Renewable Energy Manufacturing Opportunities For Camborne, Pool & Redruth

Final Report

Paper prepared on behalf of Cornwall Sustainable Energy Partnership, funded through Local Area Agreement (LAA) funding and Combined Universities in Cornwall (CUC) Business Support Programme

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1: Executive Summary:

This report investigates the potential to set up a renewable energy manufacturing base within the Camborne, Pool and Redruth (CPR) area. The study has involved analysing existing CPR businesses, and exploring their current product and services skill sets, to see if they could be transferred to the renewable manufacturing industry. Different technologies have been investigated, to find which would be most suited to being manufactured in the CPR area.

The report has shown that Ground Source Heat Pumps (GSHP), Solar Hot Water Panels and Micro Wind turbines may be most suited to the area. The rationale behind this conclusion is found in Fig 10, on page 23. The main reason for recommending these three technologies is:

- They are small scale, therefore suited to local manufacturing clusters.
- Some or all components can be sourced locally, therefore supporting local regeneration objectives.
- Some or all of the skills needed are available locally.
- There is a good/growing market for these technologies.

Component sourcing and final assembly could both be undertaken within the CPR region. GSHP and Solar Collectors will face competition from existing companies, but are proven technology. Micro wind turbines on the other hand, are an emerging technology so there are risks in design, yet there is more potential and interest in the technology.

Although the manufacture of biomass boilers is not currently suited, due to a low demand for these systems in the UK, biomass still has an opportunity within Cornwall, in the form of liquid bio fuels. If crops were grown in the area and a bio diesel refinery installed, there is a large opportunity for Cornwall to be one of the UK leaders in environmentally friendly fuels.

Micro CHP, wave and tidal stream technologies are still largely in the R&D stage, but in the near future they could offer potential for significant development in the local area. It would be in Cornwall's interest to invest in development of wave and tidal energy harnessing devices in particular, as the county has enormous potential for utilising these resources. These provide R&D opportunities for the Combined Universities in Cornwall (CUC).

2: Introduction

2.1: CPR Regeneration:

One of twenty two urban regeneration companies within the UK, CPR Regeneration is a company dedicated to regenerating the areas of Camborne, Pool and Redruth to restore its reputation as an area of innovation, wealth and quality of life.

The CPR area was once one of the richest and successful areas within the UK, thanks to its local engineering and mining Industries. The evidence can be seen with the remnants of the old mining lifestyle and large old Cornish houses, which once would have been admired, now have trouble being heated and aren't as popular as they once where.

Sadly with the downfall of mining over the last 100 years the area has become neglected, but CPR Regeneration aims to combat this. Its aim is to ensure sustainable regeneration including a range of affordable new homes, greater employment opportunities, leisure & community facilities and an improved environment.

Set up in November 2002, CPR Regeneration is funded through Cornwall County Council (CCC), English Partnerships, Kerrier District Council and the South West Regional Development Agency (SWRDA). It aims to achieve its goals through projects involving the public/private sectors and community/voluntary groups.

It is hoped CPR Regeneration will encourage local clusters of sustainable energy industries to develop, add to CPR/Cornwall's reputation as a centre of sustainable expertise and aid CPR into becoming a more sustainable community. These will all aid in bringing wealth and people back into the area.

2.2: Cornwall Sustainable Energy Partnership (CSEP):

CSEP is a partnership focusing on a sustainable energy future for Cornwall and the Isles of Scilly, through integrating sustainable energy into the public, private and community sectors. Since its establishment in November 2001 CSEP has created, assisted and delivered projects that address the energy needs of Cornwall. Part of this is to aid Cornish organisations in meeting the Energy Strategy for Cornwall, Action Today for a Sustainable Tomorrow, currently signed by 72 different public and private organisations.

CSEP is managed by Community Energy Plus (CEP), a charity organisation working with local authorities in Cornwall and other organisations to encourage the sustainable use and provision of energy as a means of addressing climate change, energy security and the elimination of fuel poverty. CEP also manages the Cornwall Energy Efficiency Advice Centre, the Cornwall Community

Renewables Initiative, the Cornwall Envision business advice programme and the Home Health Programme.

3: CPR Area Renewable Energy Industry & Skills Survey:

3.1: Introduction:

CPR Regeneration and CSEP have a joint vision in developing the CPR area into an exemplar energy generating and sustainable energy community. This includes an ambition to realise the economic and employment benefits of sustainable energy by facilitating the development of local clusters of renewable energy manufacturing, supply, installation, knowledge and service businesses.

3.2: Scope of Report

The scope of this report is purely for manufacturing renewable technologies. This means installing, fuel production, etc are not covered. The report focuses on what can currently be manufactured using local existing businesses, and although may suggest for possible future technologies which could be developed, it will focus on developed technology.

The scale of manufacturing which this report deems suitable for renewable energy clusters are small to medium scale; large/industrial scale manufacturing of renewable technologies will be discounted. This is because large industrial processes may not be compatible with other regeneration plans, such as tourism and housing.

3.3: Method of Report:

The focus of this study is to assess the potential to set up a renewable energy manufacturing base. In order to set this up, there needs to be the skills and manufacturing facilities present, or if not they need to be identified so they can be set up. Once these are present, a manufacturing chain can be set up:

Component Manufacturing → Component Supply → Assembly (→ Distributor)

Not all technologies may be suitable for the manufacturing industry, such as those which are still in the research and development (R&D) stage and those which are designed individually for their circumstance (tending to be larger projects).

