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Energy Statement for Ruabon Park

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1.0 EXECUTIVE SUMMARY

- 1.1 This report describes the proposed development at Ruabon Park and sets out the planning policy and regulatory framework relating to Energy. The report indicates suggested features which could be incorporated in order to meet the energy targets, set by Planning Policy and Legislation.
- 1.2 It is currently understood that the most stringent energy requirements are those set out in PPW section 4.12.4. This section confirms energy the target requirement of 6no. credits under the Ene1 – Reduction of CO₂ Emissions section, which requires a 25% improvement on 2010 BR Part L2A and a 59% improvement on 2010 BR Part L1A for non-domestic and residential units respectively.
- 1.3 Recommendations have been made in this report for the inclusion of energy efficiency measures and the consideration of low or zero carbon technologies, though the exact mix of features will be determined through the detailed design of the buildings proposed for the site.
- 1.4 It will be for the individual units to determine what is the best approach, given their constraints, and submit their reasoning in their detailed planning application.
- 1.5 Incorporation of the most appropriate strategies during the design development will ensure that the required CO₂% improvements are achieved.

2.0 THE PROPOSED DEVELOPMENT

2.1 The application site is a parcel of land approximately 24.9 hectares in size located to the south-west of the village of Ruabon near Wrexham at central OS grid reference SJ 297 432. The A539 forms part of the northern boundary of the site, a caravan park set within an area of parkland is located to the east, arable farmland is located to the south and broad-leaved woodland and a small industrial park are located to the north and north-west respectively.

2.2 The proposed development comprises a mixed-use development comprising commercial and residential uses (detailed below) and also includes land reserved for a Primary School (Class D1). The primary access will be off the A539 and B5605. The application will be made with all matters reserved except means of access.

2.3 The proposed uses are as follows:

- Class A1 foodstore with petrol filling station 1,858m² (GFA) associated car parking;
- Commercial B1 (Office) 12,960m² (GFA);
- Class B8 (warehousing) and/or Class C2 (extra-care) 4,646m² (GFA);

- Class A4 (pub) and/or Class C1 (Hotel) 2,787m² (GFA); and
- Class C3 residential, 300 units. The residential element assumed for indicative purposes to take the form of 14 x 2-bed, 169 x 3-bed and 90 x 4-bed dwellings. 10% (30 dwellings) would be affordable housing.

3.0 POLICY BACKGROUND

3.1 There are a number of international and national policy drivers for energy efficiency and reduced carbon dioxide (CO₂) emissions, which have been introduced to address the issue of global warming and the implications of climate change. This includes the Kyoto Protocol on an international level, and in response to the UK Government's commitment, national policies have been developed including the *Energy White Paper*¹.

International Policy Drivers

Kyoto Protocol (1997)

3.2 The Kyoto Protocol was agreed at the 1997 UN Convention on Climate Change. The UK's target is to cut its emissions by 12.5% below 1990 levels by 2008-2012. The UK Government

committed to a more challenging target to cut the UK's CO₂ emissions to 20% below 1990 levels by 2010.

- 3.3 A successor agreement to the Kyoto Protocol has been, and will be, subject to intense protracted negotiations between member countries of the UN. At the conference of the parties in Durban 2011, member countries agreed to adopt a new agreement by 2015 that will come into force by 2020.

National Policy Drivers

Energy White Papers

- 3.4 The *Energy White Paper: Our Energy Future – Creating a Low Carbon Economy*¹ is a change in direction for energy policy in response to the increasing challenges faced by the UK, including climate change, decreasing domestic supplies of fossil fuel and escalating energy prices. The *Energy White Paper* sets four priorities:
- Cutting the UK's carbon dioxide emissions - the main contributor to global warming - by some 60% by about 2050, with real progress by 2020;
 - Security of supply;
 - A competitive market for the benefit of businesses, industries and households; and
 - Affordable energy for the poor.

- 3.5 *Meeting the Challenge - A White Paper on Energy*² published in 2007 sets out the Government's international and domestic energy strategy to respond to changing circumstances; address long-term energy challenges; and how to deliver on the four energy policy goals set in the *Energy White Paper*¹.

Climate Change Act 2008

- 3.6 On 26th November 2008, the UK Government published the Climate Change Act 2008³, the world's first long-term legally binding framework to mitigate against climate change. Within this framework, the Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target to 80% by 2050. In addition, there is an interim target that the carbon budget (i.e. the CO₂ emissions) must be at least 26% lower than the 1990 baseline.

