PROJECT DEVELOPMENT STUDY REPORT

Hawkesbury Upton Village Hall
High Street
Hawkesbury Upton
South Gloucestershire

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About Encraft

Encraft are independent technical specialists in microgeneration and low carbon technologies. The company operates nationally and employs chartered electrical, mechanical and building services engineers, as well as low carbon consultants accredited by CIBSE. We are accredited by the Renewable Energy Association to provide impartial advice on all types of small scale renewables, and by BRE to act as independent consultants for the Community Sustainable Energy Programme (CSEP). The company has carried out many hundreds of feasibility and design studies since 2003.

Encraft are independent of installers, manufacturers and energy companies and offer impartial professional support to our customers, including:

- Feasibility studies
- System design and specification
- Energy strategy
- Full M&E consultancy services and indemnified designs
- Monitoring and analysis, including wind monitoring
- Passive design, including three dimensional building simulation
- Energy Performance Certificates (EPC)
- Project management

Document history

Date	Version	Author	Checked/comments
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Legal note

The information which we provide is by way of general guidance only to your situation (so for example we do not provide any assurance that particular savings will be realisable, as they are indications only at this stage).

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1. OVERALL PROJECT CONCEPT

1.1 Introduction

Hawkesbury Upton Village Hall is a charitable community hall located in the village of Hawkesbury Upton in South Gloucestershire.

The building consists of a large hall with bar and stage, kitchen, toilets, changing rooms and showers. Upstairs there is a meeting room and a small office.

The hall building is well used by local community groups and organisations. The village hall provides necessary amenities and infrastructure, without which many events would not otherwise happen. Usage levels are high, as can be seen on the Hall website calendar. There are typically around eighty booking per month, spread across fifteen different organization that together cater for hundreds of visits by adults and children of all ages.

In the local parish plan the village hall has been identified as a suitable building for a potential demonstration energy project on carbon reduction. The village hall energy group are keen to push this forward and has successfully applied for funding for a detailed energy study under the Big Lottery Community Sustainable Energy Programme (CSEP). Encraft Ltd was appointed to carry out this assessment and a site visit was carried out on 1st September 2009. The study looked at which energy options were most appropriate; this included looking at opportunities to improve the insulation in the hall, how the building may be best heated and also the options for installing on-site renewable energy systems.

The building is in a rural location with a large recreation ground well away from neighbouring buildings and trees. The NOABL average wind speed at 10m is estimated to be 6.2m/s which is considered to be reasonable high enough for a successful wind turbine installation. The Village Hall committee is keen to take advantage of this potential wind resource by installing either a 6kW or 15kW rated turbine. The possible income and carbon dioxide (CO_2) savings would be significant; for example a 15kW turbine has the potential to reduce the halls CO_2 emissions by 18.5 tonnes and to generate an annual income of £12,400 (based on the proposed Feed In Tariff for micro-generation).

For space heating a ground source heat pump proved to be the most viable in terms of CO_2 reduction and energy costs. This will reduce the yearly heating costs by around £500 and save around 10.4 tonnes of CO_2.

Taken together the overall project has the potential to reduce CO_2 emissions by up to 29 tonnes per annum and energy costs by £13,000.

Services

The community hall has a three phase electrical supply and is oil heated. The hall is not on the gas network.

Building Dimensions

The village hall is a two storey building constructed in 1981 with a total heated floor area of approximately 460m^2.

Figure: Hawkesbury Upton Village Hall

2. OPTIONS APPRAISAL

2.1 Current Energy Consumption

The total energy cost over a full year for the community hall is around £3,500 (based on recent electricity consumption and oil deliveries). The village hall uses oil for all space heating as the village is not on the gas network. The total energy requirement for the building works out to be around 75,000kWh (~64,000kWh for heating and ~ 11,000kWh for lighting and appliances). This level of energy usage is responsible for carbon dioxide emissions of approximately 20.7 tonnes per year.

The following table shows this energy consumption split between fuels and its associated cost and CO_2 emissions.

Fuel	Total consumption kWh p.a.	£ p.a.	Tonnes CO_2 p.a.
Electricity	10,714 kWh	£1,382[1]	4.6 t p.a.
Oil	64,392 kWh	£2,106[2]	16.1 t p.a.
Total	**75,106 kWh**	**£3,488**	**20.4 t p.a.**

Renewable resources

Appendix I summarises the theoretical renewable energy resource available at the hall.

According to the national wind speed database, the wind averages around 6.2 m/s at the hall at 10m above ground level (although this figure can vary by 25% from year to year). The national database is based on a topographical mathematical model of the UK, effectively modelling the wind as fluid flow over a smooth contoured surface driven by known weather patterns. This means it can be wrong, as local trees and buildings and detailed topography can have significant impacts. Taking the actual built environment into account the actual wind speed is therefore likely to be somewhat lower than 6.2m/s. However, there is no way of knowing without measuring wind speed at the proposed turbine location for at least 6 months.

Solar energy falling on the hall is relatively predictable month by month, and this is also shown in Appendix I. Over the year as a whole around 1,139kWh of solar energy will be available per square metre on this site assuming no shading.

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[1] Based on an typical tariff for electricity of 12.9p per kWh for all units
[2] Based on a delivered oil price of 35p per litre

However, the challenge for any renewable project is to transform this energy into the right form and deliver it when it is needed. The bulk of solar energy arrives in summer (see Appendix I) when heating is not required. Moreover, the efficiency of solar water heating collectors is around 50%, and the efficiency of solar electrical (photovoltaic) systems is generally lower than 15%.

2.2 Options Considered

2.2.1 Solar PV

The small area of south facing roof on the hall is heavily shaded by a number of mature trees. The performance of a PV system is very sensitive to shading and therefore installing PV here would not be recommended.

It would be technically possible to install a PV system on the north end of the building on either the west or east facing roof as both of these areas are reasonable shade free. However, installing the PV system here would result in an annual energy yield around 20% lower compared with the same sized system on a south facing roof.

2.2.2 Solar Thermal

Solar thermal water heating is suited for buildings with a consistent hot water load throughout the summer months. The community hall does not have a large hot water requirement. The main need is in wash room(s) and in the kitchen(s) where only small volumes of hot water are required during operational hours.

For this reason, we do not believe that a solar hot water system would be suitable and therefore this technology is not recommended.

2.2.3 Biomass Boiler

A biomass boiler uses wood chip or wood pellet to provide space heating and hot water. A biomass boiler is considered carbon neutral and running costs compare very favourably to oil heating systems. The main disadvantage with this system is that a new plant room would need to be built to accommodate the wood chip or pellet boiler and an adequately sized fuel store (large enough for monthly deliveries to ensure fuel costs are kept low). It is likely that planning permission would need to be granted for this. Another disadvantage is that biomass boilers tend to require more maintenance which can be expensive. For these reasons we recommend that this option is not best suited for this particular building.

2.2.4 Ground Source Heat Pump

A ground source heat pump uses a ground loop of plastic pipes buried in the ground to warm an anti-freeze mixture. This mixture then goes into the heat pump. Here, the heat from the fluid is conducted to a sealed circuit containing refrigerant, warming it up. The heated refrigerant in turn is pushed through a compressor (powered by electricity). Compressing the refrigerant creates more heat (between 35 – 50^{o}C), and this heat is transferred to the heat distribution system.

A 30kW heat pump should be sufficient to cover approximately 95% of the annual heating load and domestic hot water requirement. This will require a collector length of around 1,600m which would need around 1,000m^2 of land to accommodate the trenching. Fortunately, the village hall owns the large recreation ground at the back of the building which could easily be used to accommodate this.

A ground source heat pump should provide approximately 23,040kWh of free heat energy which will reduce the CO_2 emissions significantly by around 8.2 tonnes a year. The running costs for the GSHP option around £300 more expensive compared with running the existing oil boiler at an oil price of 35p per litre. However, looking forward, we believe that the price of fuel oil is likely to increase at a faster rate than electricity and therefore a GSHP should provide a hedge against this risk.

The GSHP system will cost £240 per tonne of displaced CO_2 over the systems assumed life of 20 years which is less than the published benchmark of £460 per tonne and is therefore within the guidelines for CSEP capital funding.

2.2.5 Air Source Heat Pump

An alternative to a ground source heat pump would be to use an air source heat pump. This uses the outside air as a heat source rather than the ground. These are less efficient than a ground source heat pump due to the variable air temperatures over the year.

Ground source heat pumps are more efficient than air source heat pumps, and as there is a large area of ground available in which to install ground loops, this would be the preferred option.

2.2.6 Wind Turbine

According to the governments national wind speed database (NOABL), the wind speed averages around 6.2 m/s at the village hall at 10m above ground level.

It is difficult to estimate precisely what the actual wind speed is without carrying out a period of wind speed monitoring. However, Hawkesbury Upton is a small rural village and the village hall has a large recreation ground that backs onto open countryside. The site is also reasonably exposed to prevailing south westerly's and is approximately 150m away from the nearest building. It is therefore reasonable to assume that the wind resource shouldn't be too affected by wind turbulence.

