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Energy Strategy and District Heating Network Assessment

November 2014

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QUALITY MANAGEMENT

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EXECUTIVE SUMMARY

This energy strategy and district heating assessment has been prepared to support the planning application for the proposed residential led development on land South East of Woodstock.

The aim is to show how the development can meet local and national policies regarding carbon emissions, energy consumption and the use of renewable energy. The relevant policies that the Energy Strategy and District Heating Assessment considered were:

- Part L of Building Regulations 2013;
- Cherwell Submission Local Plan 2006-2031 Part 1.
- West Oxfordshire Local Plan 2011
- West Oxfordshire Draft Local Plan 2012

The requirement of Part L 2013 has two main elements, relevant to this energy strategy:

1. Fabric Energy Efficiency (FEE) – Each home must demonstrate that its specification, fabric standards, air permeability and glazing does not exceed a threshold given in kWh per m2 per year (Applicable to homes only).
2. Target Emission Rate (TER) – As well as the fabric standard a specific TER is set for the new building in terms of emissions, given as kg CO2 per m2 per year.

The main target for the site is to achieve a Code for Sustainable Homes Level 4 for residential elements and a BREEAM 'good' rating for non-domestic elements. For the energy aspect this is equivalent to a 19% improvement on Part L 2013 for the residential element. The West Oxfordshire draft Local Plan policy CP20 also states that new developments should secure at least 10% of their predicted energy demand from low and zero carbon technologies.

Three representative models for dwellings were developed using National Home Energy Rating (NHER) Plan Assessor v6.0 software based on the schedule of accommodation (Appendix A) received for the proposed development. To demonstrate efficient building fabric the specification detailed in Appendix R of Standard Assessment Procedure (SAP) 2012 is used in the model as this sets out a reasonable method to comply with the fabric requirements, insulation and air permeability. To this efficient heating and lighting was added to demonstrate a representative method of complying with the overall TER. The values used are laid out in Appendix C.

The energy demand and related CO2 emissions for non-domestic elements were modelled through three representative units using Simplified Building Energy Models (SBEM) in Integrated Environmental Solutions (IES) software. The fabric and systems applied to building models were those as detailed in the National Calculation Methodology, which can be found in Appendix C.

The results of indicative SAP models (for homes) were extrapolated and added to results of SBEM models (for non-domestic buildings) to give an estimate of total site emissions and form a benchmark for the analysis of renewable energy technologies.

The following technologies were considered in the renewable energy study:

- Photovoltaic
- Solar Thermal
- Wind Turbines
- Biomass boilers
- Ground & Air Source Heat Pumps

Wind turbines have been ruled out at the site given the location and proximity to dwellings.

Whilst practical, ground source heat pumps are not recommended due to the space requirement of a borehole system within the garden of dwelling. Solar thermal is not recommended as the restriction of providing <60% of hot water demand limits its benefits in a way that does not apply to photovoltaics (PVs).

Photovoltaics are considered applicable to the development given availability of roofs orientated to south-east. This technology could be applied on the suitably orientated unshaded roofs at the development and have the potential to reduce carbon emissions by required 19% as required.

Air Source Heat Pumps are recommended for inclusion in dwellings that cannot include rooftop solar tile due to orientation or protected view. This technology allows for the 19% target to be achieved, assuming an efficient system and would require the inclusion of a low temperature heat distribution system. Given the sensitivity of Phase 1 air source heat pumps will be applied to all dwellings.

The high thermal standards of the development do now allow for a sufficiency thermal density to make a district heating system viable. In addition the use of CHP units is not recommended due to the projected increase in CO_2 emissions and increased air pollution in the medium term.

1 INTRODUCTION

1.1 WSP was commissioned by the Pye Homes Ltd. and Vanbrugh Unit Trust to develop an Energy Strategy and District Heating Assessment that would consider relevant local and national policies governing sustainable construction and District Heating. Both reports have been combined within this Energy Strategy and District Heating Assessment.

