Energy Statement: Plot B

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Ecological Land Co-operative Ltd. | The Hub, 5 Torrens Street, London EC1V 1NQ

For a Living, Working Countryside

This report has been prepared by Zoe Wangler of the Ecological Land Co-operative Ltd. It is written to be read in conjunction with the planning application, plans and other documents accompanying this planning application.

INTRODUCTION

This report sets out the projected energy consumption and planned energy sources for one new temporary agricultural worker's dwelling (Plot B) which forms part of a proposal for three new low impact smallholdings for new entrants to ecological agriculture developed by the Ecological Land Co-operative, a co-operative society and social enterprise. Although this statement supports the application for Plot B's agricultural worker's dwelling, it is proposed that the planned energy sources will be used by all three smallholdings.

According to the Department of Energy Climate Change, from 2005 – 2009 domestic energy use in Mid Devon in heating, electricity and cooking generated ~ 1.01 Mega tonne CO_2 (~ 2.7 tonne CO_2 per year per person)[1]. One of the central principles of our proposed scheme is for all households to be 'low impact' which includes dramatically reduced carbon emissions as a result of onsite renewable energy generation. The proposed development is aiming for a target of ~ 0.2 tonne CO_2 per year per person from domestic energy consumption.

ENERGY DEMAND

Space heating and hot water energy demand

The temporary dwelling will be positioned to maximise passive solar heating from direct sunlight. Heating and hot water demand calculations are not included in this report as 100% of this demand will be met via carbon neutral energy source using solid biomass heating (woodburning).

Electrical energy demand

Efficient and low energy light bulbs and energy efficient appliances will be used. This will significantly reduce the electrical energy demand.

The projected electrical energy demand for Plot B has been estimated using data from current electricity consumption, an audit of their current appliances and an interview to ascertain their projected electricity consumption once they move to Greenham Reach. A detailed breakdown of the list of appliances that they anticipate using are shown in Appendix 1.

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[1] AEA (2011) *Local and Regional CO2 Emissions Estimates for 2005-2009*. Department of Energy & Climate Change.

The average and peak annual electrical energy demand for Plot B has been estimated as ~ 705 and ~ 1,082 kWh respectively (see Figure 1).

For the whole development (3 smallholdings), the total average and peak annual electrical energy demand has been estimated as ~ 1,550 and 2,550 kWh respectively.

