovery Air handling units for the ventilation and energy efficient lighting will achieve significant reductions in CO₂ emissions to meet the requirements of Part L2B of the Building Regulations.

2.0 Introduction

Zerum MEP has been commissioned to prepare an Energy statement in line with policy EN 6, to accompany a planning application for the proposed development at the 47 Peter Street to renovate the existing Grade II listed former Victorian warehouse, into a boutique hotel.

The energy strategy is formulated to demonstrate the total regulated energy requirement of the completed development, and the associated carbon emissions around a collective approach to implement a sustainable development incorporating environmentally sound methods of construction, low or zero Carbon Emissions and Passive design techniques. It is intended to highlight within this review, the systems which provide a renewable energy strategy to serve the relevant elements of the Building Services for the site.

Policy EN6 also sets targets for emissions reduction for new developments compared with Part L (2010). In this case were this to be assessed as a new building a target of 10% would be applicable as a building served exclusively by electrically driven building services systems.

Whilst the 10% is not a specific obligation for this development and there is no requirement to submit SBEM output documentation to Building Control to verify this standard has been met, given the building services strategy proposed, it is envisaged that the emissions would comfortably meet the standard.

Part L2B is the appropriate approved document for this development and for buildings changing their use the document prescribes that the fabric U values are upgraded to meet the standards in table 5.

The glazing specification remains subject to review. Replacement of the existing single glazed windows would realise significant energy and carbon savings however this may conflict with aesthetical considerations. Supplementary secondary internal glazing would also be effective in respect o energy should new windows not be suitable.

The energy assessments below would offer sufficient tolerance such that the final glazing specification selected would not impact to the point of rendering the figures inaccurate at this stage of the design process.

It is anticipated that this report shall be a "live" document that shall be updated at regular intervals as the building designs develops and shall progress to advise in more detail such elements as the target building energy usage and the predicted building carbon dioxide emissions verses the savings achieved by the sustainable design elements implemented.

The design approach in respect to minimising carbon emissions from the development would align with the best practise guidelines being adopted by other authorities in Core Strategies Policy necessitating Lean, Clean and Green energy savings to be considered sequentially.

The lean savings which are measures to improve the baseline energy performance and would typically mean improvements in the fabric, glazing, high efficiency pumps, high efficiency boilers, high efficiency lighting and lighting control systems.

The clean savings are measures that reduce carbon dioxide emissions as compared the standard design approach but rely an element of non-renewable energy consumption. The technologies that could be considered here would be combined heat and power (CHP) and air source heat pumps (ASHP).

The green savings are measures that provide energy from wholly renewable sources. Examples of the technologies that fall within this category are solar thermal for heating and hot water, solar photo-voltaic (PV), wind power and biomass.

2.0 The Site

The proposed area of development is shown in the site plan below.



The building is located on the corner of Peter Street and Southmill Street in Manchester's city centre. The building is located on a prominent corner bounded on three sides by Peter Street to the south, Southmill Street to the west and Bootle Street to the north. On the eastern boundary of the site the building abuts a seven-storey contemporary office building.

The building currently consists of four storeys above ground with a semi-submerged lower ground/ basement level. The lower ground and ground floor levels are currently occupied by a critically acclaimed Asian restaurant. The proposed development is to renovate the first, second and third floors, creating a mezzanine level on the third floor.

3.0 Energy Assessment

Assessment of development's annual energy usage

The simple rule of thumb benchmarking appraisal below is based on BSRIA/CIBSE guidance. Good practise figures for a luxury hotel from CIBSE Guide F table 20.1 are used.

Usage	Area m ²	Fossil Fuel kWh/m ² pa	Elec kWh/m ² pa	Annual Heat kWh	Annual Elec kWh
Accommodation	991	300	90	297,300	89,190

Assessment of development's benchmark annual CO₂ emissions

Usage	Annual Heat kWh	Annual Elec kWh	Annual kGCO ₂	Annual kGCO ₂
Accommodation	297,300	89,190	54,703 *	25,597 **

* based on www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018 natural gas 0.184 kGCO₂/kWh

** based on www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018 grid electricity 0.287 kGCO₂/kWh

The assessed annual benchmark CO₂ emissions are therefore 80,300kg/991m² = 81.03kGCO₂/m²

The resulting emission to meet EN6 would therefore be 72.93kGCO₂/m².