We estimate that a Proven Wind Turbine rated at 15kW on a 15m tower could potentially generate an annual income for the village hall of £12,400 (based on the proposed Feed In Tariff) and reduce CO_2 emissions by around 18.5 tonnes.

This system will cost £151 per tonne of displaced CO_2 over the system's assumed life of 20 years. This is less than the benchmark of £345 per tonne CO_2 and is therefore within the guidelines for CSEP capital funding.

2.3 Recommendations

A freestanding wind turbine and a GSHP heating system are both technically possible. The Village Hall has a reasonably high predicted wind speed and the characteristics of the site (rural and fairly exposed) should ensure that the predicted energy yield is realised. A Proven 15kW turbine with Feed In Tariff support has the potential to generate an annual income for the hall of £12,400 and reduce CO_2 emissions by around 18.5 tonnes.

The hall has a large recreation ground that would easily accommodate the trenching required for a GSHP system. Replacing the existing, inefficient, oil boiler with a GSHP system would cut CO_2 emissions by 8.2 tonnes and insulate the hall against future increases in oil prices.

3. PROJECT MANAGEMENT

The project will be managed by Hawkesbury Upton Energy Group, with advice from Encraft Ltd, a low carbon consultancy.

Anticipated start date of ground source heat pump installation: **June 2010**

Anticipated start date of wind turbine installation: **June 2010**

Anticipated completion date of project: **July 2010**

These dates are subject to approval of the grant and scheduling of contractors.

4. COMMUNITY INVOLVEMENT

The design and development of this project has proceeded with the fullest community involvement. An effective process of community consultation was established during preparation of the Parish Plan, which canvassed views and solicited active participation on the widest basis that the village has seen for many years. Every household in the village was invited to attend public meetings and become involved. A survey of all Parish residents was undertaken and the results were collated as part of the Vision Project, in which a large proportion of respondents expressed an interest in renewable energy. This data was incorporated into the Parish Plan, which was subsequently adopted by the Parish Council.

An Energy Action Group was established to advance the vision embodied in the Parish Plan. Project design has involved a group of 8-10 volunteers meeting regularly over two years to establish the need, evaluate options and define the project. They have reached out to involve all stakeholders and constituted groups that are directly affected, including the Village Hall Committee and representatives of the wider community, such as the Parish Council and District Council. Minutes from meetings and information about future plans are made freely available to everyone via the Village Hall website.

Whilst everyone who uses the village hall will benefit directly from this project, we are also mindful of the need to offer benefits to sections of the community that will not benefit directly. The village school is an important beneficiary. We recognize the importance of engaging the attention and interest of children whilst they are young, so that what we have begun will be carried forward by future generations, both in the village and further afield.

With the encouragement of their teachers, local school children produced draught excluders for the inaugural public meeting (Watt's It All About – a morning of bright ideas) on 4th October 2008. They learned about different ways to save energy, illustrating them with posters that were displayed during the event. Sponsorship was obtained to provide free low energy light bulbs for everyone who attended the event and information about different technologies and grant schemes was provided to villagers considering improvements to their homes and businesses. There is evidence of progressive uptake of such schemes since the inaugural meeting, including successful application for grant-aid to install domestic cavity wall insulation.

5. ESTABLISHING NEED

Hawkesbury Upton is a working village which, like many others, faces growing challenges to its rural economy. Limited public transport means that regional arts, sports and leisure facilities are inaccessible and so the village hall has become the natural focus for village life. According to the Parish Plan survey, 70% of people use the Hall at least once every 6 months.

The need for this project stems from the high energy costs for the village hall, which are forecast to continue rising, plus a desire to harness the experience gained in preparation of this proposal to showcase energy savings and renewable alternatives for the wider benefit of the community. Furthermore, the oil-fired boiler in the village hall is reaching the end of its life, providing the catalyst for action now. This project is intended to reduce energy costs and enable the cost of activities to remain affordable despite weakness in the wider economy. Each reduction in the running costs of this community facility will enable more resources to be applied so that the village hall can deliver better services, enhanced facilities and leisure space for the benefit of all local residents.

The village hall provides necessary amenities and infrastructure, without which many events would not otherwise happen. Usage levels are high, as can be seen on the Hall website calendar. There are typically around eighty booking per month, spread across fifteen different organization that together cater for hundreds of visits by adults and children of all ages. Recent activities and meetings include: karate, pre-school, toddlers, badminton club, youth club, Evergreens, W.I., Buffs, modern/tap dancing, ballet, local history group, indoor and outdoor football, PTA, tennis club, cricket club, Friends of St. Mary's, drama group, girl guides, Parish Council meetings, Polling Station for local elections, meeting room hire, weddings and private parties, and the Hawkesbury Horticultural Society Annual Show.

6. PUBLIC PROFILE AND PROMOTION

We have demonstrated the ability to conduct a planned, deliberate and sustained public awareness campaign with coordinated actions between all relevant stakeholders. The Energy Action Group provides material for the monthly Parish Magazine and village website, augmented by leaflet drops for specific initiatives.

A very successful inaugural public meeting was staged on 4th October 2008. It was opened by Steve Webb MP, with support from government agencies and companies showcasing a range of renewable energy technologies. The event was well attended, with well over one hundred visitors from Hawkesbury Upton, Bristol and surrounding villages. It was reported by the news media (Spark of inspiration set to save energy, The Gazette, 9th October 2008). Plans are advanced for a drop in day on 22nd January 2010 at which information and a topical update on these proposals will be provided to villagers, enabling us to consult widely and listen to their views.

Since then, the Energy Action Group has worked hard to enhance public awareness and understanding of renewable energy. We identified the village hall and the school swimming pool as two strategic priorities for our community and have worked closely with the Parish Council and other constituted bodies to secure grant aid, which has enabled us to take forward the project detailed in this proposal.

The Village Hall is at the heart of village life. It is open to everyone and used by almost all villagers on a regular basis as they attend social events, clubs and sports activities, as well as attracting visitors from further afield. Many people have been involved in preparation of this proposal and gained greater understanding of sustainable energy schemes that are relevant to a village situated in an Area of Outstanding Natural Beauty. Everyone that uses the village hall will be touched by this project and will benefit from it. Look and Learn poster displays will raise awareness during and after commissioning. The experience gained will be used to address needs elsewhere, especially our other strategic priority. As an on-going operation, this project will yield knowledge that will be of value to nearby villages wishing to follow our lead and realize the benefits of a blended and synergistic combination of renewable energy technologies.

7. PROJECT LONGEVITY

Our cost model for the project as a whole is based on a combination of lower outgoings and development of revenue streams to meet the costs of maintenance as they arise, whilst raising funds to cover depreciation over the useful life of the assets. We have drawn upon historic data and published accounts to establish a baseline. We commissioned Encraft to forecast the cost a range of options during the Feasibility Study, taking account of sensitivity to key variables such as the price of oil. The preferred options were examined in greater detail, including spreadsheet modelling of specific design options.

Fully insulating the building reduces energy consumption and translates directly into lower heating costs, thereby offering a significant saving for the village hall. The project includes specific measures to improve insulation and these offer the earliest return on investment.

There is an income stream from hall rental to a wide range of groups and organizations. The Village Hall Committee augments this with fundraising events as and when required. This is sufficient to meet maintenance costs as incurred whilst making provision towards the cost of depreciation. The long-term success and the value of these initiatives are recorded in the published accounts.

For accounting purposes, we propose to depreciate capital equipment over a twenty year period (i.e. 5% per annum) on the basis that replacement cost should not exceed purchase cost indexed for inflation. We recognize that capital costs are higher because we have chosen to achieve meaningful reductions in fossil fuel consumption and CO_2 emissions, rather than simply replacing the existing oil-fired boiler with a new condensing boiler. Therefore we propose to add a new revenue stream through installation of a wind turbine that will generate electricity for sale to the grid.

Whilst there are currently incentive payments to encourage small-scale electricity generation, we acknowledge the risk that they may vary in future. Therefore we have specified a wind turbine with more than the minimum capacity required for a sustainable project. This should provide a prudent margin to guard against the inherent uncertainties in any long term forecasts. The first call on any income will be maintenance and depreciation costs. If a surplus is generated then it has been proposed that it will be used to benefit the local community, especially through ensuring that use of facilities remains affordable and encouragement of small scale sustainable energy initiatives.

8. ENERGY EFFICIENCY

It is important to start with energy efficiency, as all other energy projects will be cheaper and easier the more efficient energy is used.

8.1 Insulation Options

External walls

The main village hall building that was built in 1981 and is constructed with a block inner skin, cavity (~50mm) and stone outer skin. The Village Hall has recently had confirmation from a specialist cavity wall installer that all the external walls in the original building have been cavity insulated.

Roof

The Village Hall doesn't have a cold attic however there are a number of areas in the building with suspended ceilings (for example, the main hall and meeting rooms). It would be possible to add insulation fairly easily above the ceiling tiles. There is a product on the market specifically designed for this purpose called insulation pads. These are 200mm thick slabs of fibre glass sealed in polythene that sit directly above the ceiling tile.

