



GREENBUILD CONSULT
A Complete Sustainable Consultancy

Energy & Sustainability Statement for Proposed Mixed Use Roadside Service Station, Holt Road, Wrexham

27th June 2016



Document Control

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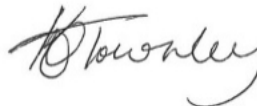
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1.0 INTRODUCTION

1.1 Overview

This statement has been prepared for Liberty Properties Developments Ltd to address potential approaches to the reduction of energy demand and CO₂ emissions in relation to the proposed development.

This statement is based upon information provided by the Design Team. The proposed development consists of the construction of a mixed use roadside service station development incorporating a petrol filling station with ancillary kiosk and retail unit, drive-thru coffee shop, family pub/restaurant and associated car parking. The proposed development site is located at Holt Road, Wrexham.

2.0 ENERGY HIERARCHY

It is widely recognised that there is little point investing in LZC heat and power microgeneration technology without first making significant attempts to minimise the demand for both heat and power. This is largely achieved through a 'fabric first' design approach where the overall energy demand for the building is reduced through improvements in building fabric elements, and only then a consideration is given to the use of an appropriate LZC system, if still required.

2.1 Passive Design Measures

An exhaustive investigation of such measures lies outside the scope of this study, but areas which may be considered during the design for this project include:

- Buildings designed to maximise useful solar gain in winter but minimise over-heating summer,
- Use of reflective external finishes to minimise structural solar gain,
- Use of bio-shading to minimise solar overheating,
- Use of suitable construction materials and methods to achieve high thermal performance and so minimise heat loss,
- Use of thermal mass,
- Reduction of air permeability and the use of appropriate ventilation strategies,
- Maximum use of daylighting and energy efficient lighting,
- Minimise electrical demand, e.g. through energy efficient appliances,
- Real-time metering showing current heat/power consumption.

2.2 Building Fabric & Building Services Improvements

In consideration of some of the above passive design measures, building fabric and building services parameters may also be improved upon in order to reduce overall energy demand and regulated CO₂ emissions, such as:

- Improvement in external wall u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 0.35W/m²k.
- Improvement in roof u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 0.25W/m²k.

- Improvement in ground floor u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 0.25W/m²k.
- Improvement in external glazing u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 2.2W/m²k.
- Improvement in entrance doors u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 3.5W/m²k.
- Improvement in personnel doors u-value beyond the minimum Building Regulations Approved Document Part L2a (2014) figure of 2.2W/m²k.
- Improvement in air permeability rating beyond the minimum beyond the Part L2a (2014) minimum required test value of 10m³/hr/m² @ 50Pa.
- Energy efficient internal lighting design in order to maximise the quality of light provided and greatly reduce the amount of energy consumed by each light fitting
- Provision of an appropriate metering strategy, providing separate sub metering of lighting and HVAC systems and the facility to identify 'out of range' consumption trends.

2.3 Building User Education & Energy Monitoring

Where LZC technologies are used, particularly those that produce electricity, research has shown that real-time displays showing the amount of energy being produced and consumed can help raise user awareness to energy efficiency and result in significant reductions in demand. Potential measures to assist in regulating energy consumption may include:

- Energy and water consumption data for at least 12 months after occupation is collected and compared with what was expected.
- Analysis of any discrepancies with a view of adjusting systems if they are not operating as expected/designed.
- A commitment to provide aftercare support to all the building occupiers, which includes the following:
 - A meeting (programmed to occur as soon as possible after occupation) to introduce the aftercare team (or individual) and Building User Guide (where existing), present key information about how the building operates and answer questions.
 - Initial aftercare e.g. on site attendance on a weekly basis (this could be more or less frequent depending on the complexity of the building) for at least 4 weeks after handover.
 - On site FM training to include a walkabout of the building.
 - Longer term after care e.g. a helpline, nominated individual or other appropriate system to support building users for at least the first 12 months of occupation.