Assessment of development's actual predicted annual CO₂ emissions

Accommodation	Annual Thermal kWh	Annual Elec kWh	Annual kGCO ₂
Heating	375,000	95,000	27,265
Cooling	75,000	19,000	5,452
Domestic water	75,000	16,000	4,592
Ventilation		35,000	10,045
Lighting		30,000	8,610
Small Power		15,000	4,305
Total		210,000**	60,270

4.0 Sustainable Design Options

The following table outlines the sustainable design options that are proposed for consideration on this site. These are as follows:

Sustainable Design Option	Suitability for site
Biomass boiler	No
Ground source heat pumps	No
Air source heat pumps	Yes
Bio-diesel Generator	No
Solar water heating	Yes
Photovoltaic cells	Yes
Wind Turbines	No
Biomass Fuelled Combined heat and power plant	No
Gas Fuelled Combined heat and power plant	Yes
Hydrogen Fuel Cell	No
Rain water recycling	Yes
High efficiency chillers and thermal heat stores	No
Natural ventilation and night cooling	Yes
High thermal mass structure	Yes

4.1 Biomass Boilers

System Description

Biomass is an alternative solid fuel produced from forest products, untreated wood and energy crops such as short rotation coppice such as willow plant. Biomass differs from fossil fuels in that the organic matter is of recent origin and provided products are continually re-grown this makes it sustainable and almost carbon neutral. In essence, the CO₂ released during the generation of energy from biomass is balanced by the CO₂ absorbed during the fuels production.

Advantages

- Very low carbon emissions when compared to gas and electric heating systems. Can be a major contributor to reducing carbon emissions of overall scheme.
- Biomass boilers can provide heat at flow temperatures matching traditional heating systems and therefore can be included into heating systems

Disadvantages

- Large plant areas are required for the boilers, accumulator vessels and fuel storage areas.
- The delivery cost for the fuel needs to be factored into the running costs for the building
- Boilers do not have a good turn down ratio and therefore need to have suitably sized buffer vessels to smooth out demand variations.
- Boiler return temperatures are higher than standard condensing boiler systems and therefore this needs to be considered if standard boiler efficiencies are to be maintained and/or the biomass boiler is to be protected from condensation.
- There is a rising concern over the level of pollution emitted from biomass boilers into the atmosphere as well as local carryover of ash particles.

Suitability of the site

During the initial assessment the use of biomass boilers on the site has been considered, and it has been concluded that biomass cannot be accommodated, there is insufficient space for plant and fuel storage and there could be difficulties in large delivery vehicles accessing the site.

4.2 Ground Source Heat Pump

System Description

Ground source heat pumps transfer the renewable heat stored in the ground into a building to provide space heating and domestic hot water demand. The ground temperature a few metres down remains at a constant 11°C - 12°C throughout the year. Utilising the constant temperature from the ground as a heat source and passing this through the refrigeration cycle, this 11-12°C heat can be upgraded to a flow temperature of 30-40°C that can then be supplied to the building's heating system. This type of system is best suited to underfloor heating systems that run at a lower flow temperature. It can be used for radiator systems also, however the radiators must be larger than installed in a traditional system running at a 60°C flow temperature. Typically, under the most favourable conditions, a ground source heat pump can achieve a 4:1 operational efficiency, that is to say that 4kW of heat will be produced for every 1kW of electricity used.

The main components of the ground source heat pump system are:

- Ground loop - Pipes buried in the ground
- Heat pump
- Heat distribution system

There are two main options for the ground loop (the external pipes) and these are to bury the pipes in a coiled pattern in a trench at depth of around 2 metres for alternatively, vertical bore holes drilled into the ground to a depth of 100-150 metres.

Advantages

The system has an extremely good efficiency, operating up to the 4:1 level of performance (4kW of heat output for every 1kW of electricity used in the generation of this heat).

The plant associated with this system is relatively small and there is no requirement for external plant that could trigger planning considerations.

The technology operates using electrical energy which if generated from renewable sources equates to totally clean heat.

Disadvantages

The system requires external trenching or bore holes to lay the external ground loop pipework.

The system flow temperatures are not as high as a traditional heating system, requiring underfloor heating systems or oversized radiators.

The system is more expensive than a traditional system to install.