The Village Hall has acquired a quote from a local National Insulation Association (NIA) installer to undertake this work and this will be carried out as part of the overall project.

To improve insulation levels in those areas in the building where the roof is sloping roof is not so straightforward. Those areas where the roof rafters can be easily accessed have already been improved by fitting PIR insulation between the roof rafters (leaving a wide enough air gap between the insulation and roof felt for ventilation). Other areas would require removing the existing plasterboard which would be very disruptive and expensive unless part of a bigger refurbishment project.

Product type	Suspended ceiling - 200mm insulation pads
Specification	Improve u-value of suspended ceilings to 0.2 W/m^{2}K (approximately 150m^2)
Indicative installation cost	£1,000
Estimated annual fuel saving	£190

Windows

The windows in the building are single glazed and air-leaky around the frames. Ideally they should be replaced with high performance double glazed units. Modern double glazed units with a U-value of 2.0 $W/m^2/K$ or better would reduce current heat losses by around 60%.

Fitting double glazing would have other benefits besides saving energy. For example, condensation on the panes would be reduced, draughts would be eliminated and noise from outside would be less audible.

Product type	U-PVC double glazed units
Specification	Improve u-value of windows from 4.8 $W/m^2/K$ to 2.0 W/m^2K (60% improvement)
Indicative Installation Cost	£4,000 - £5,000
Estimated annual fuel saving	£58

Unfortunately, the capital costs required to carry this measure are very high and as the likely fuel savings will be quite small the payback on investment will be long (especially when compared with other energy efficiency improvements identified). For this reason, this measure will be deferred until further funds come available.

8.2 Lighting

The village hall uses a mixture of fluorescent battens (switch control gear with T12 and T8 tubes), and compact fluorescent bulbs.

The T12 fluorescent tubes with switch start fittings use more energy and have a shorter life than the more efficient 26mm triphosphor (T8) tubes. Replacing T12 lamps with T8 tubes will reduce energy consumption per fitting by around 10%. This is a very cost effective measure with a quick payback and will be prioritised by the village hall for action.

Replacing old control gear fittings with modern high frequency ballasted fittings can reduce energy consumption by 25% for better light output. High frequency fittings designed for the slimmer and more efficient slimmer T5 tubes can potentially save an additional 15%.

To avoid the high costs associated in replacing old switch control fittings (typically £100-£150 per fitting) cheaper T5 adaptor kits have been developed. Adaptor kits simply plug into the existing luminaire, transforming it electronically from conventional control gear to high frequency.

Typical savings for standard sizes of T8 lamp using conventional control gear are detailed below:

Existing Lamp	New Lamp	Run hours for financial payback*	Expected Energy Savings
6 feet T8 70W	T5 49W	7,450	30%
5 feet T8 58W	T5 35W	6,670	40%

4 feet T8 36W	T5 28W	19,435	22%

* Assumes a £20 installed cost (including new T5 tube) and electricity at 12.9p per kWh

The Village Hall will look at carrying out a small trial installation of these adaptor kits in an area where lighting use is high. If the trial is a success then the adaptor kits will be installed in other high use areas.

8.3 Current Heating and Hot Water Systems

The space heating for the community centre is supplied from an IDEAL oil boiler rated at 41kW. The boiler also heats a single coil 300litre hot water cylinder which supplies hot water to the kitchen, toilets and showers. Although it isn't possible to identify the exact age of the boiler (the data badge that could have helped to identify the year of manufacture is missing) it is reasonable to assume that it dates from when the building was built and therefore is over 25 years old. The efficiency of a boiler deteriorates over time and therefore a boiler this old is likely to perform with a seasonal performance of no more than 70%.

It was also observed during the energy survey that the hot water tank is poorly insulated and the pipe work in the plant room is not lagged.

We have re-calculated the heat loss calculation to determine what the energy demand would be for the building if you were to implement the recommended improvements to the building fabric (i.e. improved roof insulation). The required heating load required would fall from 40kW to about 36kW based on a temperature uplift of 22^{o}C.

We have estimated below what the indicative capital costs would be to replace the existing oil boiler with a new condensing oil boiler and the likely fuel and CO_2 savings that this would generate.

Product type	36 kW oil condensing boiler with new hot water cylinder
Indicative Installation Cost	~£4,000

Energy input p.a.	46,075 kWh
Energy output p.a.	41,468 kWh
System efficiency	90%
Oil cost p.a. @ 35p per litre	£1,520 @ 3.3 p/kWh
Estimated fuel saving p.a.	£586

9. ENERGY PERFORMANCE

9.1 Wind Turbine

Suitability of Wind Turbine at Hawkesbury Village Hall

The amount of electricity generated by a wind turbine increases with average site wind speed and wind speed increases with height and distance from large obstacles like trees and buildings. This means that optimum economic returns are achieved when turbines are sited on large masts away from obstructions. A free standing turbine would need to be positioned as far away from the hall building and surrounding trees as possible (ideally at a distance of 10 times the height of the largest obstruction).

According to the governments national wind speed database (NOABL), the wind speed averages around 6.2 m/s at the village hall at 10m above ground level. This NOABL figure is a modelled wind speed and is more accurate for flat, open countryside than for complicated terrain and takes no account of local topography such as hills and valleys and nearby obstructions such as trees and buildings.

It is difficult to estimate precisely what the actual wind speed is without carrying out a period of wind speed monitoring (6 months minimum). However, Hawkesbury Upton is a small rural village and the village hall has a large recreation ground that backs onto open countryside. The site is also reasonably exposed to prevailing south westerly's and is approximately 150m away from the nearest building. It is therefore reasonable to assume that the wind resource shouldn't be too affected by wind turbulence.

The best site to locate a wind turbine would be alongside the northern perimeter of the playing field. This backs onto open farm land and looks to be the most exposed to south westerly's. It is also a good distance away from trees, buildings and other obstructions.

The total value of the electricity generated by a grid connected wind turbine will consist of three elements:

(i) The value of the electricity used on site that would otherwise have been brought in from the grid.
(ii) The value of any surplus electricity that will be exported back into the supply grid if not used on site.
(iii) An amount paid for the total annual generation. This is currently referred to as a Renewable Obligation Certificate(ROC). A more generous support mechanism called a Feed In Tariff (FIT) will shortly be available. Both are discussed below.

The overall value of (i) and (ii) will depend on the electrical load profile for the hall (which will vary on whether the hall is in use or not) compared to the generation profile for the wind turbine (which will vary by month).

A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for renewable electricity generated. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated. If the electricity companies do not have enough ROCs they have to pay the other suppliers who do have enough. This means that the suppliers want to buy your ROCs to avoid being penalised. The payment depends on the supplier but they currently pay around £35-£45 per ROC.

From April 2010 the government will be introducing a new support mechanism for micro-generation technologies. The proposal is to provide financial support by paying a set 'feed in' tariff (FIT) for the total amount of power generated. For wind turbine systems up to 15kW the suggested tariff will be 23p per kWh. This will be paid for a set period of 25 years.

Unfortunately, the government's proposals state that installations that have been in receipt of a government capital grant will not be entitled to FIT payments unless the grant is paid back in full however they would still be entitled to receive ROC payments. The government is currently undertaking a consultation on these proposals and this requirement may yet be changed. A final decision is expected soon.

A suitable sized turbine for the site would have a rated output of between 5-15 kW. In this output range there are now a number of products in the market that are accredited for government grant funding. The British company Proven Wind Ltd markets two products in this output range; the Proven 6kW and the Proven 15kW turbine.

A cost analysis of the Proven 6kW and Proven 15kW turbines are shown below. The analysis includes the potential income streams for both ROC and FIT support mechanisms.

Proven 6kW Turbine

This type of turbine would be mounted on a 10-15m tower. The rotor diameter is 5.5 m. The tower requires concrete foundations 3m x 3m x 1.2m.

The table below summarises a budgeted cost for such a system. These costs are before any available grants are applied.

Item	**£**
6kW Proven turbine Self tilt tower – 15m Grid connect inverter Miscellaneous	£9,999.00 £6,499.00 £2,856.00 £1,267.00
Foundation works	£4,500.00
Installation and commissioning	£3,560.00
Total	**£28,681.00**

The estimated electricity generation, income and CO_2 savings for this model of turbine are shown below:

		With FIT support	**With ROC support**
6 kW Proven wind turbine with a rotor diameter of 5.5m mounted on a 15m tower. 	Estimated energy yield per year[3]	14,700 kWh	14,700 kWh
	Estimated annual savings from displaced power @ 12.9p per kWh	£379	£379
	Estimated annual exported power @ 5p per kWh	£588	£588
	Potential value of FIT @ 23p per kWh	£3,381	Nil
	Potential value of ROC @ 9p per kWh	Nil	£1,323
	Total annual saving	**£4,348**	**£2,290**
	Total annual carbon dioxide saving	**6.32 tonnes**	**6.32 tonnes**

The calculation assumes that 20% of the total generation is used on site and 80% is exported. Savings are calculated based on an electricity tariff of 12.9p per kWh and an export tariff of 5p per kWh. Carbon dioxide emissions are calculated using a CO_2 emissions factor of 0.43kgCO_2/kWh.