Although the inclusion of the above measures will ultimately assist in the reduction of building energy demand and CO₂ emissions, the full benefits of their inclusion cannot be quantified at this stage and have not been allowed for in this study.

3.0 LOW & ZERO CARBON ENERGY TECHNOLOGIES

Further to the passive design measures and building fabric improvements mentioned above, the specification of low carbon renewable systems may also provide a further CO₂ reduction.

3.1 Heat Recovery

Heat recovery is essentially making use of heat that would otherwise be lost, usually through ventilation and cooling. If the building adopted a fully mechanically ventilated strategy then heat could be recovered from the exhaust air to pre-heat the incoming fresh air.

Heat recovery is most suited to applications which generate large amounts of excess heat such as an industrial process or computer server room, where waste heat can be captured and used for heating or hot water.

3.2 Cooling

Excessive heat gains within a building can require some form of cooling to maintain user comfort or required process temperatures. Traditionally the solution was the use of mechanical ventilation and air conditioning; however chillers and the associated air handling plant use large amounts of electricity. Mechanically ventilated and cooled buildings with high internal heat gains, are likely to be cooling dominated rather than heating dominated when considering energy consumption.

To minimise energy consumption associated with cooling two approaches can be followed: first to reduce the need for cooling, and second to provide cooling in the most energy efficient manner. Based upon the proposals, and building functions, it is expected that mechanical cooling will be required, which will also utilise a heat recovery function in order to maximize energy efficiency and reduce overall electrical consumption of the chiller units.

3.3 Solar Hot Water

3.3.1 Overview

Solar hot water (SHW) systems use the energy from the sun to provide hot water, with domestic and commercial systems differing significantly only in terms of scale. The heart of a SHW system is the solar collector, which is connected via a closed circuit of heat transfer fluid to a heat exchanger which feeds into the DHW and possibly the heating system. Depending on the system selected, an auxiliary immersion heaters or a gas boiler are then used to raise the temperature of the hot water to the required level, and ensure demand is met if solar radiation is low and to comply with Legionella legislation. In the UK a pump is generally used to circulate the heat transfer fluid around the primary circuit. Thermo-siphon systems, where by fluid moves around the primary circuit without a pump via convection, are available but the storage tank must be located above the collector they are not widely used in the UK.

Two types of solar collector are commonly used: flat plate and evacuated tube. Flat plate collectors consist of a matrix of pipes embedded in an absorber plate, housed in an insulated, glazed frame, through which the heat transfer fluid is circulated. Flat plate collectors can achieve output temperatures from 20°C to 80°C depending on incident solar radiation.

Evacuated tube collectors use sealed heat-pipes located in evacuated glass tubes, which contain a special fluid that begins to vaporise at low temperatures. The heat-pipes are connected to a condensing heat exchanger which is in turn connected to, or located inside, a heat exchange manifold through which the heat transfer fluid circulates. Evacuated tube collectors can achieve output temperatures of 20°C to 120°C and perform better in low sun shine conditions, but are slightly more expensive than flat plate collectors. Evacuated tube collectors are more fragile than flat plate collectors however, and thus more susceptible to accidental damage or vandalism.

3.3.2 Advantages and Disadvantages

The associated advantages and disadvantages of Solar Hot Water System are summarised below:

Advantages	Disadvantages
• Zero CO₂ emissions once installed • No fuel costs. • Can supply almost all hot water needs in summer and up to 20% in winter. • Suitable for almost all locations in the UK. • Simple and relatively inexpensive installation. • Can be easily integrated into design. • Minimal maintenance requirements. • System will qualify for RHI tariff.	• Peak output does not correlate with peak demand.

3.4 Solar Photovoltaic

3.4.1 Overview

Photovoltaic (PV) cells convert solar energy into electricity without any moving parts, minimal servicing, and zero CO₂ emissions. The direct current (DC) power produced can be used in conjunction with large batteries to provide a low voltage supply at any time for applications such as lighting, or an inverter can be used to produce an alternating current (AC) supply for use just like mains 240V electricity installations. The latter scenario requires a grid connection to allow the use of grid electricity when PV are not generating and to facilitate the sale of excess electricity back to the grid; this does, however, carry an additional cost and legislative burden. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

Depending on the requirements of the building, PV systems can be used to make a visible statement, or integrated into the structure disguised as roofing slates or structural cladding in sensitive areas. PV cells can also be incorporated into window or atria glass, sun-shades over windows or over walkways.