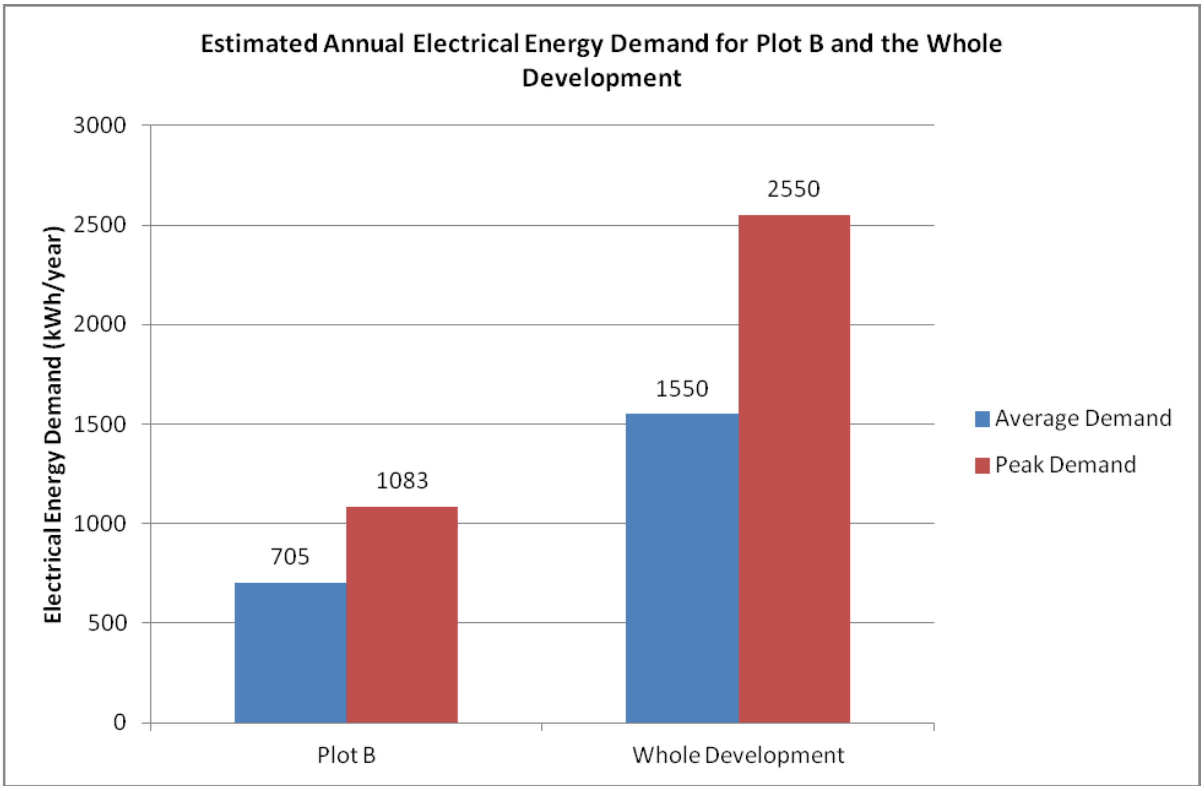

Figure 1: Estimated annual electrical energy demand for Plot B and the whole development

Cooking

It is expected, at least in the initial occupancy stages, that a gas hob using bottled gas will be used for cooking. This is one area of energy use which will produce carbon emissions. Projected use for gas cooking by the family of three on Plot B is six 15kg gas cylinders/year[2], providing ~ 480 hours (approximately 1 hour 20 minutes per day) of cooking time. This will produce estimated carbon emissions of ~ 0.29 tonne CO_2 per year (see Appendix 2) or ~ 0.1 tonne CO_2 per year per person.

[2] According to Carbon Trust (dated 02/12/2011), LPG calorific value is approximately 13.667 kWh/kg. Therefore 10 No. 15 kg LPG cylinder is anticipated to provide 13.667 x 15 x 10 = 2050 kWh.

Further sustainability features

Water use

In addition to efficient energy use, sustainable measures for water use including a compost toilet, biological waste water treatment system, rainwater harvesting and borehole water abstraction are proposed.

RENEWABLE ENERGY TECHNOLOGIES

Seven low carbon and renewable energy technologies have been reviewed for the development and preferred options have been identified. These technologies are listed below:

- Photovoltaic cells (PV)
- Solar hot water (SHW)
- Solid biomass
- Biodiesel (for power generation)
- Ground source heat pump (GSHP) and air source heat pumps (ASHP)
- Combined heat and Power (CHP)
- Hydro electric power

Preferred renewable energy technologies

Photovoltaic cells (PV)

Preliminary assessment indicates that the ideal size of a PV system for Plot B is ~ 1.5 kWp. This system should be sufficient to meet the maximum peak demand of ~ 1,083 kWh as shown in Appendix 1. The PV panels' area is ~ 11.5 m^2. The PV panels are proposed to be installed on the barn's roof. If necessary, besides the barn's roof, there is sufficient unshaded land area that can be used for PV panel installation.

For the whole development, the suggested capacity of the PV system is ~ 3.75 kWp, and the total PV panels' area is ~ 28.5 m^2.

	PV system capacity (kWp)	PV system area (m^2)
Plot B	~ 1.5	~ 11.5
Whole development	~ 3.75	~ 28.5

Table 1: Summary of suggested PV system for Plot B and the whole development

The proposed PV system is anticipated to meet all of the electrical energy demand. All energy generated will be stored in electric battery.