1.2 The proposed development comprises a mixed-use development comprising: Outline Planning Application for up to 1,500 dwellings, including affordable housing and up to a 150 unit care village with associated publicly accessible ancillary facilities; site for a new primary school; up to 930sqm of retail space; up to 7,500sqm locally led employment (B1/B2/B8); provision of site for new link and ride facility; site for a Football Association step 5 football facility with publicly accessible ancillary facilities; public open space; associated infrastructure, engineering and ancillary works, (all matters reserved except for means of access to the development); and Full Planning Application for the development of Phase 1 at the south western corner of the site for the erection of 29 residential dwellings (29 of the 1,500 described above) with associated open space, parking and landscaping; with vehicular access provided from Upper Campsfield Road (A4095), Shipton Road and Oxford Road (A44)

Site context

1.3 The Proposed Development lies on agricultural land to the South East of Woodstock and is bordered by Shipton Road to North East, Upper Campsfield Road to South east, the A44 to South West, and the existing development of Woodstock to North East.

Picture 1; Site Location

2 LEGISLATION AND POLICY

2.1 The application site falls within two planning authority areas, West Oxfordshire and Cherwell District Councils. It is therefore necessary to consider the application in the context of two sets of policies.

Table 1; Policy Context

Policy		
National policy/legislation	**Local Policy**	**Project Target**
Climate Change Act 2008 The Government's renewable energy strategy aims to cut its carbon dioxide emissions by 29% against 1990 baseline levels by 2017. **Building Regulations Part L 2013.** The dwelling must achieve or better the Target Fabric Energy Efficiency (TFEE) and the Target Emissions Rate (TER). The Target Fabric Energy Efficiency is based on a notional building the same size and shape as the actual using the values detailed in SAP 2012 (Appendix B), The dwelling fabric energy efficiency must be within 15% of this. This effectively requires a minimum level of building fabric energy efficiency for compliance and is detailed as kWh/m2/year. The Target Emissions Rate is a representation of allowable emissions per m2 based on regulated loads of building. **National Planning Policy Framework 2012.** This lays out the presumption in favour of sustainable development. **Planning Practice Guidance 2014.** Outlines specific planning criteria for certain technologies.	**Cherwell Adopted Local Plan 1996 &** **Cherwell Submission Local Plan 2006-2031 Part 1.** Policy ESD 3 – Sustainable Construction 'All new homes will be expected to meet at least Code Level 4 of the Code for Sustainable Homes' Policy ESD 4 – Decentralised Energy Systems 'The use of decentralised energy systems, providing either heating (District Heating (DH)) or heating and power (Combined Heat and Power (CHP)) will be encouraged in all new developments.' Policy ESD 5 – Renewable Energy **West Oxfordshire Sustainable Construction - Interim planning advice** Developments of 10 or more dwellings to achieve at least Code level 4. All new non-residential development to achieve at least Code Level 4. **West Oxfordshire; Draft Local Plan Ocotber 2012.** The Draft policy CP20 states that new developments should secure at least 10% of their energy from decentralised and renewable or low carbon sources. CP3 requires new dwellings to ahcieve Code Level 4 from 2013, and Code Level 6 from 2016.	There is no adopted local policy governing sustainable design or construction in either district council. Guidance indicates that a Code Level 4 should be sought for dwellings, which is equivalent to a 19% improvement on Part L 2013. The second project target is to achieve a 10% contribution to predicted energy demand from renewables. All non-domestic uses should achieve a BREEAM 'Good' rating which is equivalent to compliance with Part l 2013.

3 SITE ENERGY DEMAND

Indicative Units, Residential

3.1 Three representative Standard Assessment Procedure (SAP) models were developed for residential units and based on the schedule of accommodation (Appendix A), which includes up to 150 units within a care village. These models consisted of a 2/3 bed flat with an average area of 69m^2, a 3 bed semi-detached with an average of 88m^2 and a 4 bed detached dwelling with an average area of 151m^2. The results of these models were then extrapolated to estimate the energy demand and related CO_2 emissions for all residential elements of Proposed Development.

3.2 The baseline models for the dwellings were developed using values of a notional building as detailed in SAP2012 using the National Home Energy Assessor (NHER) Plan Assessor v6.0. These specifications are used as a guide to achieve both Target Emissions Rate (TER) and Target Fabric Energy Efficiency (TFEE), and thus compliance with Part L of Building Regulations 2013.

3.3 The Target Emissions Rate for each of the domestic units was found to be;

- 2/3 Bed Flat: 16.01kgCO_2/m^2/yr
- 3 Bed Semi-Detached: 15.93kgCO_2/m^2/yr
- 4 Bed Detached: 16.16kgCO_2/m^2/yr

Which when extrapolated across the whole development gives a total emissions figure of 1,970.2tCO_2/yr for the residential element of the development.