This system will cost £227per tonne of displaced CO_2 over the system's assumed life of 20 years. This is less than the benchmark of £420 per tonne CO_2 and is therefore within the guidelines for CSEP capital funding.

[3] Annual energy yield calculated using the Proven Energy Calculator. The yield is dependent on estimates of site wind resource which have a degree of uncertainty at this stage of the project as no wind monitoring has been undertaken at the site.

Proven 15kW Turbine

This type of turbine would be mounted on a 15m tower. The rotor diameter is 9m. The tower requires concrete foundations 4.25m x 4.25m x 1m.

The table below summarises a budgeted cost for such a system. These costs are before any available grants are applied.

Item	**£**
15kW Proven turbine	£20,999.00
Self tilt tower – 15m	£10,999.00
Grid connect inverter	£8,398.00
Miscellaneous	£3,237.00
Foundation works	£5,250.00
Installation and commissioning	£7,238.00
Total	**£56,121.00**

The estimated electricity yield, income and CO_2 savings for this model of turbine are shown below

		With FIT support	With ROC support
15 kW Proven wind turbine with a rotor diameter of 5.5m mounted on a 15m tower. 	Estimated energy yield per year[4]	43,100 kWh	43,100 kWh
	Estimated annual savings from displaced power @ 12.9p per kWh	£556	£556
	Estimated annual exported power @ 5p per kWh	£1,940	£1,940
	Potential value of FIT @ 23p per kWh	£9,913	Nil
	Potential value of ROC @ 9p per kWh	Nil	£3,879
	Total annual saving	**£12,409**	**£6,375**
	Total annual CO2 saving	**18.5 tonnes**	**18.5 tonnes**

The calculation assumes that 10% of the total generation is used on site and 90% is exported. Savings are calculated based on an electricity tariff of 12.9p per kWh and an export tariff of 5p per kwh. Carbon dioxide emissions are calculated using a CO_2 emissions factor of 0.43kgCO_2/kWh.

This system will cost £151 per tonne of displaced CO_2 over the system's assumed life of 20 years. This is less than the benchmark of £345 per tonne CO_2 and is therefore within the guidelines for CSEP capital funding.

The wind turbine will require a simple annual service by a specialist contractor, consisting of lowering the tower and checking the security of the bolts.

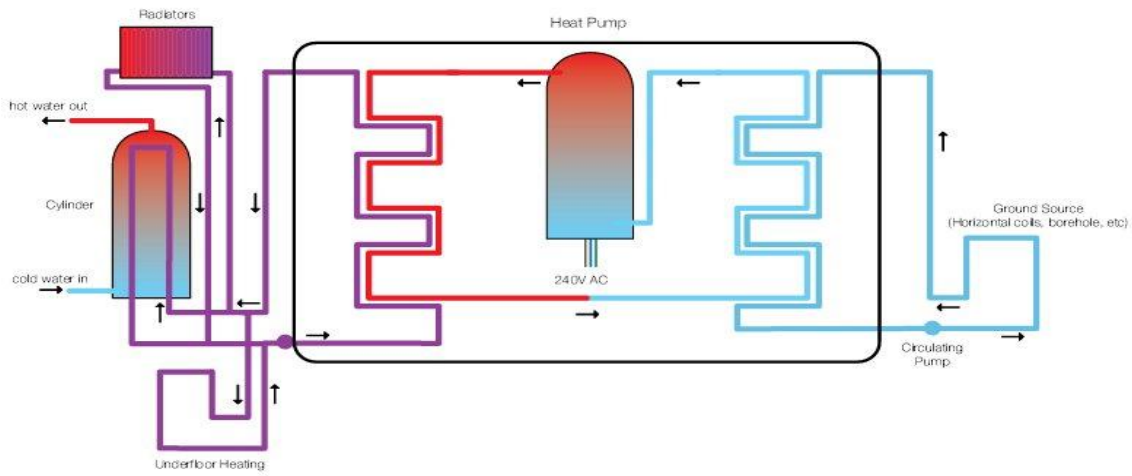
The inverter is an item of complex electronics and could fail after 10 to 15 years. To replace the inverter at today's cost would be between £3,000 – £8,000 depending on the size of turbine installed.

[4] Annual energy yield calculated using the Proven Energy Calculator. Annual energy yield calculated using the Proven Energy Calculator. The yield is dependent on estimates of site wind resource which have a degree of uncertainty at this stage of the project as no wind monitoring has been undertaken at the site.

An energy display near the main entrance will be installed to show hall visitors and users how the system is performing.

9.2 Ground Source Heat Pump

Heat pumps use the refrigeration cycle to transfer heat from a source (such as the ground, the ambient air or water) through a heat distribution circuit to an internal space. Heat pumps are like a refrigerator in reverse. A refrigerator removes heat from the icebox making it colder and discards the heat which has been removed as waste into the kitchen. The device is called a heat pump because it takes heat from a low-grade source, a cold place and converts it into a higher-grade form by releasing it into a warmer place. The basic components of a heat pump are shown in the figure below:



The technology in heat pumps is essentially the same whether the heat source is from the ground, the water or the air. However, as there is an inherent difference in temperature stability between these sources the overall efficiency (commonly described as the coefficient of performance – COP) will tend to vary.

With a ground source heat pump (GSHP) system the earth absorbs a large proportion of the solar radiation that in the UK helps to ensure that the ground stays at a relatively stable 10-12^{o}C all year round. Air source heat pump systems (ASHP) cannot offer the same year round efficiencies since the ambient temperature is far more variable. Efficiencies will drop off as the ambient temperature falls just when there is a demand for heat. Water sourced systems potentially offer the best efficiencies.

The efficiency of a heat pump decreases as the required water temperature increases. Therefore, if the building's heat distribution system can be designed to effectively use water at only 35-40^{o}C then the COP will be significantly better than one that needs to heat the water to 55^{o}C. This is the reason why under floor heating is so desirable when connected to a heat pump: it only needs to be warm to heat the building compared to conventional radiators that require flow temperatures well over 55^{o}C. This is also why it is better to install heat pumps in well-insulated buildings. In a well insulated building the water temperature for the under floor heating might be only 35^{o}C resulting in a COP of

3.2. However, in a building not so well insulated it might be 55°C resulting in a lower COP of only 2.25.

Suitability of a GSHP at Hawkesbury Village Hall

A ground source heat pump (GSHP) collects the ambient heat from the ground using either boreholes (50-100m deep) or trenches (1.5-2 m deep and at least 3 meters apart). To drill vertical boreholes is however very expensive (drilling rigs are costly to hire and it takes time to carry out the drill). There are also uncertainties attached to drilling that are not easy to identify beforehand, for example, the ground may be difficult to drill, the thermal properties of the ground may alter with depth and the level of the water table may introduce complications. Because of this provided there is enough spare land available adjacent to the building the preferred option for the ground collector is to use shallow trenches.

To keep capital costs down a GSHP system is typically sized to provide around 70% of the maximum heat load for the building. This should cover approximately 95% of the annual heating load with the difference supplied using an electric online heater. Therefore, if these design guidelines are applied to the estimated maximum heat load of 36kW (assuming the insulation improvements are carried out) a 26kW heat pump should be big enough to provide most of the required space heating. This will need to be increased slightly (i.e. to around 30kW) if the system is to provide domestic hot water too. This will require a collector length of around 1,600m which would need around 1,000m^2 of land to accommodate the trenching. Fortunately, the village hall owns the large recreation ground at the back of the building which could easily be used to accommodate this.

To compensate for the lower flow temperature the existing radiators would need to be replaced with larger radiators (typically 50% bigger). Under floor heating would be preferred but isn't practical as it would be too expensive and disruptive to do.

The heat pump would need a buffer tank to prevent the heat pump cycling; this would need to be approximately 200 litres in size.

We have estimated below what the indicative capital costs might be for such a system (including trenching costs) to provide space heating and hot water:

	Indicative Capital Cost
30kW GSHP	£14,000
Ground collector (1,600m circuit)	£20,000
Installation and commissioning cost	£4,000
Total Cost	**£38,000**

The total cost excludes the cost of replacing the existing radiators which is a non eligible cost for CSEP. We estimate that this is likely to cost between £3,000 and £4,000 and would be meet from hall funds.

Estimated annual running costs and CO_2 emissions for a GSHP system and the savings compared with the existing system are shown in the table below. The annual running costs shown are calculated on the current electricity tariff of 12.9p per kWh. The calculations use the SAP 2005 COP for GSHP systems with radiators.