Regional Policy Drivers

National Planning Policy

- 3.7 The Welsh Government has set out to achieve annual carbon reduction-equivalent emissions reductions of 3 per cent per year from 2011 in areas of devolved competence, and to achieve at least a 40% reduction in all greenhouse gas emissions by 2020 against a 1990 baseline⁴.

3.8 Climate responsive developments are those that tackle the cause of climate change and adapt to the current and future effects of climate change through incorporation of mitigation and adaption measures.

3.9 To move towards more sustainable and zero carbon buildings in Wales, the Welsh Government expects that the criteria set out in PPW Section 4.12.4 to be met:

- *'Applications for 5 or more dwellings received on or after 1st September 2009 to meet Code for Sustainable Homes Level 3 and obtain 6 credits under issue Ene1- Dwelling Emission Rate;*
- *Applications for 1 or more dwellings received on or after 1st September 2010 to meet Code for Sustainable Homes Level 3 and obtain 6 credits under issue Ene1- Dwelling Emission Rate;*
- *Dwellings registered under the Code for Sustainable Homes (Version 3) will be expected to meet Code for Sustainable Homes Level 3 and obtain 1 credit under issue Ene1- Dwelling Emission Rate;*
- *Applications received on or after 1st September 2009 for non residential development which will either have a floorspace of 1,000 m² or more, or will be carried out on a site having an area of one hectare or more, to meet the Building Research Establishment*

Environmental Assessment Method (BREEAM) 'Very Good' standard and achieve the mandatory credits for 'Excellent' under issue Ene1 - Reduction of CO₂ Emissions'

3.10 The Welsh Government's Energy Policy Statement (2010) identifies the sustainable renewable energy potential for a variety of different technologies including biomass electricity, PV, wind and hydro. They are subject to the requirements of the EU Renewable Energies Directive, which include the UK targets of 15% of energy from renewables by 2020.

3.11 In section 12.8.7 the PPW describes renewable energy as:

'...the term used to cover those sources of energy, other than fossil fuels or nuclear fuel, which are continuously and sustainably available in our environment. This includes wind, water, solar, geothermal energy and plant material (biomass). These sources of energy can be utilised to generate power, heat, fuels(for transport) and cooling through a range of renewable energy technologies such as solar panels and wind turbines. For the purposes of planning policy, low carbon energy is the term used to cover technologies that are energy efficient (but does not include nuclear). Renewable and low carbon energy developments will feature in many types of situations such as those that:

- *Are directly incorporated into the fabric of a building;*

- *Built within a new development (e.g. development scale combined heat and power);*
- *are stand-alone directly connected to the grid;*
- *Provide heat for a number of buildings (e.g. District heating); and*
- *Provide cooling.⁴*

3.12 The PPW have set a 4TWh per annum renewable electricity production target by 2010 and a 7TWh target by 2020 as stepping-stones to their ambition of 60% carbon savings by 2050. The Technical Advice Notes (TAN) provide technical advice to supplement the policies set out in the PPW and the Ministers Interim Planning Policy Statement (MIPPS) on renewable energy, which amends the PPW. TAN 8 states the renewable energies promoted to achieve the renewable energy production targets:

- Combined Heat and Power (CHP) – a plant that simultaneously generates heat and power (usually electricity) in a single process;
- Community (or District) Heating – A community heating main and central boiler house rather than a CHP should be investigated as a community heating solution;

- Energy from waste – all regions have expressed interest in mechanical and biological treatment (MBT), which involves burning refuse derived fuel to produce heat and/ or electricity;
- Anaerobic digestion (biogas);
- Hydropower;
- Methane – generation of energy from landfill gas;
- Solar thermal and photo-voltaic;
- Fuel crops, including woodfuel; and
- Offshore and onshore wind farms;

3.13 The PPW highlights the lucrative potential of wind farms as a main source of large scale renewable energy generation. On a smaller scale they state:

12.8.18 'Local planning authorities should facilitate local authority-wide scale renewable energy in development plans by undertaking an assessment of the opportunities and potential for renewable energy in the area. They should also look for opportunities to co-locate major developments in order to optimise renewable energy potential and to promote district heating schemes.'

12.8.19 Feed-in Tariffs provide financial support for projects in the sub-local authority scale category by requiring energy

suppliers to make regular payments to customers who generate their own electricity. The upper limit of Feed in Tariffs is currently 5MW. There is potential for communities and small businesses to invest in ownership of renewable energy projects or to develop their own projects for local benefit. The Welsh Government's policy is to support community driven renewable energy projects where benefits from the projects are returned to the host community. Local planning authorities should ensure that development plan policies are supportive of projects benefitting from, or eligible for, Feed-in Tariffs.