In addition, the prospective tenants of the scheme are aware that as they are powered by an off-grid system they will have to consider the time of day to use major appliances. They have all made a commitment to work within the limits of this system. Further guiding information and training for the tenants will be provided.

<u>Solid biomass heating</u>

Space heating and domestic hot water demand will be provided by solid biomass heating technology using a woodburning stove. Wood will be sourced locally and in time, some will be sourced from the site itself. With this approach, 100% of the space heating and domestic hot water energy demand will be met via a carbon neutral source.

Technologies that can be retained as an option

The technologies that can be kept as an option for the development are as follows:

<u>Solar hot water (SHW)</u>

The applicants are likely to include a solar water heater to provide their domestic hot water during summer. For this option, a storage tank would be used with an immersion heater to top-up the hot water temperature as required / when surplus solar energy was available.

<u>Biodiesel power generation</u>

A backup electric generator with a 5 kW capacity is proposed for the development. This generator will be used to replenish the energy generated by the PV system only if required. As a potential option, the electric generator could be fuelled by biodiesel fuel. There are different types of biodiesel fuel available in the market. The backup electric generator is not anticipated to be used frequently. For this reason, a suitable biodiesel fuel with long degradation period should be used.

Technologies considered unsuitable for the development

The following technologies are considered unsuitable for the development:

Ground source heat pump (GSHP) and air source heat pump (ASHP)

GSHP technology utilises ground temperature to provide heat at low grade temperature. It also requires arrangement of pipework to be buried below the ground surface (~ 2 – 4 metre deep). ASHP technology operates similar to the GSHP however it utilises air temperature.

Both GSHP and ASHP systems are driven via electricity. The development's heating demand will be met via solid biomass heating, which is carbon neutral source. GSHP and ASHP are not considered as suitable options.

Combined heat and power (CHP)

CHP technology is suitable for buildings with high hot water demand such as hotels. The technology requires the system to run continuously for long hours to be cost effective (e.g. 15 hours a day). The development's hot water demand will be met via solid biomass heating. For these reasons, CHP is not considered as a feasible option.

Hydroelectric power

Hydroelectric technology utilises water power to generate electricity. The water flow must be sufficient enough to drive the hydroelectric turbines. There is a water stream close to the development. However while it has not yet been established whether the water flow is sufficient for electric power generation, hydroelectric power systems are more complex and require higher running costs compared to PV systems. For this reasons, hydroelectric technology has not been considered further.

Overall CO2 emissions

Apart from the carbon emissions as a result of gas consumption for cooking, the development is aimed to be carbon neutral. The anticipated CO_2 emission for the dwelling is ~ 0.29 tonne of CO_2 per year.

CONCLUSION

To minimise space heating energy demand, any temporary dwelling will be sited to maximise solar gain and will be well insulated. The proposal includes a number of sustainability features such as a dry toilet, a biological waste water treatment system, rainwater harvesting and borehole water abstraction for low and efficient water use.

The electrical energy demand has been estimated using using data from current electricity consumption, an audit of their current appliances and an interview to ascertain their projected electricity consumption. The expected average electrical demand for Plot B and the whole development is ~ 705 and 1,550 kWh per year respectively. While the peak demand has been estimated as ~ 1,083 and ~ 2,550 kWh for Plot B and for the whole development respectively.

Seven low carbon and renewable energy technologies have been reviewed. Two technologies have identified as preferred options: (a) solid biomass heating to provide all the space heating and domestic hot water demand, (b) photovoltaic cells (PV) to meet the electrical demand. This preliminary assessed showed the PV system that can be suggested is as in the following Table.

	PV system capacity (kWp)	PV system area (m^2)
Plot B	~ 1.50	~ 11.5
Whole development	~ 3.75	~ 28.5

Copy of Table 1. Summary of suggested PV system for Plot B and the whole development

Two technologies can be retained as options: (a) solar hot water (SHW) to contribute to the hot water demand particularly in summer, (b) biodiesel to drive the backup electric generator.