3.4.2 Advantages and Disadvantages

The advantages and disadvantages associated with Photo-voltaic systems are summarised below:

Advantages	Disadvantages
• Zero CO₂ emissions once installed. • No fuel costs. • Can be easily integrated into design of structure. • Minimal maintenance requirements. • Electricity generated qualifies for Feed in Tariff • Output is highest in summer, when output from wind turbines is lowest.	• Peak output (summer) does not correlate with peak demand (winter) • Very high capital costs. • Very vulnerable to shading; further study into overshadowing recommended.

3.5 Biomass Heating

3.5.1 Overview

Biomass is mankind's longest standing fuel source, and has enjoyed resurgence in recent times as a renewable source of heat. Although some carbon emissions are associated with its biomass fuel harvesting, processing and transport, overall emissions from sustainably produced biomass are a fraction of comparable fossil fuels, since the CO₂ released during combustion will be re-absorbed when the next crop of fuels are grown.

Biomass boilers can be used for both individual installations or for community heating networks, and the use will therefore dictate the fuel type and size of boiler to be used. For larger systems serving a community heating network (from a large multi-building district scheme or commercial building down to a system serving several flats or apartments in one building) a wood chip or pellet system is likely to be most suitable, while for individual domestic installations or small commercial applications a fully automated pellet boiler would be the most convenient solution for DHW and space heating via a conventional wet heating system.

While biomass can in theory be used to provide space heating and hot water for any building there may be limitations in terms of fuel supply and storage on site. Biomass fuel costs vary significantly depending on the processing received, distance transported and the nature of supplier (i.e. whether biomass is a by-product to be disposed of such as forestry thinnings, or a premium product to be marketed such as high quality wood pellets). For example biomass that has been dried and pelletised into a homogeneous fuel can cost from £150 to £250 per tonne or 4.1p/kWh and 8.2p/kWh (given an energy density of 4.8kWh/kg), while higher moisture wood chips cost from £60 to £90 per tonne or 1.7p/kWh and 2.6p/kWh (given an energy density of 3.5kWh/kg) depending on the supplier and market conditions. Conversely wood chips produced on site from arboreal management or wood harvested on site can be effectively free of charge once equipment capital costs are covered. For comparison, mains natural gas can be from 6p/kWh to 19p/kWh depending on the supply tariff.

3.5.2 Advantages and Disadvantages

The advantages and disadvantages associated with Biomass Boilers are summarised below:

Advantages	Disadvantages
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• Fuel costs can be lower than natural gas for “off gas-main” site, or where significant biomass can be harvested on site. • Very low/zero CO₂ emissions once installed. • Potential to displace large amounts of CO₂. • Can supply majority of DHW and space heating year round. • System will qualify for RHI tariff	• Fuel costs can be higher than natural gas/kWh in some cases. • Ideally need local fuel supply for minimal overall carbon emissions. • Cannot be quickly turned on/off or up/down • Land and access required for fuel storage and delivery. • Require full boiler backup.
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3.6 Combined Heat & Power (CHP)

3.6.1 Overview

Combined Heat and Power (CHP) is the onsite generation of electricity and the recovery of heat produced during this process which can then be used for space heating or generation of domestic hot water. Further to this tri-generation can be achieved by combining CHP with absorption chilling to give simultaneous production of heat, power and cooling.

The application of CHP will reduce CO₂ use in buildings due to the utilisation of heat from electricity generation and the avoidance of transmission losses because electricity is generated on site, CHP typically achieves a 35 percent reduction in primary energy usage compared with power stations and heat only boilers. This can allow the host organisation to make economic savings where there is a suitable balance between the heat and power loads.