12.9.2 Local planning authorities should guide appropriate renewable and low carbon energy development by undertaking an assessment of the potential of all renewable energy resources and renewable and low carbon energy opportunities within their area and include appropriate policies in development plans. Local planning authorities are encouraged to work collaboratively in order to gather evidence on a sub-regional basis wherever possible.

12.9.5 Policies for strategic renewable energy development in areas outside Strategic Search Areas (SSAs), if appropriate, should be included in development plans informed by local authority renewable energy assessments.

12.9.6 Other than onshore wind projects, the most likely form of renewable energy installations to be considered through the

planning system will be strategic scale biomass projects. The sustainability of the sources of biomass fuel is not a planning consideration.

12.9.7 The potential for the development of renewable and low carbon energy development within urban/industrial brownfield sites remains largely untapped. There may be further opportunities for the development of wind or other renewable energy schemes on urban/industrial brownfield sites.

12.9.8 Local planning authorities should also seek to maximise the opportunities for district heating and generation schemes in their development plan by co-locating new proposals and land allocations with existing developments and heat suppliers and users.'

- 3.14 The local planning authorities should support the shift towards a low carbon economy, as described in section 7.4 of PPW:

'...They should look favourably on proposals for new on-site low carbon energy generation including, for example, high efficiency energy recovery from waste, as well as generally facilitating the provision of an integrated network of waste facilities, provided that there are no unacceptable impacts on local amenity.'⁴

- 3.15 The PPW states that:

*'Development proposals should mitigate the causes of climate change by minimising carbon and other greenhouse gas emissions associated with their design, construction, use and eventual demolition. The overall aspiration is to secure zero carbon buildings while continuing to promote a range of low and zero carbon (LZC) technologies as a means to achieve this.'*⁴

Local Planning Policies

- 3.16 Regarding general Energy Strategy aims Wrexham Unitary Development Plan (UDP) states:

*'2.6 Activities associated with energy supply should be consistent with protecting the local and global environment. Any environmental damage or loss of amenity caused by energy supply or ancillary activities should be minimised and unnecessary sterilisation of energy resources prevented. Renewable energy generation sources (e.g. wind, waste, water, sun, and wood) are preferred. Central government policy on waste management is based on a hierarchy of reduction, re-use, recovery (including material recycling, energy recovery, and composting), and safe disposal as close as possible to the point of generation. Derelict land should be restored and returned to beneficial use. Development should be located so as to reduce the risk from natural or man-made hazards.'*⁵

- 3.17 As a general development principle:

'4.1 All development proposals must satisfy certain general requirements, the regulation of which is a key function of the planning system (e.g. drainage/liability to flood, stability, natural hazard, energy efficiency, materials and design, etc.). Many of these matters are the responsibility of statutory organisations that are automatically consulted on development proposals.'

Building Regulations

- 3.18 The Building Regulations 2000 (England & Wales) set out standards and requirements that individual aspects of building design and construction must achieve. The 'functional' requirements are also considered in a series of Approved Documents that provide general guidance in common building situations.
- 3.19 In total, there are 14 technical areas that each Approved Document provides practical guidance on, including fire safety, ventilation, hygiene, drainage and access. Approved Document Part L (Conservation of Fuel and Power) of the Building Regulations deals with the energy efficiency requirements:

Approved Document Part L – the Conservation of Fuel and Power

'Reasonable provision shall be made for the conservation of fuel and power in buildings by:

a. Limiting heat gains and losses:

i) Through thermal elements and other parts of the building fabric; and

ii) From pipes, ducts and vessels used for space heating, space cooling and hot water services;

b. Providing and commissioning energy efficient fixed building services with effective controls; and

c. Providing to the owner sufficient information about the building, the fixed building services and their maintenance requirements so that the building can be operated in such a manner as to use no more fuel and power than is reasonable in the circumstances.'

- 3.20 On 1st April 2002, Part L of the Building Regulations came into force, with a view to reducing heating costs, conserving fuel and protecting the environment from the effects of climate change. However, to ensure that Part L of the Building Regulations was in line with the commitments made in the Energy White Paper of reducing CO₂ emissions from buildings,

and to implement the Energy Performance Building Directive amendments to the Approved Document were made in 2006.