Indicative Units, Non-Domestic

3.4 Three representative “Simplified Building Energy Models” (SBEM) were created based on the schedule received for non-domestic elements (Appendix A), and included retail, employment and education uses.

3.5 The baseline models for non-domestic elements were developed using values for notional building within the national calculation methodology (NCM) in Integrated Environmental Solutions (IES) software.

3.6 The Target Emissions Rate for the non-domestic notional buildings were found to be;

- Retail Unit: 57.1tCO_2/m^2/yr
- Education: 24.6tCO_2/m^2/yr
- Employment: 30.1tCO_2/m^2/yr

3.7 Which when extrapolated out across the number of each unit type at the development gives a total emissions figure of 283tCO_2/yr

4 LOW AND ZERO CARBON TECHNOLOGIES

4.1 Low and zero carbon technologies have been assessed with a view to determine their applicability to the site in order to optimise generation potential and achieve a reduction in emissions.

4.2 We have evaluated a range of technologies to assess their applicability to achieving this objective including;

- Solar Photovoltaics
- Solar Thermal
- Biomass Heating
- Ground Source & Air Source Heat Pumps
- Wind turbines
- District heating

4.3 Site specific analysis for Solar Thermal, Biomass Heating, Wind Turbines and Ground Source Heat Pumps are provided in Appendix B as they are not recommended for the site.

5 SOLAR RESOURCE

5.1.1. The solar resource present in the UK is suitable for photovoltaic panels which convert sunlight into electricity. The priority when including this technology in design is to maximise the level of sunlight received, this is achieved by ensuring panels are orientated towards south and are un-shaded.

- These technologies should be orientated between South West and South East
- Tilted from 10-50^{O}
- Unshaded by trees or buildings

5.1.2. Photovoltaics are recommended for the proposed development given the level of available unshaded roof space. It is recommended that these panels be installed on dwellings orientated to the South East in order to avoid any impact on the protected view from Blenheim Palace. The PV GiS solar resource map suggests that a roof mounted system at the site could produce 880 kWh/kWp (kilo-Watt peak).

5.1.3. The recommended photovoltaic technology consists of solar tiles that have a reduced visual impact as they are very similar to standard roofing tiles, see Picture 2 below. These tiles, (as with panels) are also not expected to have any impact on the nearby airport as they are designed with a matt finish in order to maximise the absorption of light.

Picture 2; Solar Tiles

5.1.4. The individual system size required to meet the 10% contribution to predicted energy demand which surpasses the 19% CO_2 emissions reduction target for each individual dwelling amounts to 0.68-kWp. This is equivalent to approximately 13.5 solar tiles requiring 5m^2 of roof space.

5.1.5. As previously mentioned in policy review there is no target improvement beyond Building Regulation for non-domestic elements.

5.1.6. Photovoltaic panels are the recommended technology for achieving compliance with Code Level 4, and 10% contribution where required in phase 2 or outline application.

5.2 Air Source Heat Pumps

5.2.1. Air Source Heat Pumps (ASHP) take a low grade heat resource (air) and increase the temperature through a vapour compression cycle. Heat

pumps can deliver this heat source typically at a co-efficient of performance of 2 to 4.5, meaning that for each kilowatt hour of electricity consumed by heat pump 2 - 4.5 kWh of useable heat is delivered.

5.2.2. This technology can achieve both the target 19% improvement in emissions and 10% contribution to energy demand and could therefore be included in the dwellings that are considered unsuitable for PVs or as well as PVs. Given the sensitivity of Phase 1 we recommend that ASHPs be applied to each dwelling. These units would be located at the base of dwelling and not visible in principal elevation of dwelling.

5.2.3. This technology would require a low temperature heat distribution system in the form of underfloor heating. A heat pump unit will have to be located outside of dwelling and may require sensitive siting given potential for noise issues.