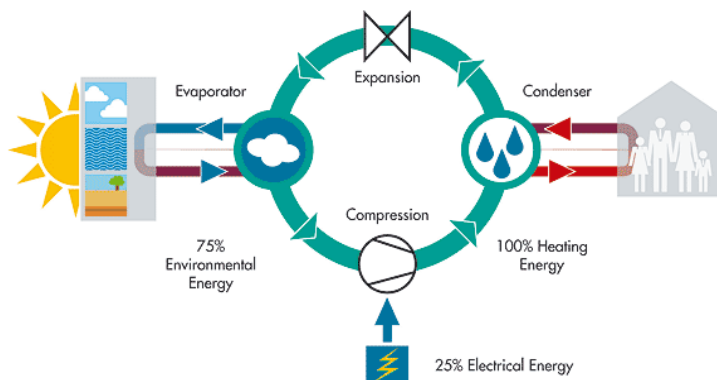
Electrical consumption of the system can be high.

Suitability of the site

Ground source heat pumps are not suited to this type of development, there is no adjacent land to facilitate below ground energy collection pipework.

4.3 Air Source Heat Pump

The air source heat pump system utilises the same technology as the ground source heat pump systems with the exception that the energy is drawn from the air and not from the ground.



Advantages

In summary the advantages are as follows;

- Cost effective installation
- Large expanses of land are not required
- Higher efficiencies can be achieved in warmer ambient conditions
- If operating using renewable electricity, it can be considered completely clean energy

Disadvantages

In summary the disadvantages are as follows;

- Lower efficiencies and COP's than ground source as the air temperature can go lower than ground making it more difficult to extract useful energy
- External plant would be required.
- External plant provides a risk of external noise

Suitability of the site

The assessment of the site has shown that this technology is extremely suitable.

The configuration of the system/s would be optimised to negate the requirement for refrigerant leak detection in accordance with EN378 legislation. Therefore separate systems serving individual floors would more feasible.

There are additional benefits from this proposal from Renewable Heat Incentive (RHI) subsidies should the systems be arranged as 'heat only', but this will not be realistically applicable for the majority of systems in this development.

Typical picture of an air source heat pump outdoor units similar to equipment proposed for this development.



The projected total usage for the site is 605,000kWhpa. The grid electricity needed for to produce this output would be 210,000kWh therefore it could be said that 395,000kWhpa is produced from a renewable source.

This equates to 65% of the site's requirement met from renewable sources.

4.4 Bio-diesel Generator

System Description

A bio-diesel generator system is, in effect, a standard diesel generator that has been converted to run on bio-diesel fuels. These bio fuels are either oil from organically ground crops such as rape, or from recycled cooking oils.

Advantages

In summary the advantages are as follows:

Electricity is produced on site with associated carbon savings, which can be a major contributor to reducing site carbon emissions. Ideally electricity provision will be at a rate that is cheaper than any standard electricity supplier;

- The waste heat generated by a generator may be sufficient to provide all of the heat energy requirements of the building and therefore, whilst the boiler plant would still be installed sized for the full load so as to act as a backup, whilst the generator is running the boilers will not be required and will save on gas consumption. There would be a slight cost for the respective heat exchangers/link pipework from the generator to the building plant room;

Disadvantages

In summary the disadvantages are as follows:

- Fuel demand is currently causing fuel delivery shortages and therefore rising fuel prices such that the electricity is likely to be as expensive or more expensive overall than buying straight off the grid supplies, making this system currently unviable;
- The plant requires a large area of space;
- The plant can be noisy, around 70dBA. It is likely that an acoustic screen will be needed around the generator set to reduce noise levels to those imposed by local planning requirements or the generator can be housed in a plant room;

Suitability of the site

The use of biodiesel generators on the site has been considered, and it has been concluded that this technology could not be accommodated as space for plant, fuel storage and large delivery vehicles is not available. Lack of security of supply is however of concern. We are reluctant to recommend this measure.

4.5 Solar Water Heating

System Description

Solar Hot water systems are well established in many countries however the perception that the UK weather is not sunny enough has reduced their use in the UK. However solar thermal systems do not actually require direct sunlight and therefore do in fact work very successfully within the UK.

The system uses the thermal energy from the sun collected in solar thermal panels on the roof of the building to heat water that is passing through pipes fixed to the solar plates. These systems are generally operated with a backup source of heat as for a traditional system, such as gas or electricity.

There are two types of solar collectors, flat plate collectors or evacuated tube collectors. Evacuated tube collectors are more efficient but also tend to be more expensive. If flat plate collectors are installed the ideal tilt of the collector would be 40°. If evacuated tubes are used the angle is less critical.