- 3.21 On 6th April 2006, the amends to the 2002 version of Part L of the Building Regulations were implemented, introducing new energy efficiency requirements and other relevant changes, which included:
- 3.22 A single calculation method was introduced (setting maximum CO₂ emissions for the whole building), replacing the three previous methods of demonstrating compliance;
- 3.23 The CO₂ emissions standards for new buildings were raised by between 20% and 28% compared to 2002 standards (dependant on the type and size of building); and Standards for work on existing buildings were generally higher than in 2002.
- 3.24 Subsequently, following the publication of planning policy and legislative drivers identified above, a need to reconsider and revise the 2006 editions of the Approved Document Part L was identified. The latest revision to the document, the 2010 version of Part L, was adopted from October 2010.
- 3.25 Within the current 2010 version of Part L, a number of changes have been made, including the following:
- 3.26 The Target Emissions Rate (TER) is no longer based on a 2002 notional building and an improvement factor but will take an

'aggregate approach' for the non-dwellings sector. The TER will be based on a building of the same size and shape as the actual building, constructed to a concurrent specification, provided in the 2010 National Calculation Method (NCM) modelling guide. This approach has been adopted, because the level of improvement that can be reasonably expected is considered to vary significantly across the building sector and therefore, a blanket improvement factor is considered inequitable. Therefore, some buildings (e.g. those buildings that use a higher load of lighting versus, say, hot water) are expected to exceed the 25% reductions target, while other buildings are allowed to achieve less than 25%;

- 3.27 In order to assist Building Control Officers to enforce regulations, design-stage submissions must be accompanied by a copy of the design specifications. This will also increase the emphasis on commissioning to ensure that systems perform as intended. This also enables the Building Controls Officer to be able to check that the relevant elements are in place. Should any changes be made and the building to the design stage list of specifications, a list of these changes must be provided to the Building Control Officer, as well as a certificate signed off by a suitably accredited energy assessor; and
- 3.28 Accredited construction details that cover building elements, such as thermal bridging no longer make assumptions. Under

the 2010 Building Regulations, each of the junctions must be measured, multiplied by the appropriate psi value (values supplied by the SAP 2009 document), and added up to produce an 'effective' value.

- 3.29 On the 31st December 2011, the Welsh Government received the power to make Building Regulations a devolved power. Subsequently the Welsh Government announced their intention to make even more challenging carbon emissions targets for new buildings in Wales than current planning policy and Building Regulations.
- 3.30 In September 2013 the Welsh Minister for Housing and Regeneration announced that, following a consultation period that new targets for the reduction of carbon dioxide emissions would be set out in updated Building Regulations for Wales. Of the targets announced an 8% reduction in emissions for dwellings over Part L1A 2010 and a 20% reduction for non-dwellings over Part L2A 2010.

4.0 BREEAM AND CSH

BREEAM

- 4.1 The proposed development is being assessed under the Building Research Establishment's Environmental Assessment Method (BREEAM), a nationally recognised means of reviewing

and improving the environmental performance of buildings. BREEAM considers a wide range of key global and local environmental issues, and the internal environment for building occupants under various categories including energy.

- 4.2 The PPW has stated that all non-residential buildings are required to have BREEAM New Construction (NC)⁶ assessment undertaken and achieve a BREEAM 'Very Good' rating with a score of 55%; additionally one of the mandatory requirements for 'Excellent' (achieving 6no. credits under the Ene1 – Reduction of CO₂ Emissions section) must also be achieved. It should be noted that to achieve 6no. credits under Ene 1 for BREEAM NC 2011 a 25% improvement on 2010 Building Regulations Part L2A must be achieved.

Code for Sustainable Homes

- 4.3 The Code for Sustainable Homes (CSH) is intended to facilitate a step change in the environmental performance of new housing, in accordance with the Government target that all new housing be zero carbon by 2016.
- 4.4 The most recent version of the CSH was released in November 2010 to be aligned with the introduction of the new 2010 Building Regulations; this replaced the previous May 2009 CSH version and is the most up-to-date version that was used for this pre-assessment.

- 4.5 The PPW has stated that all residential dwellings are required to undertake a CSH assessment and achieve a Level 3 rating with a score of 57%; additionally achieving 6no. credits under the Ene1 – Reduction of CO₂ Emissions section. It should be noted that to achieve 6no. credits under Ene 1 for CSH Nov 2010 a 59% improvement on 2010 Building Regulations Part L1A must be achieved.