The main CO_2 emission impact of the proposed temporary dwelling is anticipated from the use of gas cooking and has been estimated as ~ 0.29 tonne CO_2 per year (< 0.1 tonne CO_2 per person per year). This is significantly lower than typical CO_2 emissions from domestic energy use in the region (~ 2.7 tonne CO_2 per year per person, as indicated by DECC).

The proposal is aimed to be exemplary for a sustainable, low carbon, and energy efficient development.

APPENDICES

Appendix 1: Breakdown of electrical energy demand for Plot B

Month		Fridge	Lights	Music	Television	Phone	Chargers	Computer	Hairdryer	Chest freezer	Washing machine (1)	Total
January	Average	0.00	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**1.78**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
February	Average	0.00	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**1.78**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
March	Average	0.24	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**2.02**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
April	Average	0.24	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**2.02**
	Peak	0.24	0.40	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.90**
May	Average	0.24	0.20	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**1.92**
	Peak	0.24	0.40	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.90**
June	Average	0.24	0.20	0.03	0.05	0.01	0.02	0.55	0.03	0.60	0.18	**1.90**
	Peak	0.24	0.30	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.80**
July	Average	0.24	0.20	0.03	0.05	0.01	0.02	0.55	0.03	0.60	0.18	**1.90**
	Peak	0.24	0.30	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.80**
August	Average	0.24	0.20	0.03	0.05	0.01	0.02	0.55	0.02	0.60	0.18	**1.89**
	Peak	0.24	0.30	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.80**
September	Average	0.24	0.20	0.03	0.05	0.01	0.02	0.55	0.03	0.60	0.18	**1.90**
	Peak	0.24	0.30	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**2.80**
October	Average	0.24	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**2.02**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
November	Average	0.24	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**2.02**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
December	Average	0.24	0.30	0.03	0.05	0.01	0.02	0.55	0.04	0.60	0.18	**2.02**
	Peak	0.24	0.60	0.04	0.10	0.03	0.02	0.90	0.32	0.60	0.25	**3.10**
No days per annum	365											
Annual Electrical Energy Demand (kWh)	Average	73.00	94.29	10.95	18.25	2.92	7.30	200.75	13.70	219.00	63.88	**704**
	Peak	87.60	170.33	14.97	36.50	10.22	7.30	328.50	116.80	219.00	91.25	**1083**

Appendix 2: Estimated gas cooking demand

The gas cooking demand information in the table below is extorted from BREDEM-12, Model Description produced by the BRE (2011):

Table 5.1: Cooking fuel use and associated gains

Cooking system	**E_k, Cooking fuel (GJ/year)**	**G_k, Cooking gains (W)**
Electric	1.70 + 0.34 N	48.5 + 9.7 N
Gas	2.98 + 0.60 N	70.9 + 14.3 N
Kitchen range	3.91 + 0.85 N	111.6 + 24.3 N
Gas hob and electric oven	1.49 + 0.30 N (Gas) 0.85 + 0.17 N (Electricity)	59.7 + 12.0 N

Where **N** is the number of occupants.

As a simplified approach, for a total number of 3 people, the annual gas cooking demand is ~ 2.98 + (0.6 x 3) = 4.78 GJ ~ **1,330 kWh/year**.

According to Carbon Trust, the carbon emission factor for LPG = **0.2147 kgCO_2/kWh**[3]

Annual CO_2 emissions from gas cooking for the single dwelling (3 tenants) = 1,330 x 0.2147 = 285.55 kgCO_2/year ~ **0.29 tonne CO_2/year**.

[3] Carbon Trust (dated 02/12/2011), http://www.carbontrust.co.uk/cut-carbon-reduce-costs/calculate/carbon-footprinting/pages/conversion-factors.aspx, based on Defra 2011 conversion factors.