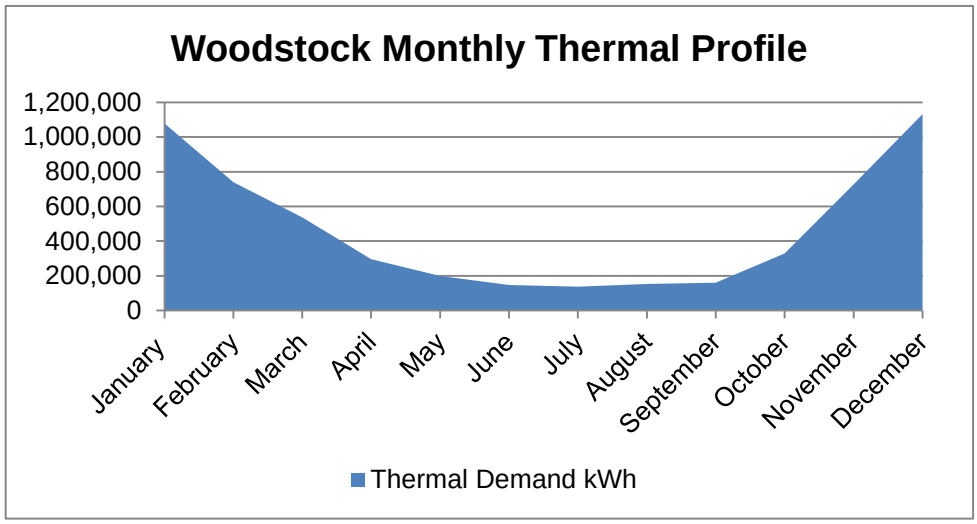
6 DISTRICT HEATING NETWORK AND CHP

6.1 A minimum of 300 dwellings (or equivalent) with a density of greater than 60 dwellings per hectare is generally the threshold before which a CHP (Combined Heat and Power) district heat network is considered. This proposed dwelling density is significantly below this level. Beyond this, modelling undertaken for the Greater London Authority indicated that a thermal demand density of >70kWh per m^2 per annum is required to make a district heating network economically comparable to providing individual gas-fired heating without increasing fuel poverty.

6.2 Generally speaking CHP engines or biomass boilers are used to serve the baseload of thermal demand with support from gas-fired boilers in a dedicated energy centre. Although CHP engines are noisy and have higher emissions of air pollution they can generally be acoustically attenuated and the flue designed to minimise the impact on the local receptors.

Thermal Demand Profile

6.3 The thermal demand of the housing, employment, education and retail space on a monthly basis is shown below on a graph, based on the modelling undertaken.



6.4 Monthly demand varies from 137MWh to 1,132MWh with a total demand of 5,634MWh, as below. On the basis of a CHP engine providing 60% of thermal demand and running for 5,000 hours per annum, which is typical a CHP engine(s) of 676kWt (kW thermal) would be required.

	MWh
Minimum	137
Maximum	1,132
Total	5,634

Table 2; Heat demand

6.5 The site is 74.6a and has a thermal demand density of 8.59kWh per m^2 per annum and therefore is not considered viable for the use of a district heating network.

6.6 Generally a heat network follows the street network of a development (to allow for laying, access for maintenance and access to each address) and this would give an indicative DHN length of >5,000m. This length is due to the low density nature of the proposed development.

6.7 On this basis the overall system would have thermal losses of 782MWh using an estimated calculation based on BS EN 13941. This equates to approximately 14% network losses.

Heat Loss flow pipe	8.97	W per m
Heat loss return pipe	8.88	W per m
Combined Heat Loss	17.85	W per m
Overall losses	89.3	kW continuous
Annual Losses	782431	kWh

Table 3; Heat loss, DHN

6.8 A CHP led district heating scheme with these losses will actually increase CO_2 emissions, particularly as the electrical grid decarbonises. Below is a graph of how this will work:

	Gas Boiler	CHP
Efficiency	**0.85**	**42%t/44%e**
Year	**kg CO_2 per kWh**	
2014	0.22	-0.04
2016	0.22	0.08
2018	0.22	0.16
2020	0.22	0.24
2022	0.22	0.25
2024	0.22	0.25
2026	0.22	0.28
2028	0.22	0.3
2030	0.22	0.33
2032	0.22	0.34
2034	0.22	0.36

Table 4; Emissions comparison

6.9 Although a CHP will show an initial benefit, very quickly the emissions actually increase compared to local gas fired boilers. (A CHP unit produces heat and power. This is why it can have a negative CO_2 emission factor in the first couple of years; the

emissions related to the production of heat are more than offset by the reduction in emissions from the production of electricity. (The calculation methodology used here slightly favours CHP but does not significantly alter the main point.)) This does not take into account losses on the network.

6.10 In conclusion the due to the type of development and high standards of thermal efficiency the development will not have sufficient thermal demand density to make a district heating system viable. In addition the use of CHP units is not recommended due to the projected increase in CO_2 emissions and increased air pollution.