5.0 PASSIVE DESIGN & ENERGY EFFICIENCY

- 5.1 In order to construct buildings that comply with Building Regulations Part L1A/L2A and improve upon the TER, measures to make the building energy efficient must be incorporated within the scheme design.
- 5.2 The following key energy efficiency design measures to reduce emissions are likely to be incorporated in the design of the buildings:
- 5.3 External shading on all west, south and east-facing facades to limit active cooling and avoid summertime overheating;
- 5.4 Proposed thermal element U-values:
- Floors, 0.15 W/m².K;
 - Walls, 0.15 W/m².K;
 - Roof, 0.15 W/m².K;

- Windows, $1.8 \text{ W/m}^2.\text{K}$;
 - Doors, $1.0 \text{ W/m}^2.\text{K}$;
- 5.5 External lighting to be highest efficacy achievable with minimum lux levels, photo cell operation and dawn to dusk time switches to reduce the minimum safe lighting level for security. Performance criteria:
- Building, access ways and pathways light fittings no less than 50 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) greater than or equal to 60 or 60 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) less than 60;
 - Car parking areas, roads and floodlighting light fittings no less than 70 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) greater than or equal to 60 or 80 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) less than 60; and
 - Signage and uplighting light fittings no less than 60 lamp lumens/circuit Watt when the lamp wattage is greater than or equal to 25W or 50 lamp lumens/circuit Watt when the lamp wattage is less than 25W;
 - Installation of energy efficient lifts which operate in standby during off-peak periods, are installed with energy efficient lighting (average lamp efficacy of 55 lamp lumens/circuit watt), and have a drive controller capable of variable-speed, variable-voltage, variable-frequency (VVVF);
 - Inverter drives installed on all fans/pumps to control the speed of each fan/pump to accurately match the duty and load;
 - Energy-efficient heat recovery ventilation system designed to achieve a specific fan power of no greater than $1.5\text{W}/(\text{litre}.\text{s}^{-1})$;
 - Meeting rooms, offices, corridors and store areas within the commercial units will be provided with PIR control to reduce energy use and reduce running costs based on reduced operation. This will ensure that lighting will only be utilised when required and not continuously;
 - Photoelectric sensors will also be provided in luminaire fittings adjacent to windows to allow for dimming when sufficient natural light is available;
 - Low flow wash hand basin taps and showers; and
 - Air permeability of $5\text{m}^3/\text{m}^2.\text{hr}$ @ 50Pa or less.

6.0 LOW OR ZERO CARBON TECHNOLOGIES

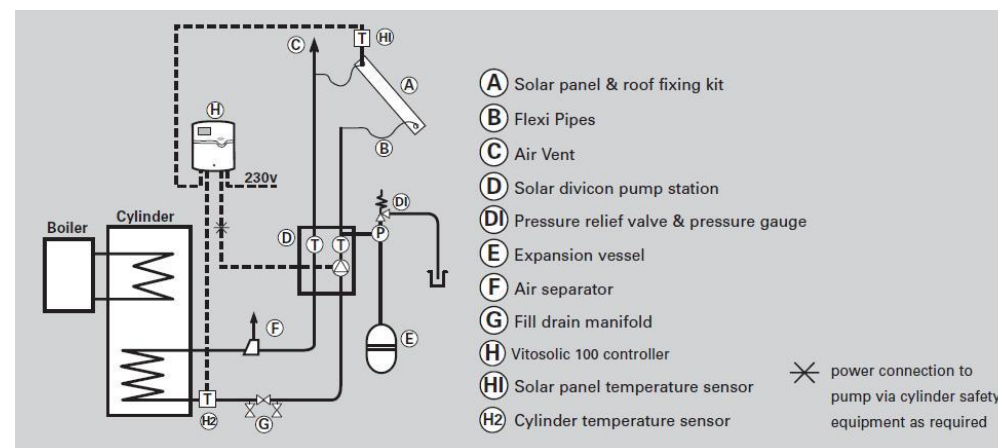
Solar Hot Water

- 6.1 Solar thermal panels are used to produce hot water and consist of roof mounted collector panels that make use of heat energy from the sun and use it to heat water circulating in a closed loop. Usually this heat is then transferred via a heat exchanger into a hot water storage tank that is also heated by a gas or other boiler.
- 6.2 Two main types of solar water heating system are used in the UK; flat plate collectors and evacuated glass heat tubes. Flat plate collectors circulate water around a black coloured receiver plate that is heated by direct sunlight and to some extent by indirect light; heat being retained by a thermally glazed panel above. Evacuated glass heat tubes are more efficient, particularly in the UK, as they can work more effectively at low solar radiation levels. They are however, more expensive than flat plate collectors. They consist of rows of parallel transparent glass tubes, each containing an absorber tube which converts the sunlight into heat energy.