During the summer months, in general, almost all of the hot water demand can be met by a sufficiently sized solar hot water system, with a significant reduction in the amount in winter months when there is less solar energy available.

As with the photovoltaic system the optimum location for the panels are on a sloped roof with a southerly orientation, however east and west orientations are also acceptable.

Advantages

- The system is relatively maintenance free;
- The system requires very little energy to operate;

- There are potentially sizeable energy savings, dependent on the water usage patterns within the building;
- If designed correctly, the solar water heaters can be used to contribute to the space heating of the building as well as heat domestic hot water;
- There is potential to generate income through the renewable heat incentive scheme.

Disadvantages

- The systems need to be located on the roof, this can cause planning issues;
- The systems are relatively expensive in initial procurement and installation costs;
- The system efficiency depends on building orientation.

Suitability of the site

It is clear that this development could accommodate solar thermal water heating and this could be utilised to provide heat to the domestic hot water demand if necessary, therefore this technology is a viable option.

Picture of flat plate solar collector



Picture of evacuated solar tube collector



4.6 Solar PV

System Description

Photovoltaic cells convert sunlight directly into electricity with no waste and no emissions. When the light from the sun hits the silicon in the PV cell direct current electricity (DC) is created. The DC is collected in a central location and converted to alternating current (AC) so that it can be used to supply household appliances.

During daylight hours electricity produced from PV panels would be supplemented by the local distribution network operator (DNO). If, however, excess electricity is produced then electricity can be fed back into the electricity grid.

The previous Renewable Obligation Certificates (ROCs) system was superseded by the Feed in Tariff system in 2010. The tariff applicable is dependent on the installed capacity and classification of building i.e. new build or retrofit.

This type of system depends on the roof area available facing predominantly south with a horizontal angle of up to 40°. Roofing products that can replace conventional roof tiles or framed systems attached to the roof can be installed.

Alternatively, PV cells can be mounted on vertical façades of the building or mounted horizontally on solar shading elements of the building structure such as brise soleil, or set inside glazing elements of windows to act as a solar shading frit as well as an electricity generator.

The electricity generated by the PV cell can be stored or used in one of the two following manners.

Option 1 – Battery storage

The electricity generated by the PV cells is produced as direct current (DC) electricity. This can be taken from the cells and stored directly into batteries. The batteries can then be discharged as and when required through a DC to AC convertor unit and the AC electricity can then be used to power standard equipment.

This type of arrangement is generally cabled so that the electricity supply point has two supplies, one from the main incoming local area grid supply and one from the batteries. Automatic sensing equipment regulates the supply from the two sources so as to maximise the use of the batteries and synchronises the change over between the two sources so that a changeover is unnoticeable.

Instead of synchronising the two supplies together, a simpler arrangement is to have a timed changeover, such that the batteries are charged during the day and then the supply is changed over to the batteries during the night time to power the essential supplies where the building electrical load is lower.

The drawback of the battery storage option is the space required for the batteries and the additional maintenance requirement. The advantage is that stored electricity can be used during period of poor daylight or overnight.

Option 2 – Direct on line supply

In this option, the electricity that is generated by the PV cells is channelled straight into the buildings supply network via a DC to AC convertor and the synchroniser unit, similar to the battery storage option, except with this option the electricity is fed direct into the building supply. The PV cell electricity is therefore only available during the periods when there is sufficient daylight. This option has the advantage that it does not require large plant areas for battery storage.

Anticipated Electrical Outputs

In the recommended roof top location the maximum peak electrical generation from a PV cell in the North West of England is approximately 150 W/m². When averaged out, taking into account shading effects, seasonal variations, angle of incident of sun to solar panel etc. the figure for electrical generation that can be expected to be achieved is approximately 15Wh/m².

Life Expectancy and Maintenance

PV cells are a relatively new technology and therefore there is no firm and proven research into the maximum life expectancy of the cells. The cells themselves have no mechanical parts and are therefore not susceptible to any wear and tear that limits the life expectancy of such systems as fans and pumps etc. However the current estimated advised by PV cell manufacturers is that the operating efficiency of the cells will decrease to 90% after the first ten years followed by a further decrease to 80% output after 25 years.