	Village Hall (with insulation improvements)
Energy input p.a.	18,430 kWh
Energy output p.a.	41,468 kWh
Coefficient of Performance (from SAP2005)	225%
Electricity cost p.a.	£2,377 @ 12.9 p/kWh
CO_2 emissions p.a.	7.9 tonnes

A ground source heat pump should provide approximately 23,040kWh of free heat energy which will reduce CO_2 emissions significantly by around 8.2 tonnes a year. The running costs for the GSHP option will be approximately £300 more than running the existing oil boiler at an oil price of 35p per litre. However, looking forward we believe that the price of fuel oil is likely to increase at a faster rate than electricity and therefore a GSHP should provide us with a hedge against this risk.

The GSHP system will cost £240 per tonne of displaced CO_2 over the systems assumed life of 20 years which is less than the published benchmark of £460 per tonne and is therefore within the guidelines for CSEP capital funding.

10. SUSTAINABILITY

Hawkesbury Village Hall Committee is committed to protecting and actively promoting the improvement of the local environment. Environmental priorities are integrated into the decisions it takes on all its services. For example, measurers have been adopted to avoid waste and to encourage the re-use and recycling of materials. We also encourage those using the hall to walk, cycle or use public transport rather than drive.

Energy conservation is another important area that the committee is keen to promote. This project development study has investigated areas where energy is currently wasted and actions that can be taken to ensure that the energy used causes the least environmental impact. The hall committee are now keen to successfully realise these recommendations; not only will the renewable technologies reduce CO_2 emissions but they will also inspire and encourage staff, volunteers and visitors to do likewise in their own lives.

11. BUILDING INTEGRATION

11.1 Wind Turbine

The wind turbine will be located near to the northern perimeter of the recreation ground. The location is identified in the image below. The inverters will be installed near to the village hall distribution board. The cable run between the inverter and turbine will be around 150m. The turbine will consist of 3 rotor blades with a diameter of 9m providing 15.0 kW power. The system will be mounted on a 15m turbine tower that is fixed on a concrete base.

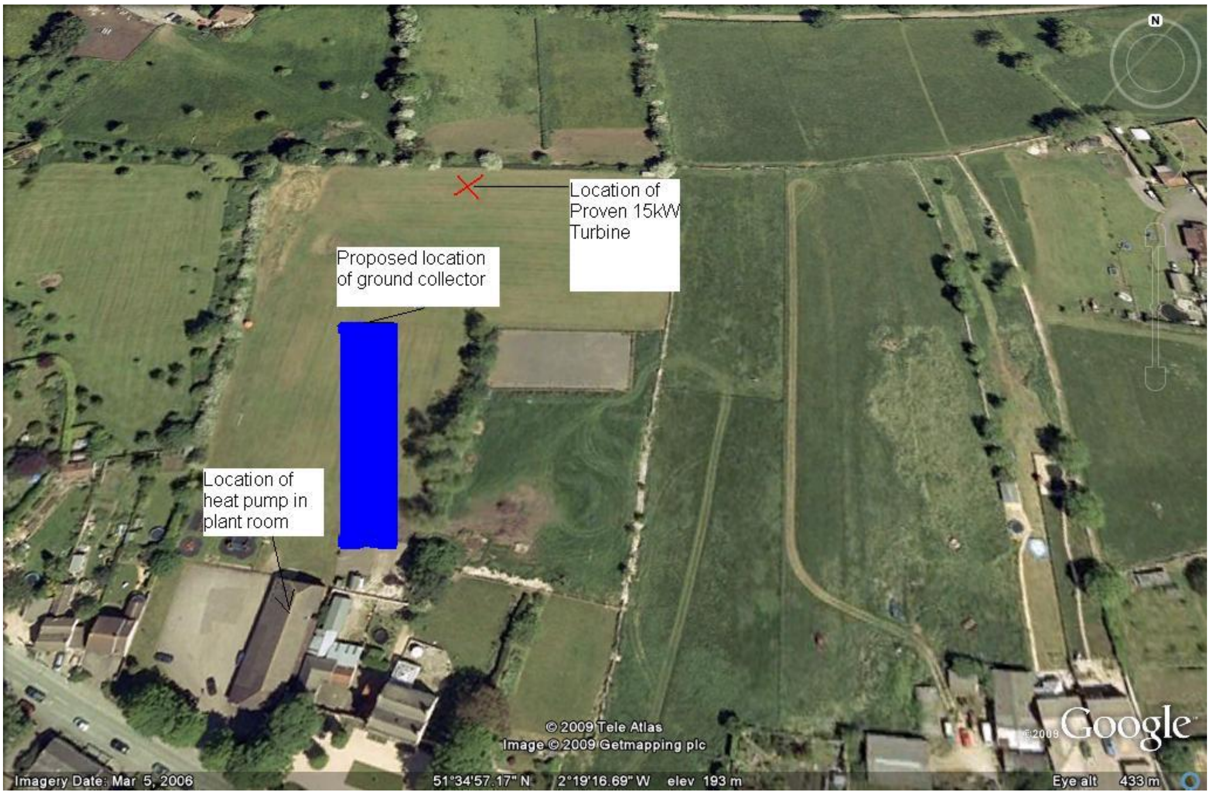


Figure: Location of proposed wind turbine and GSHP system

11.2 Ground Source Heat Pump

The ground source heat pump, buffer tank and DHW cylinder will be located in the existing plant room (the existing oil boiler and DHW cylinder will be decommissioned and removed).

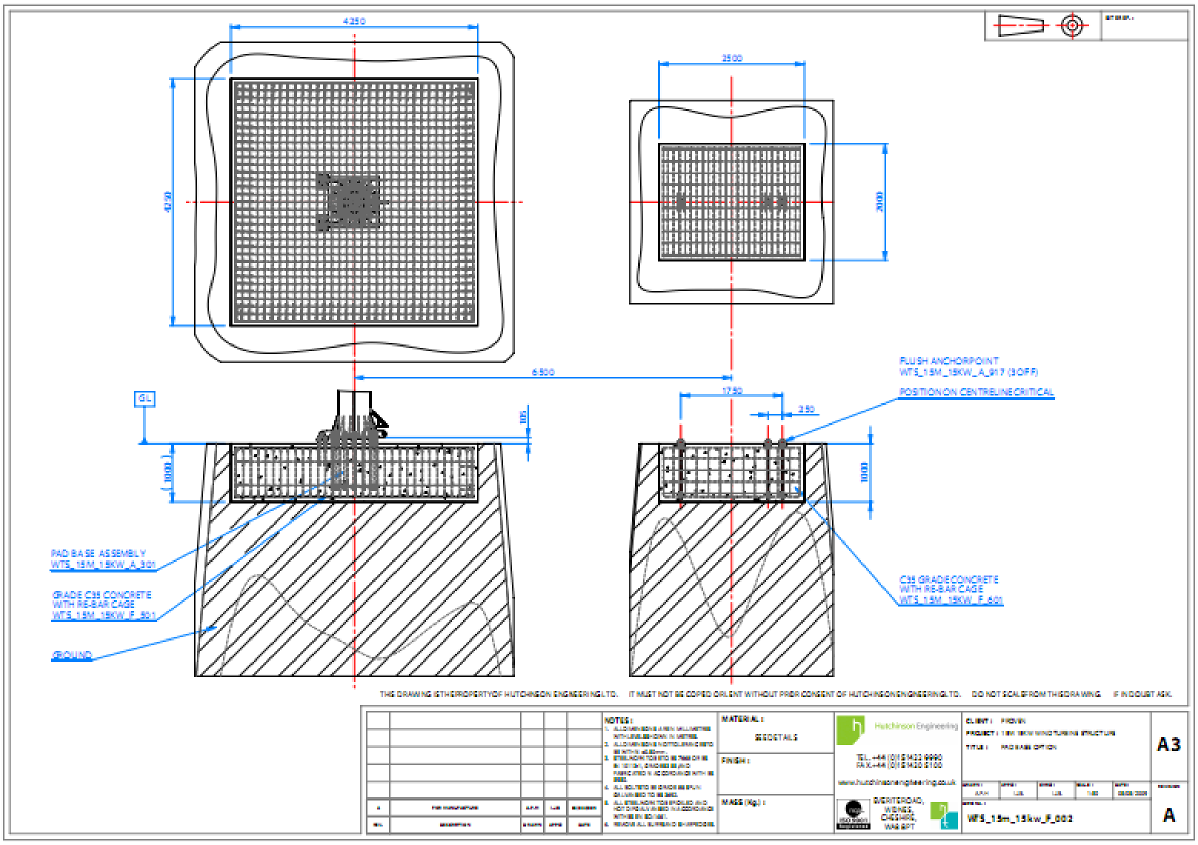
The manifold will be housed in a manhole situated outside the hall building. Flow and return pipework will be fitted from the manifold to the existing plant room. The proposed location of the ground heat exchanger will be the recreation ground immediately behind the village hall - see image above.