Figure 6.1 **Solar Thermal Evacuated Tube Panels**



Figure 6.2 **Diagram of Large Scale Solar Thermal Installation**



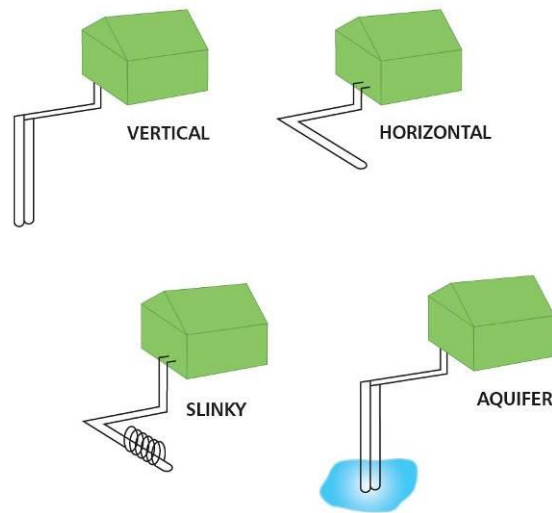
- 6.3 Solar hot water systems could be installed at the buildings, but may not be suitable where another form of low carbon heating is provided for the development.

Ground Source Heating and Cooling

- 6.4 Ground source heat pumps (GSHP) extract heat from the ground. GSHPs work on the principle that the below ground temperature is more constant compared to above ground. In the winter months, the below-ground temperature is warmer than above ground and the heat carrier fluid circulating within the absorber pipes absorbs the heat. This heat energy is then raised by a compressor (using the compression cycle) and through a heat exchanger, distributed via a low temperature distribution system such as under floor heating, to satisfy a proportion of space heating requirements. GSHP systems are not suitable for satisfying high temperature hot water demands.
- 6.5 In the summer months, the below-ground temperature is colder than above ground and the heat carrier fluid circulating within the absorber pipes rejects building heat. This heat rejecting capacity is then raised by a compressor (using the compression cycle) and through a heat exchanger, distributed via a chilled water distribution system to satisfy a proportion of space cooling requirements.

- 6.6 As 0 indicates, there are a number of configurations for GSHP systems. A vertical collector system is considered the most appropriate in the context of the proposed development given the large scale of the system and limited area available for horizontal collectors. Vertical collectors can be between 15m – 180m deep with minimum spacing between adjacent boreholes should be maintained at 5-15m to prevent thermal interference.
- 6.7 A key component of this technology is the heat exchanger. Larger heat exchangers deliver greater heat transfer and are, therefore, more efficient but they have a higher capital cost.

Figure 6.3 **Diagram of Different Configurations of Ground Source Heat Pumps Systems**



- 6.8 It is important to establish ground conditions (depth of soil cover, the type of soil or rock and the ground temperature) at the application site but the likely presence of a soil layer and underlying sandstone means that installation of both open and closed loop ground couplings could be achievable at the development site (although this would be subject to a ground survey).

- 6.9 During detailed design consideration must be given to the expense of installation, the number of boreholes required to meet the load requirements of the development and the operational risk of the ground coupling developing a fault or degrading in effectiveness.

Air Source Heating and Cooling

- 6.10 Air source heat pumps (ASHPs) utilise the outside air as a heat source or heat sink. Heat can be used to warm water for radiators or underfloor heating systems, or to warm the air within a dwelling. ASHPs work on a similar principle to a fridge, which extracts heat from its inside. An evaporator coil, mounted outside absorbs or expel the heat; a compressor unit then drives refrigerant through the heat pump and compresses it to the right level to suit the heat distribution system. Finally, a heat exchanger transfers the heat from the refrigerant for use, depending on which of the two main types of systems (identified below) is installed:
- Air to air system - produces warm air which is circulated by fans to heat a building; and
 - Air to water system - uses heat to warm water. Heat pumps heat water to a lower temperature than a standard boiler system; therefore, these systems are more suitable for underfloor heating systems than

radiator systems, requiring less space to incorporate, compared with an air to air system.