With regard to maintenance, the systems can be regarded as low maintenance items that only require periodic cleaning of the panels to ensure maximum sunlight is getting through to the panels. The individual cells embedded within the glass are wired in series circuits therefore any failure of a single cell would render the whole pane non operative. Individual panes are best cabled in parallel circuits however, to ensure that the loss of one PV/Glass panel would not affect the operation of the other units.

Advantages

The system is simple to operate with very low maintenance requirements;

Contributes to offsetting the electrical consumption of the building and therefore offsets the highest carbon emitting energy source;

The use of PV cells within the glazing as a frit arrangement can be utilised as an option to provide solar shading into the internal building area behind, potentially removing the need for the brise soleil on the external surface of a glass wall. The cost of the PV cells can then be offset against the cost of the brise soleil which it could potentially fully replace. The level of solar shading will be dependent on the quantity/density of coverage of the PV cells.

Disadvantages

Plant space requirements can be large for a storage system;

System does not operate at night;

The installation may require planning consent;

Life expectancy of the PV cells are unproven;

The cost of PV cells is high.

Suitability of the site

The overall suitability of the system depends on the final building form, shape and orientations. However, in general, photovoltaic cells can be accommodated on almost every building and therefore, if implemented at an early stage, there does not appear to be any reason why PV cells cannot be successfully accommodated into the scheme. The carbon dioxide emissions offset benefit that PV technology brings is considered as necessary on this scheme to achieve compliance with the planning conditions.

PV cells used as part of a roofing system



4.7 Wind Turbine

System Description

Wind energy has been identified and utilised for many years as a source of clean and renewable energy. The United Kingdom is Europe's windiest country and benefits from 40% of Europe's total wind energy resource. The technology exists to easily convert the wind energy directly into electricity by the use of modern wind turbines where the power of the rotating shaft is converted into electricity via a generator unit.

In similar fashion to the photovoltaic cells the electricity generated from the wind turbine can be either stored in batteries or fed direct into the building's electrical supply. Unlike photovoltaic cells the wind turbine will continue to generate after dark and therefore the electricity generated can be used to support the essential systems within the building.

Wind generated energy can also attract the subsidies from the Feed in Tariff.

There are a number of wind turbine manufacturers and the range of units available vary considerably in size from small domestic units sized at around 1.5 kW to large scale wind farm turbines that are capable of generating 3 MW (3,000 kW). However, the basic design of the units is relatively similar.

Advantages

- Wind turbines can provide a meaningful energy contribution to the site;
- Wind turbines can be used as a good visible public relations statement.

Disadvantages

- Wind turbines will require planning consent and potentially consent from Civil Aviation Authority if close to airports or flight paths.
- Wind turbines can raise local resident complaints and objections.
- Wind turbines do create a level of operational noise that must be considered.
- Wind turbines are a relatively expensive sustainable energy option.

Suitability of the site

In general, the site is not considered as being suitable for a wind turbine installation due to the proximity of the local properties and potentially restricted wind patterns from the surrounding trees and buildings. The restricted wind patterns could be overcome by mounting the turbines on the buildings but this may then incur additional structural issues and also planning concerns from the visual aspect, therefore wind turbines are discounted for this site.

4.8 Combined Heat and Power CHP

System Description

The gas fired Combined Heat and Power systems are not renewable energy systems but are considered low carbon green energy systems as waste heat generated by electricity production is used as a by product, resulting in an overall lower carbon emission for the system than if separate grid supplied electricity and gas fired boiler systems were used to provide the same electricity and heating provision to a building.

A CHP system therefore derives its name (combined heat and power) from the fact that fuel is burnt to provide power (electricity) and heat is also produced as a useful by product. The generation of two useful energy sources also leads this type of system to be called a cogeneration system. A central energy centre at the site would contain:

- a CHP generator;
- a thermal storage vessel (accumulator);
- Gas fired boiler plant;
- Heating distribution system pump;
- Electrical switchgear;
- Heat rejection plant.

In this development modest demand for waste heat would exist all year round from domestic hot water requirements and the system warrants serious consideration.

Advantages

- Electricity is generated on site;
- Heat is provided as a free by product;
- Cooling can be provided when combined with an absorption chiller unit;
- The CHP unit can act as a standby generator set to back up essential supplies to IT servers etc.

Disadvantages

- Plant areas required can be large.
- If heat produced by the generation of electricity is not required, eg during summer, then the heat still needs to be rejected to the atmosphere and so separate heat rejection plant is needed.
- Plant requires maintaining by the client.