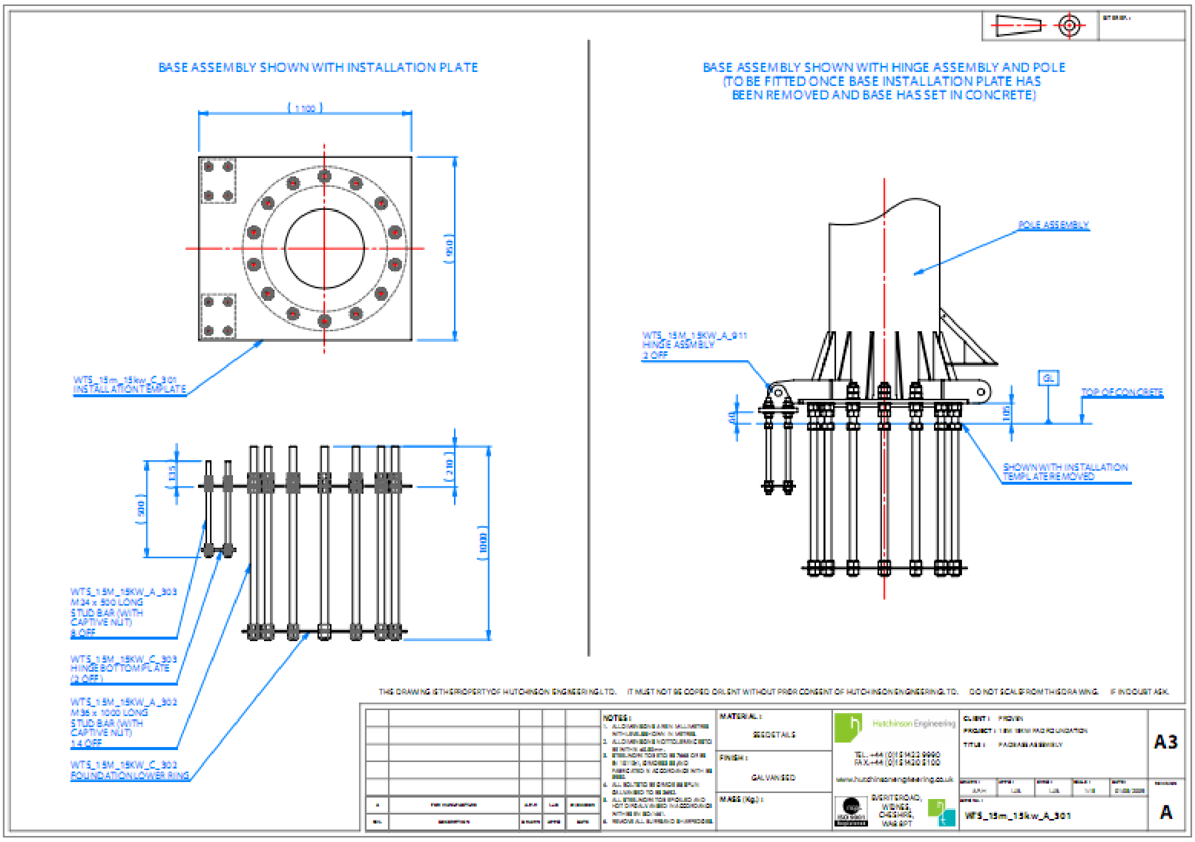
12. STRUCTURAL DESIGN

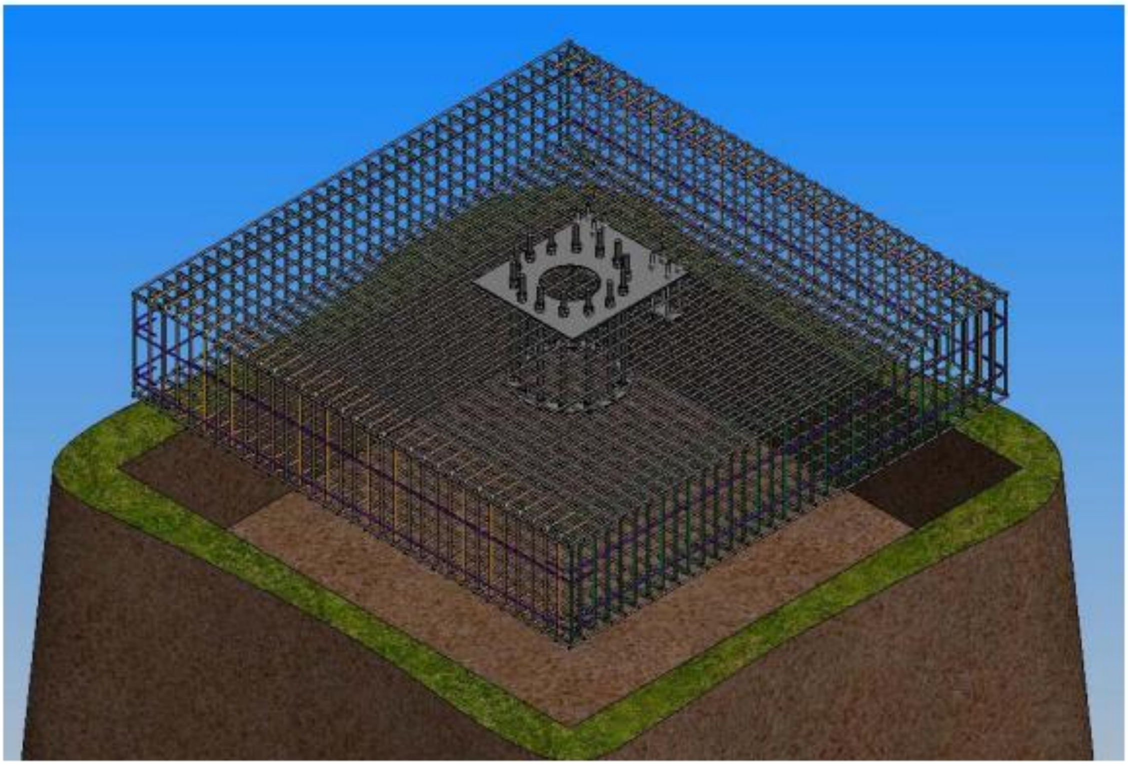
12.1 Wind Turbine

The wind turbine is to be fixed onto an approved galvanised steel tower of 15m height. The rotor diameter of the turbine is 9.0m. The tilt-up self supporting wind turbine mast will be fixed using a pad type concrete foundation 4.25m x 4.25m x 1m deep. This consists of a lower foundation ring an upper installation template 2 x hinge plates and M36 x 1m long stud bars. For the installation and also during maintenance procedures, a further foundation concrete block of 2.5m x 2.0m x 1.0m is required to provide and anchor point for the winch. This winch will allow the raising and lowering of the tower.

Engineering drawings detailing the pad foundation for this type of turbine are shown below:







Pad base wired to rebar cage in correct position, and lowered into 4250 x 4250 x 1000 hole. Assembly to be levelled prior to the concrete pour.

The Windy Boy grid connected inverters will be located near to the distribution board in the village hall. The cable run from the turbine to the inverters will be approximately 150m.

12.1 Ground Source Heat Pump

A schematic showing the system layout will be included in the project development study supplied for the capital grant application once a final decision has been made on which product to install.

13. ELECTRICAL SCHEMATICS

13.1 Wind Turbine

The Proven 15/300 is specially designed for connection to LV network at 230Vac 50Hz nominal by means of a SMA WB6000 Windy Boy grid connect inverter.

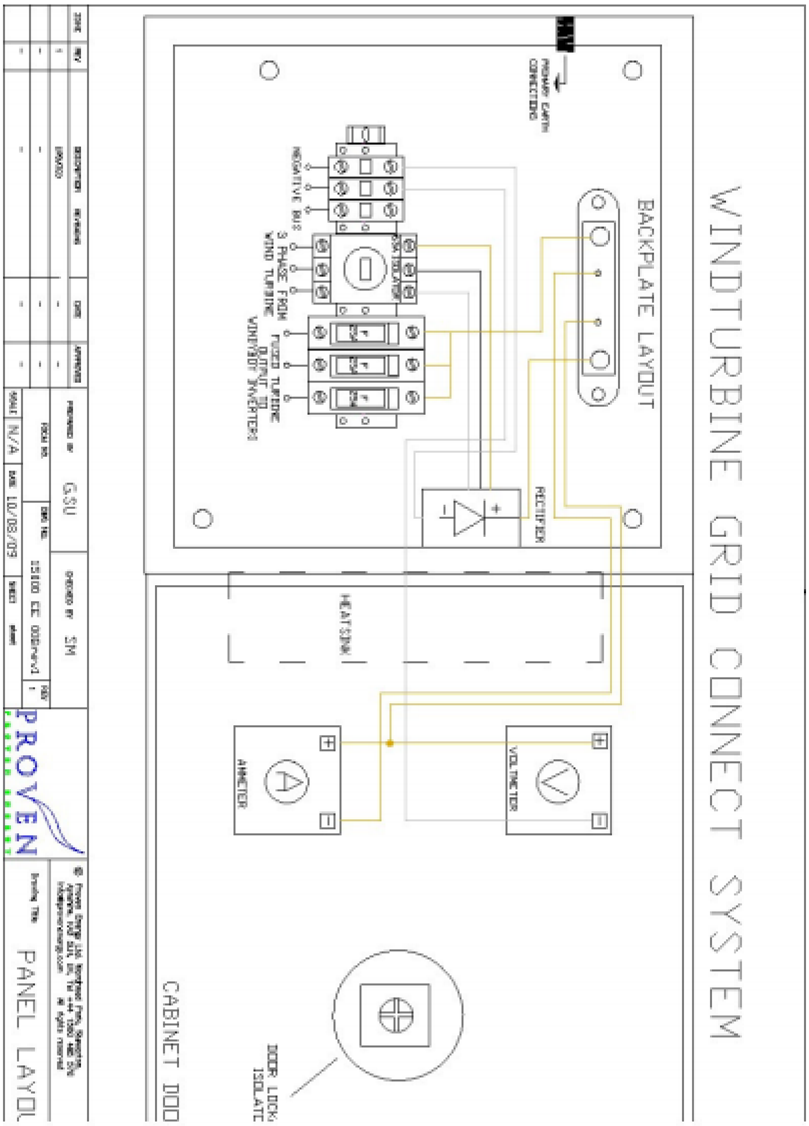
The main electrical elements are:

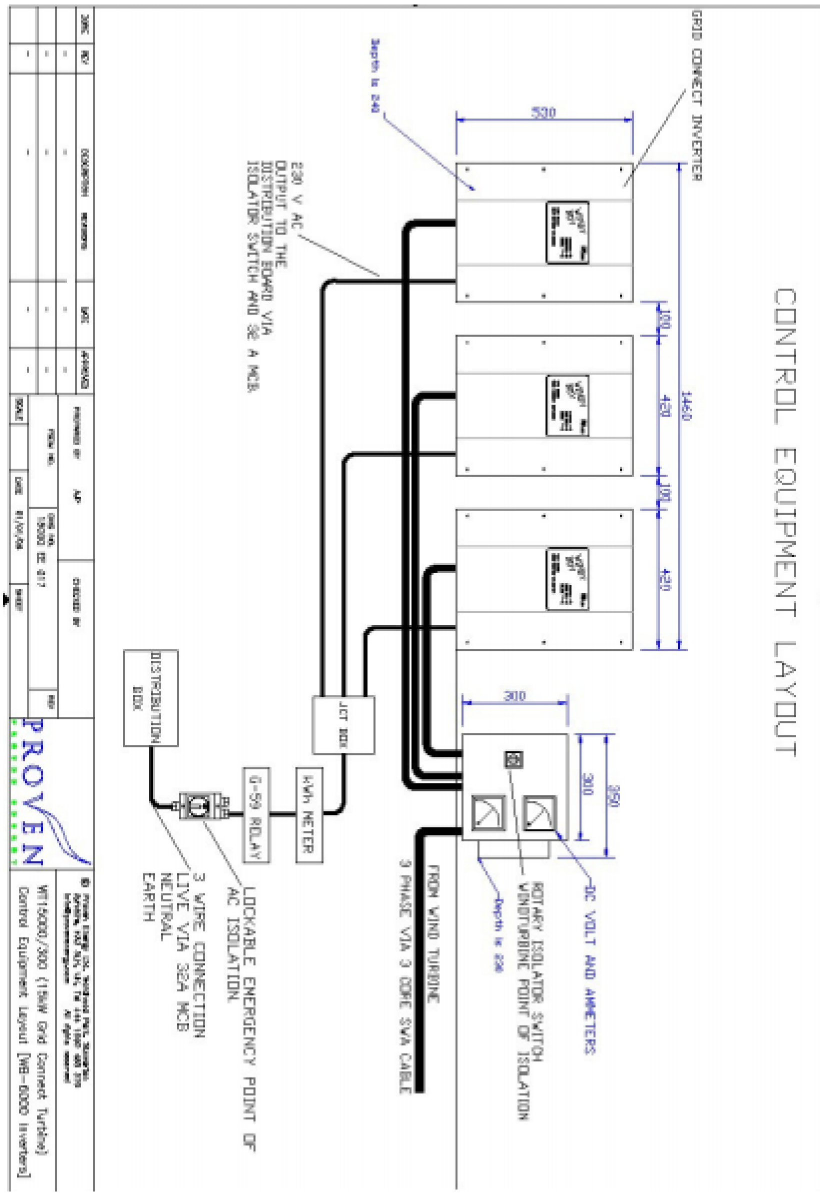
- Proven 15 wind turbine containing GW15000 3-phase AC synchronous.
- Proven grid connect inverter & controller package comprising:
    - DC Disconnect – allowing the turbine to be isolated from the grid connect inverters.
    - ECM15004ME/300 controller which displays turbine voltage and current, rectifies AC input from the turbine and outputs DC power to the grid connect inverters.
    - 3 x WB6000 6kW SMA Windy Boy grid connect inverters of the self commutating static type.

- AC Disconnect Lockable – allowing the grid to be securely isolated from the inverter(s).

All electrical wiring will be carried in accordance with the Energy Saving Trust publication CE72 – 'Installing small wind – powered electricity generating systems' and BS7671 – ' IEE Wiring Regulations for Electrical Installations'.

Schematic drawings for the Proven 15kWshowing the panel and control equipment layout are below.


WINDTURBINE GRID CONNECT SYSTEM
BACKPLATE LAYOUT
RECTIFIER
HEATSINK
AMMETER
VOLTMETER
NEGATIVE BUS
3 PHASE FROM WIND TURBINE
PROVEN
G.SU
SM
N/A
10/08/09



13.2 Ground Source Heat Pump

The building has a three phase supply.

An electrical schematic will be provided once the final choice of heat pump has been made.

14. PROJECT TEAM

The main team members who will oversee the successful implementation of the project are:

Project Management

The overall project will be managed by the Hawkesbury Village Hall Energy Group with the Chairman Angelo Sauro taking day to day responsibility for managing the installation works.

Installers

The installation of the wind turbine and ground source heating system will be carried out by Micogeneration Certified Scheme (MCS) certified installers. These are to be confirmed.

Technical advice and support

The Village Hall Management Committee will consult Encraft Ltd - a local low carbon technology consultancy – for any additional technical advice or support that maybe required. www.encraft.co.uk

15. LEGAL ISSUES

The project is to be managed and owned by Hawkesbury Village Hall with advice from Encraft Ltd.

The village hall is not a listed building, neither is it in a conservation area.

The building and surrounding land/recreation ground are owned by the Village Hall.

The Proven 15kW wind turbine system will be generating more than 16 amps per phase and therefore will need to comply with Engineering Recommendation G59/1 (although this will be at the discretion of the Distribution Network Operator (DNO)). If the system is deeded to require a G-59/1 application then it will be the responsibility of the installer to complete the necessary paperwork and panel testing.

16. UNCERTAINTIES

Hawkesbury Upton Village Hall is applying for funding from the Low Carbon Building Programme Phase 2 in addition to the CSEP to fund the installations of the ground source heat pump and the wind turbine. In addition, the committee will also be submitting an application for additional funding from the E.ON Sustainable Energy Fund. The fund is available to community groups, charities and not for profit organisations across England, Scotland and Wales and provides grants of up to £20,000. Non eligible costs (for example, replacing radiators) will be paid for from hall funds.

Planning consent will be required for the wind turbine and ground source heat pump system. An application is now being assembled and will be submitted shortly.

Hawkesbury is in an Area of Outstanding Natural Beauty (AONB) so planning permission will be more problematic to obtain. Small scale turbines have been permitted within AONBs provided that the applicant can prove that the visual impact of the development is minimal and that the natural beauty of the AONB will be conserved.

South Gloucestershire Council is very keen to support the adoption of sensitively planned small scale renewable energy systems and therefore the committee is confident that the application will be successful.

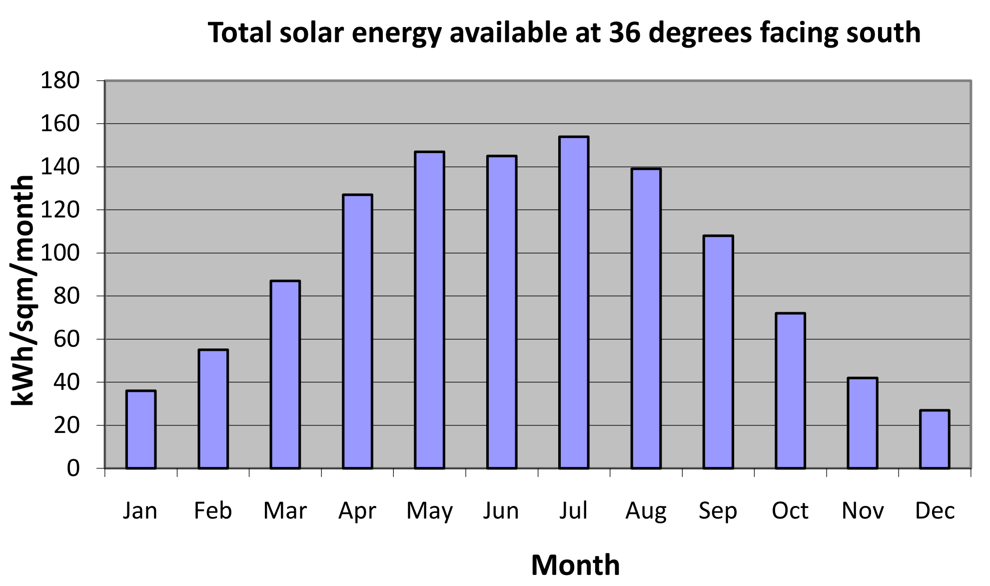
APPENDIX I: RENEWABLE RESOURCES

The table below shows the total annual renewable resources anticipated in a typical year. Data is taken from EU and DTI databases.