7 CONCLUSION

7.1 Three representative dwellings including a 2/3 bed flat, a 3 bed semi-detached and a 4 bed detached house were modelled using the SAP methodology determined from the Schedule of Accommodation for the proposed development.

7.2 The output of the NHER software allowed the assessment of whether the building specification chosen achieved compliance with both the Target Emissions Rate (TER) and Target Fabric Energy Efficiency (TFEE) of Part L of the Building Regulations 2013 in each case. Compliance with Building Regulations was assured as specifications as detailed in Part L of Building Regulations were used as a minimum (Appendix C). The output of this software allowed for an estimate of total energy consumption and CO_2 emissions from residential elements to be calculated through extrapolation.

7.3 In order to ascertain the energy demand and carbon emission of the non-domestic elements at site three representative SBEMs were developed in IES software to represent the non-domestic elements. The fabric and systems applied to the building model were those as detailed in the national calculation methodology, which can be found in Appendix C.

7.4 An assessment was carried out in order to outline which technologies could be included in design in order to reduce carbon emissions of dwellings at the site in line with local policy targets requiring a 19% improvement (Code for Sustainable Homes Level 4) on Part L for residential element and a 10% contribution to predicted energy demand.

7.5 Given sensitivity of phase 1 air source heat pumps are recommended for all dwellings. This would only require only minor alteration from standard servicing strategy in the form of a low temperature heat distribution system, and an ASHP unit as base of dwelling.

7.6 Solar Photovoltaics are recommended alongside ASHPs for outline given the likely presence of unshaded roofspace orientated to South East. The recommended photovoltaic technology consists of a solar tile that reduces visual impact and would only require 0.68kWp per roof to achieve a 10% contribution surpassing carbon target.

8 REFERENCES

Appendix A

Schedule of Accommodation - Residential

Residential		
Unit type	Number of Units	Total Area (m^2)
1 bed flat	148	9,206
2 bed flat	150	11,490
2 bed house	185	14,523
3 bed house	523	51,254
4 bed house	264	39,838

Schedule of Accommodation – Non Domestic

Non-Domestic	
Unit type	Area (m^2)
A1/A2/A3/A4 - Retail	790.5
D1 - Education	1884.45
B1/B2/B8 - Employment	6375

Appendix B

Technologies Not Used

The following technologies were not considered feasible at site;

- Solar Thermal
- Biomass Heating
- Ground Source heat Pumps
- Wind Turbines

Solar Thermal

Though feasible given available roof space within development it is not recommended for site as unshaded suitable roof area is designated for use for photovoltaic panels. This option would also require a different servicing strategy to standard approach given the requirement to include a thermal store within the building.

Biomass Heating

This technology is not recommended for majority of dwellings given low thermal demand of efficient units. This option would also require a fuel store to be located within each dwelling. Please see District Heating Assessment for further analysis.

Ground Source Heat Pumps

Though feasible at the site the added cost and space requirement required for ground source heat pumps and associated boreholes serve to discourage the inclusion of this technology.

Wind turbines

Wind turbines have not been included given the proximity of dwellings within and adjacent to site. Certain areas of site also fall under a protected view from Blenheim palace and should therefore be avoided,

Appendix C

Baseline Energy Efficiency Parameters Used in Modelling – Based on SAP Appendix R 2012

Building Element.	(Notional)
External Walls (W/m^2K)	0.18
Floors (W/m^2K)	0.13
Roof (W/m^2K)	0.13
Window (W/m^2K)	1.4
Openings %	25% of floor area
Thermal Bridging (W/K)	0.05
Heating (Mains Gas)	89.5%
Controls	Time and temperature control, weather compensation, modulating boiler and interlock
Air Permeability (m_3m^2h)	5
Ventilation	Natural

Non Domestic Baseline Energy Efficiency Parameters (National Calculation Methodology)

Building Element.	(Notional)
External Walls (W/m^2K)	0.26
Floors (W/m^2K)	0.22
Roof (W/m^2K)	0.18
Window (W/m^2K)	1.6
Openings %	25% of floor area
Heating (Mains Gas)	91%
Air Permeability (m_3m^2h)	5
Ventilation	Natural

Appendix D

Energy conversion factors used in this report

Energy Source	$kgCO_2/kWh$
Electricity (mains fed)	0.519
Electricity (onsite generation offset)	0.519
Gas	0.216
Biomass (pellets)	0.039