Suitability of the site

The viability gas fired CHP plant has been considered for the site and whilst its inclusion could be viewed as ambitious and there would be management, ownership and maintenance arrangements to consider there would most definitely be energy, CO2 emissions and cost advantages of this.

Photo showing a small scale gas CHP Unit



The installation would require large energy storage capacity however the significant domestic hot water demand would make this technology viable.

The interpretation of the benefit of CHP differs from authority to authority, however it could be considered that on-site electricity generation from gas combustion has a comparable carbon factor to grid electricity therefore the resulting thermal output is the low carbon energy benefit.

4.9 Hydrogen Fuel Cell Plant

In many ways fuel cells can be regarded as power generators. However, whereas conventional generators use internal combustion engines to rotate an alternator, fuel cells generate power by producing electrons directly, with few moving parts. As a result, they have the potential to be very efficient and reliable.

Moreover, fuel cells are comparatively quiet and, other than electricity and heat, they produce only water vapour. This makes them ideal for indoor use, meaning that the generated power can be close to, or inside the computer room.

In a direct comparison with diesel generators, the capital cost of fuel cells is higher but, as with every new technology, these costs are now falling. However, because of the absence of moving parts, fuel cells are considerably less expensive to maintain than generators.

Where fuel cells really come into their own is where generators are not an option. This could be because of limited space or the inability to obtain planning permission, or where organisations have environmental policies that focus on improving air quality and reducing carbon-based emissions. Factors that weigh heavily in their favour are: reduced footprints, extended runtimes and lower life-time costs.

Suitability of the site

For this technology to be considered, a site wide strategy would be required which we believe is not favoured.

Hydrogen cells are not considered a viable option from an operational perspective. The cost of this type of installation exceeds other more main stream technologies such as gas fired CHP, with no meaningful advantages. Therefore this system is not proposed for this site.

4.10 Rainwater, Black Water and Grey Water Recycling

System Description

Grey water is defined as the waste water produced from baths, showers, clothes washers, and wash-hand basins. The wastewater generated by toilets is called blackwater. Wastewater from kitchen sinks and dish-washers is often considered to be blackwater as well, due to the higher organic content. As its name implies, greywater is of lesser quality than potable water, but of higher quality than black water. Rainwater is water collected from surface run off from buildings such as from roofs. In general, the main collection systems utilised in buildings are from rain or grey water sources.

A water recycling system collects this water (rain or grey) and stores it within tanks and then resupplies it back to the building where it is used to supply the non-potable water consuming appliances, such as the toilets and watering plants. In this way, the overall water consumption of the building is reduced.

Advantages

- Water consumption on the site can be dramatically reduced as the prime water usage is via the toilets;
- The grey water recycling tank can double up as the site drainage attenuation tank.

Disadvantages

- The grey water storage tank can be large and requires space either within the building or outside;
- Pipework arrangements must be routed so as to allow for the collection of the water and also the redistribution of the grey water back to the appliances. Therefore the system requires additional pipework;
- Pipework arrangements need to be considered to ensure avoidance of dead legs and the associated legionella risks.

Suitability of the site

Grey water quality is problematic in its reuse. Rain water systems have a higher water quality and are therefore more suitable and can be accommodated within almost any building provided the space for the tanks and plant can be accommodated and the internal plumbing can be organised for the additional pipework connections. Once again, a site wide strategy would be the most beneficial however this would rely upon a site management arrangement to own and operate the facility which we would envisage as inappropriate. Individual arrangements would be possible but would add considerable cost.

Whilst water contains an amount of embedded carbon dioxide, there is no mechanism to assess this therefore it cannot be factored into energy calculations.

4.11 Thermal Mass and Structure

Description

The thermal mass and overall construction of the building fabric (walls, floors, ceilings etc) can provide a considerable passive design benefit for alleviating peak cooling conditions, when used in conjunction with a night ventilation scheme. Measures in this respect are more typically considered for non-residential buildings however mitigation of overheating is a growing concern for all building classifications.

Thermal mass systems operate on the general principle of an energy store, holding energy during periods of excess and then releasing the energy slowly at other times. In the case of high thermal mass building structures (e.g. stone buildings such as churches and castles), the internal summertime temperatures are always considerably lower than the external temperatures, due to the effect the fabric has on the internal environment. In these instances, the fabric cools down during the night when the ambient temperatures are lower, and then retains this stored coolth so that during the day, heat is absorbed from the room into the fabric. The cycle then repeats itself the following night.