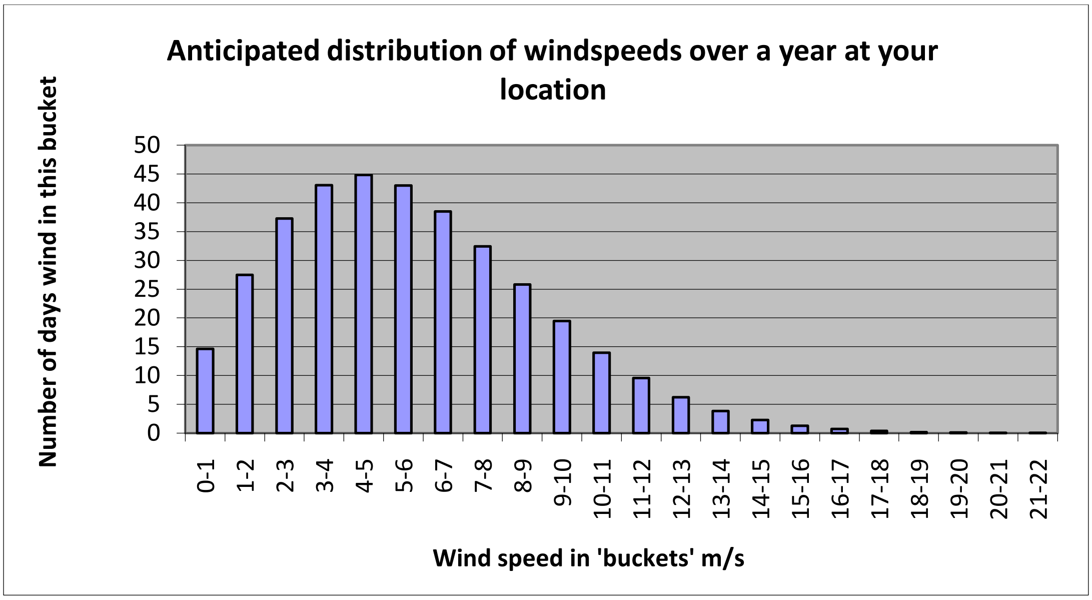
Solar energy (insolation)	1,139	kWh/m^2 at 36 degrees inclination from the horizontal
Average wind speed	6.2	m/s over a full year at 10m above ground level

Variation in renewable energy resources

The charts below show the expected variation in solar radiation and wind speed at this location over a year.



Source: European Union Joint Research



Variation in wind energy

Note that wind speed is somewhat less predictable than sunlight, and the *average* wind speed may also vary by +/-25% from year to year at the same location. The energy available in the wind is also severely limited by local obstacles, such as houses and trees.

APPENDIX II: OTHER OPTIONS CONSIDERED

Biomass Heating

Suitability of Biomass Heating at Hawkesbury Village Hall

Potentially biomass can be very well suited for a community building. Whether it is possible depends on a number of issues. Some of the key ones are listed below:

- Is there enough space for the boiler and an adequately sized fuel store?
- Is there access for delivery vehicles?
- What is the ability to source chips or pellets locally at a cost effective price?
- What level of automation would be necessary?

The existing boiler room is too small to accommodate a biomass boiler and fuel store and therefore an external plant room would be required. This could either be a new building constructed for this specific purpose or you could install a containerised boiler house with an integrated woodchip/wood pellet store.

If the recommended insulation measurers are carried out then for a chip boiler we estimate that to heat the hall would require about 15.5 tonnes of wood chip per year. This would need a fuel store with a capacity of between 22m^3 and 24m^3 (based on 4 fuel deliveries per year). Deliveries of wood chip are generally undertaken by tipping lorries where the chips are tipped straight into the fuel store or silo. This wouldn't be a problem provided the fuel store is located on the edge of the car park.

We have estimated below what the indicative capital costs might be for such a system to provide space heating and hot water:

	Indicative Capital Cost
36 kW wood chip boiler	£7,000
External flue	£3,000
Controls, accumulator tank and other equipment	£6,000
Installation and commissioning	£5,500
Containerised boiler house and fuel store	£10,000
Total Indicative Cost	**£31,500**

The annual running costs associated with the proposed wood chip boiler system for space heating are as follows:-

	Community Hall (with insulation improvements)
Energy input p.a.	51,961 kWh
Energy output p.a.	41,569 kWh
System efficiency	80%
Wood chip cost p.a.	£1,086 @ £70 per tonne
CO_2 p.a.	1.3 tonne
Fuel required p.a.	15.5 tonnes
Storage volume p.a.	77 m^3

A wood pellet heating system would need around 9.8 tonnes of pellets and therefore a smaller capacity fuel store with a volume of about 5m^3 (based on 4 deliveries each year).

We have estimated below what the indicative capital costs might be for such a system (including trenching costs) to provide space heating and hot water. These costs are before any available grants are applied.

	Capital Cost
36 kW pellet boiler	£9,000
External flue	£3,000
Controls, accumulator tank and other equipment	£6,000
Installation and commissioning	£5,500
Containerised boiler house and fuel store	£10,000
Total Indicative Cost	**£33,500**

The estimated annual running costs associated with the proposed wood pellet boiler system are as follows:-

	Community Hall (with insulation improvements)
Energy input p.a.	46,187 kWh
Energy output p.a.	41,569 kWh

System efficiency	90%
Pellet cost p.a.	£1,957 @ £200 per tonne
CO_2 p.a.	1.0 tonne
Fuel required p.a.	9.8 tonnes
Storage volume p.a.	15.0 m^3

Solar Hot Water Heating

Suitability of Solar Water Heating at Hawkesbury Village Hall

Solar thermal water heating is suited for buildings with a consistent hot water load throughout the summer months. The community hall does not have a large hot water requirement. The main need is in wash room(s) and in the kitchen(s) where only small volumes of hot water are required during operational hours.

For this reason we do not believe that a solar hot water system would be suitable.

Solar PV

Suitability of Solar PV at Hawkesbury Village Hall

Solar PV is a very popular technology choice for community buildings. It is reliable, with a predictable generation profile that involves little maintenance and can be an excellent community educational resource.

Whether a building is suitable or not and what size of PV system to fit will depend on several key factors. These include (i) the area of suitable roof you have available (ii) whether the building has a three phase electrical supply (iii) the electrical base load of the building and (iv) the size of budget you have to invest.

Unfortunately, the small area of south facing roof on the hall is heavily shaded by a number of mature trees. This would significantly reduce the performance of a PV system should you install it here and is therefore not recommended.

It would be possible install a PV system on the north end of either the west or east facing roof which are reasonable shade free. The output though would be around 20% less compared with the same system on a south roof.

Fitting solar PV onto non domestic buildings would require planning permission. Locating the system at the back of the building would ensure that it isn't visible from the road and therefore negate any doubts over visual intrusion that planners may have.

The table below summarises the budget economics for a 3.9kWp system, these costs are before any available grants are applied.

		With ROC support	With FIT support	CO_2 p.a.
3.9kWp solar PV system covering 31m^2 of roof space	Capital cost of system	£22,000	£22,000	
	Estimated annual generation	2,800 kWh	2,800 kWh	
	Estimated annual savings from displaced power	£253	£253	0.85 tonnes
	Estimated annual exported power	£42	£42	0.35 tonnes
	Potential value of FIT at 36.5p per kWh	N/A	£1,022	
	Potential value of ROC at 9p per kWh	£252	N/A	
	Total annual saving	£547	£1,317	1.20 tonnes

The calculation assumes that 70% of the total generation is used on site and 30% is exported. Savings are calculated on your electricity tariff of 12.9p per kWh. Carbon dioxide emissions are calculated using a CO_2 emissions factor of 0.43kgCO_2/kWh. The output assumes the panels are south facing and at a tilt angle of 45°.

Because of its lack of moving parts and simple connections a PV system generally requires little maintenance. To avoid any loss in performance the panels should be cleaned periodically to remove any build up of dirt (or bird droppings). However, provided the panels are at a tilt greater than 5% to the horizontal rain should keep the modules clean.

Most solar modules have a design lifetime of around 30-40 years. PV modules of all types usually have a performance warranty of 25 years. After this time the products would be expected to continue to function, but power output may be reduced. These times are only a rough guide and should be checked for each specific product.