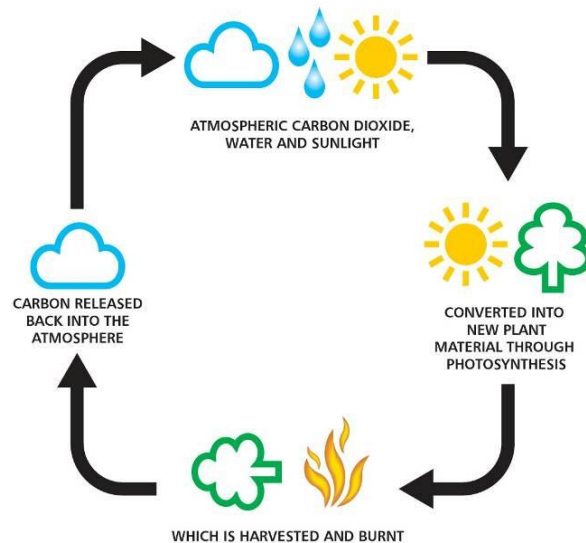
- 6.11 The efficiency of ASHPs is measured by a coefficient of performance (CoP) - the amount of heat produced compared to the amount of electricity needed to run them. As ASHPs produce less heat than traditional boilers, buildings must be well insulated and draught-proofed to ensure that the heating system is effective.
- 6.12 Using air instead of the earth as a heat source mean that ASHPs have a lower CoP than GSHPs, resulting in less carbon savings for a similar sized heat pump. However, the key issue when considering the potential carbon savings of ASHPs is the carbon content of grid electricity. The cleaner the grid electricity, the better the carbon savings from ASHPs; given the legally binding UK carbon reduction targets, it is likely that ASHPs installed with an estimated operational period of 25 years will be better in carbon terms compared with traditional condensing gas fired boilers.
- 6.13 In addition, ASHPs are becoming increasingly popular in the UK, largely due to the fact that there is no need for extensive excavation, requiring far less plot footprint and are more easily installed than GSHPs. Furthermore building plant layouts do not have to be re-engineered to obtain heat from a different fuel source should gas become scarce, and/or expensive and/or a 'dirty' fuel, compared to electricity.

- 6.14 As with ground source heating and cooling systems, air source heat pumps could be technically integrated with the heating systems at the proposed development. The carbon-saving potential of ASHPs is likely to be modest compared to condensing gas boilers and, given the uses at the proposed development.

Biofuelled Heating

- 6.15 Biomass boilers replace conventionally powered boilers with an almost carbon neutral fuel such as wood pellets or wood chips. The fuel is classed as an almost carbon neutral because the CO₂ released during the burning of biomass is balanced by that absorbed by the plants during their growth, see Figure 6.4.

Figure 6.4 **Biomass Carbon Cycle**



- 6.16 The proposed development could allocate space for boilers and fuel storage but fuel would likely be sourced from out with the area surrounding the proposed development.
- 6.17 Though biomass is a cleaner fuel than gas or heating oil, it should be noted, however, that fossil fuels are utilised in the production, processing and transportation of biomass fuels. Therefore a key issue when choosing the biomass fuel supplier is the distance between the grower and the boilers as well as the method of transportation.

- 6.18 Biomass energy can be derived from a number of sources, but are principally divided into three main types: first, second and third generation. First generation biomass include raw material which is already in a suitable form for combustion (e.g. firewood), but also include energy crops; plant grown at low cost and low maintenance harvest, which is directly exploited for its energy content. However, the use of first generation biofuels have been heavily criticised, as it is considered that there is a limit to the processes of first generation biofuel without threatening food supplies and biodiversity. Much of the criticism of first generation biofuels is due to their use of crops which are diverted from the food chain resulting in food shortages and price rises. On this basis, second generation biofuel technologies were developed to help address these limitations and ensure that biofuel can be produced sustainably.
- 6.19 Second generation biomass consists of residual food parts of crops (e.g. stems, leaves) as well as other crops that are not used for food purposes, and also industry waste. Third generation biofuel is considered to be further efficient, whereby algae culture, which is farmed at low cost, produces biofuels at high yield.
- 6.20 Although many biomass burners will meet Clean Air Act requirements, combustion of woody biomass releases higher

quantities of NO_x, SO_x and particulates (PM₁₀ and P<25) compared to a comparable system fuelled by natural gas.

6.21 Traditional first generation woody biomass tends to be a by-product of forest industries or agriculture. The wood fuel generated by forestry can be classified into the following types:

- SRW (small round wood);
- Wood chips;
- Branches and brash;

6.22 Another form of fuel which is manufactured as a by-product of sawmills is wood pellets. These tend to have a higher energy density, lower moisture content and less ash is generated from their combustion. For these reason pellets are often preferred as they use less storage area, are associated with less boiler maintenance and, due to the fact they are manufactured, offer a more consistent quality of fuel.

6.23 Biomass could technically be burned at the proposed development and will be considered in more detail during detailed design.