This effect can be used to delay the times when the internal rooms reach peak temperatures, such that the room may be at its warmest a few hours after the actual peak solar gain time. In this instance, the overall cooling load will be reduced, making the potential for using passive cooling measures such as natural ventilation more feasible and avoiding the need for mechanical cooling.

Suitability of the site

This feature of design can be accommodated into the scheme if the building fabric choices are correctly made.

Graph showing effect of fabric thermal weight on room temperature and time of peak temp

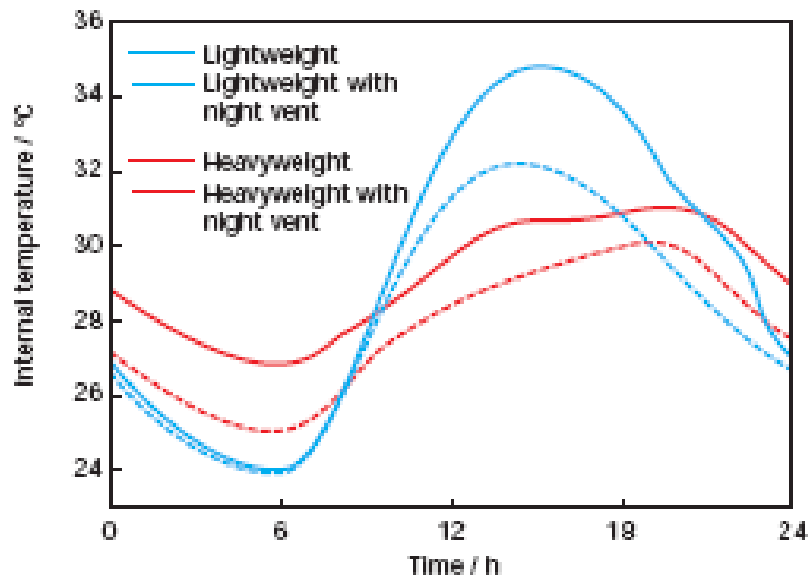


Figure 2.5 Effect of thermal mass and ventilation rate on peak indoor temperature⁽¹⁴⁾

5.0 CONCLUSIONS

From the report findings; the following conclusions can be drawn.

The energy hierarchy has been adopted for the development to ensure that the correct approach to design is taken to promote an energy-efficient low carbon solution. This has ensured that the benefits of less expensive methods of energy use reduction have been maximised first. The approach adopted is as follows:

- Minimise energy demand – Implement passive design measures and optimise the building envelope in terms of orientation, air tightness, and insulation.
- The design has applied passive principles and incorporated a 'fabric-first' approach to improve the thermal envelope and reduce primary energy requirements where possible. Given the restrictions with the historic status of the building limited measures can be taken to achieve high levels thermal efficiency.
- Meet demands efficiently – Specification of energy efficient plant, heating, ventilation, lighting and system controls to facilitate efficient operation.
- Air source heat pump systems are an effective and efficient means of heating and cooling the building in terms of energy and CO2 emissions. A variable refrigerant flow system (VRF) with a high coefficient of performance (COP) shall be used as a valid and cost-effective proposal to heat and cool the bedrooms and lounge areas.
- Combined heat and power also offers major advantages but would necessitate modifications to the building which would be prohibitive.
- Solar thermal offers a practical and cost effective means to demonstrate that the development meets the aspiration.
- Solar PV is a reliable and well established technology to accommodate however as the aspiration can be met by other means, it could be considered as an enhanced measure.
- Water-efficient fittings (e.g. aerated shower heads and taps) will help to reduce electrical loads for water heating.
- The ventilation strategy includes mechanical ventilation with heat recovery via central Air Handling Units.
- Electrical demand for lighting will be minimised through the use of energy efficient lighting throughout all areas.
- The potential for renewables and low carbon technologies such as air source heat pumps boilers has been considered as a heat source for domestic hot water and will be evaluated in the design process subject to cost constraints,
- The application of passive design principles along with the specification of a high COP Variable refrigerant flow (VRF) system for the heating and cooling, Heat recovery Air handling units for the ventilation and energy efficient lighting will achieve significant reductions in CO2 emissions to meet the requirements of Part L2B of the Building Regulations.