Conventional electricity generation is typically 35% efficient, with the most advanced technologies achieving up to 55%. The remaining 45-65% is lost as waste heat. CHP plants can achieve overall fuel efficiencies of up to 90% by generating electricity and recovering heat. In buildings, the recovered heat can be used for space heating and domestic hot water. However, CHP only saves carbon dioxide and money when it is operating; rules of thumb suggest that a system should be running for a minimum of 4500 hours per year for it to be financially viable - many end users such as offices, hotels and retail buildings do not have such large numbers of operating hours per year.

3.6.2 Advantages and Disadvantages

The advantages and disadvantages of a CHP system are summarised below:

Advantages	Disadvantages
• High overall efficiency – up to 80% or more at the point of use • Flexible and responsive heat supplies – the thermal energy produced by CHP can be easily stored and later delivered to meet demand. • Payback periods are generally more favourable than other LZC technologies.	• Financial viability would suggest minimum of 4500hrs of use/ year. • Noise transmission from CHP plant needs to be limited by attenuation. • The installation is more complicated than a standard boiler and comes with a cot premium. • Capital cost of CHP is much greater than traditional alternatives.

3.7 Wind Power

3.7.1 Overview

Wind turbines can be one of the most cost effective methods of renewable power generation. With suitable ancillary equipment such as an inverter and grid connection, AC electricity can be produced with the potential to sell excess power back to the grid. A lower voltage battery based system can be employed, allowing the storage of excess power for use at other times. Owing to the cube-law relationship between wind speed and power output, the power produced will vary significantly with wind speed; for example doubling the wind speed increases the power produced by a factor of 8. Accordingly a turbine may be rated differently for different mean wind speeds, for example: 4,400 kWh at 4m/s, 8,400 kWh at 5m/s, and 13,000 kWh at 6m/s.

Small building or mast mounted systems around 1kW are available off-the-shelf, and with careful siting have the potential to provide a viable source of power and make a clear statement even in some urban areas. Careful consideration must be given to the effect of additional structural loading associated with building mounted turbines. Larger tower mounted free-standing turbines can generally access higher wind speeds and so achieve greater efficiencies, but require a larger foot print and are subject to a more in-depth planning process.

The majority of turbines employed are horizontal axis wind turbines (HAWTs) similar to an aircraft propeller in appearance, with larger turbines usually having only 2 or 3 blades (low solidity) and smaller micro-turbines often using 5 or more (high solidity) to achieve greater efficiencies at lower wind speeds. Vertical axis wind turbines (VAWTs) have the potential to be highly efficient and are omni-directional, but their slower development means there are less commercially available VAWTs.

Potential public resistance has restricted the use of large-scale wind turbines (above 50kW), although studies show that in general the local perceptions of wind farms/turbines improve once they have been erected. A properly planned programme of engagement and consultation with local communities and other stakeholders with, for example, visits to existing wind turbines can help reduce objections and even build support.

3.8.2 Advantages and Disadvantages

The advantages and disadvantages associated with Wind Turbines are summarised below:

Advantages	Disadvantages
• Zero CO₂ emissions once installed. • No fuel costs. • Peak output (winter) correlates with peak demand. • Grant funding available. • Electricity generated qualifies for ROCs or Feed in Tariff	• Wide reaching planning process • Potential opposition from existing occupants • Large footprint needed for free standing turbine. • Cube law relationship between wind speed and output. • Require unsheltered location.

4.0 CONCLUSION

This statement has served to summarise and highlight a potential design methodology for the reduction of CO₂ emissions and energy demand for the proposed development along with a brief consideration of available low or zero carbon technologies/systems which are typically associated with this type of development.

In relation to the reduction of CO₂ emissions from the proposed development it is expected that overall improvement beyond the compliance target CO₂ emission requirements of Building Regulations Wales Approved Document Part L2a (2014) will provide a sufficiently sustainable and energy efficient development, which is fit for purpose and capable of maintaining adequate occupant comfort levels, whilst also reducing energy demand, when compared to similar developments of this type.



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