ELECTRICITY GENERATION

6.24 Small-scale renewable electricity generation has received the recent boost of a Feed-in-tariff (FiT) scheme that guarantees

that small scale electricity generators receive a return on investment of between 5-8% over the course of the life of the scheme for the energy generated by their equipment..

Photovoltaic Cells

6.25 Solar Photovoltaics (PVs) are solar panels which generate electricity through photon-to-electron energy transfer, which takes place in the dielectric materials that make up the cells. The cells are made up from layers of semi-conducting silicon material which, when illuminated by the sun, produces an electrical field which generates an electrical current. PVs can generate electricity even on overcast days, requiring daylight, rather than direct sunlight. This makes them viable even in the UK, although peak output is obtained at midday on a sunny summer's day. PVs offer a simple, proven solution to generating renewable electricity.

6.26 The main types of commercially available PV panels on offer in the UK are constructed from cells as described below:

- Monocrystalline silicon cells are the most efficient of the PV technologies with a conversion efficiency of between 15-18% (available solar energy to electricity produced). They are cut from single ingots of silicon, have an unbroken crystal lattice and are the most expensive of PVs;

- Polycrystalline silicon cells have a conversion efficiency of between 13-16%. They are less expensive than monocrystalline cells, are constructed of a number of smaller crystals and are recognisable from a visible 'grain' on the panel;
- Thin film cells have a conversion efficiency of between 5-10%. As well as being less efficient they are cheaper than silicon derived cells. Thin films can be mounted on folded or curved surfaces and are used extensively in Building Integrated PV products.

6.27 The electricity produced by PV cells is DC which is converted to AC using an inverter before use within a building or export to the local distribution network.

Figure 6.5 **Photovoltaic (PV) Panels**



Figure 6.6 **Roof Tile With Integrated PV Cells**



- 6.28 A PV array could technically be integrated on the roofspace on the buildings at the site and may also be integrated to building fabric, external shading devices and glazing, though the preference would be to install separate panels that could be more easily replaced at the end of their service life.
- 6.29 The major drawback from including PV on the buildings is the additional capital cost of panels and inverters. Though Feed-in-Tariff subsidies help to reduce the payback time, making PV a better investment, the capital outlay is still considerable and has to be borne up front by the developer.

Wind Turbines

- 6.30 Wind turbines are an established means of capturing wind energy and converting it into usable electricity. A wind turbine is usually consists of a nacelle containing a generator connected, sometimes via a gearbox, to a rotor consisting of three blades.
- 6.31 The two main types of commercially available wind turbines on offer in the UK are described below:
- Horizontal axis wind turbines (HAWT) are traditionally the most common form of wind turbines installed in the UK. They are usually formed of three blades and work best when provided with a constant laminar air flow; and
 - Vertical axis wind turbines (VAWT) are less efficient compared to HAWTs but have the advantage that they can cope with variable wind flows as they do not have to 'face' the wind.
- 6.32 Wind turbines can also be classified according to their size:
- Micro-wind: under 15kW rated capacity;
 - Small-scale wind: between 15kW to 100kW rated capacity;

- Medium-scale wind: between 100kW to 500kW rated capacity; and
 - Large-scale wind: greater than 500kW rated capacity.
- 6.33 Though small-scale stand alone turbines or roof-mounted micro-wind turbines could be installed at the site, careful consideration must be given to noise and the visual intrusion of the turbines especially where there is to be a residential component of the development.

7.0 CONCLUSION

- 7.1 This report has reviewed key Energy targets as set out in planning policy and regulatory framework which guide the proposed design development of Ruabon Park.
- 7.2 Currently the most stringent energy requirements are those set out in PPW section 4.12.4. This section confirms energy the target requirement of 6no. credits under the Ene1 – Reduction of CO₂ Emissions section, which requires a 25% improvement on 2010 BR Part L2A and a 59% improvement on 2010 BR Part L1A for non-domestic and residential units respectively.
- 7.3 Recommendations have been made in this report for the inclusion of energy efficiency measures and the consideration

of low or zero carbon technologies, though the exact mix of features will be determined through the detailed design of the buildings proposed for the site.

- 7.4 The use and design philosophy behind the proposed buildings will determine whether the use of on-site renewables is maximised versus, for example, the design of building fabric to Passiv-haus standards.
- 7.5 It will be for the individual units to determine what is the best approach, given their constraints, and submit their reasoning in their detailed planning application.
- 7.6 Incorporation of the most appropriate strategies during the design development will ensure that the required CO₂% improvements are achieved.

8.0 REFERENCES

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