Those that are being manufactured must be broken down into the components in order to identify which manufacturing/supply companies are needed. Once the components have been identified, relevant local manufacturers/suppliers can be contacted in order to see if they currently, or would move in to, producing/supplying the specified parts.

Not all parts may be available locally, but if there was a market for the parts, i.e. if a renewable technology was manufactured here, there would be a market for them. For some components they may have to be ordered in, but the more local industry which can be used, the greater the regeneration effect.

Once the components and manufacturing processes have been identified the skills which are needed can be identified, and compared with local skills in the area to see if the technology fits in to the local labour skills.

The production of this report will hopefully suggest which technologies are suited in the area, the reasons why and what methods could be taken to encourage the development of renewable manufacturing industry. The partners could use these findings to encourage companies to seriously consider creating a manufacturing base in the area.

3.4: Businesses In The CPR Area:

The following are observations which have been drawn by 2 local business reports; CPR Business Survey 2006 and the Kerrier Business Survey 2005 (see appendixes). Between the 2 reports, they provide accurate views of local businesses.

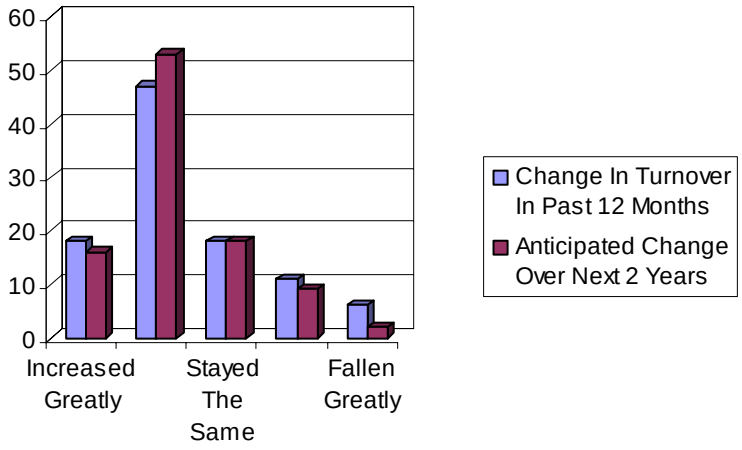


Fig 1: Changes in Turnover of Kerrier Companies

As can be seen from the above graph, growth in Kerrier company turnover is increasing and is expecting to keep on this trend. This makes it an attractive area for businesses, especially where a new niche can be found as this avoids competition. This may be partly due to the work of CPR Regeneration projects.

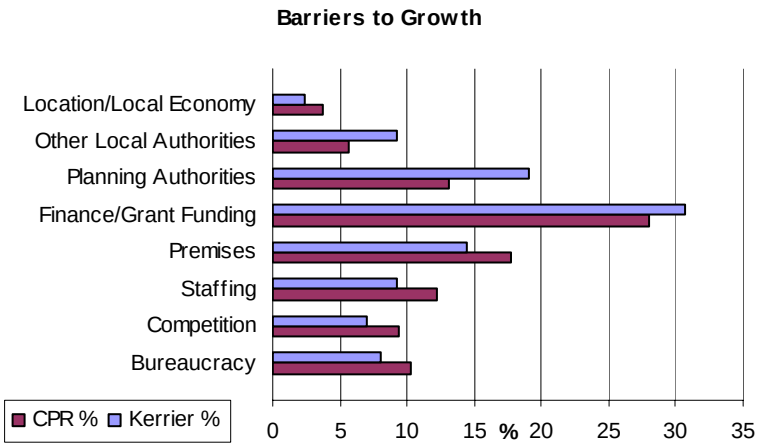


Fig 2: Graph showing barriers to growth in Kerrier

Above is a graph showing the different reported barriers to growth of companies both in the CPR area and Kerrier as a whole. Compared to issues facing renewable technology growth, there are several differences. Direct manufacturing barriers are:

- Renewable manufacturers will have smaller competition, though it will still be existent in certain areas from larger/multi-national companies. For instance, many renewable heating systems are likely to be invested in and developed by existing large heating/boiler companies.
- Though local authorities will be keen for a renewable manufacturing company, planning difficulties vary for different technologies. Certain technologies, currently solar, gain planning permission more easily, and in some areas it is not needed at all. This is because it can be incorporated into buildings without changing the roof line/colour, as set out in PPS22. CSEP's planning group are discussing setting a higher RE target than the 10%, which would aid the local renewable energy sector.
- Premises would hopefully not be such an issue for renewable manufacturing, as sites could be out of town – for instance a RE cluster at Tolvaddon Energy Park. They may need special facilities
- Finance/Grant Funding is certainly one of the major aspects in the renewable industry, as most technologies are an expensive investment. There are several grants available for installations, though funding towards manufacturing renewables is harder to secure.
- One of the major CPR difficulties is staffing. Companies have reported trouble in staffing; getting the right person for the right job, even for the simple tasks. There are still problems of unemployment in the area. These two issues could be solved through training initiatives, particularly relevant in the renewable industry as most workers will need some sort of training/education.

Market barriers which may affect renewable energy manufacturer are:

- There is a lot more bureaucracy surrounding the installation of renewable technologies, which has an indirect yet significant effect on manufacturers.
- The location/local economy will have a similar proportion of growth limitation as other businesses, but there is also the issue of NIMBY (Not In My Back Yard), which affects renewable installations and hence local demand. Thankfully renewable technologies are more popular in Cornwall than many other parts of the country.

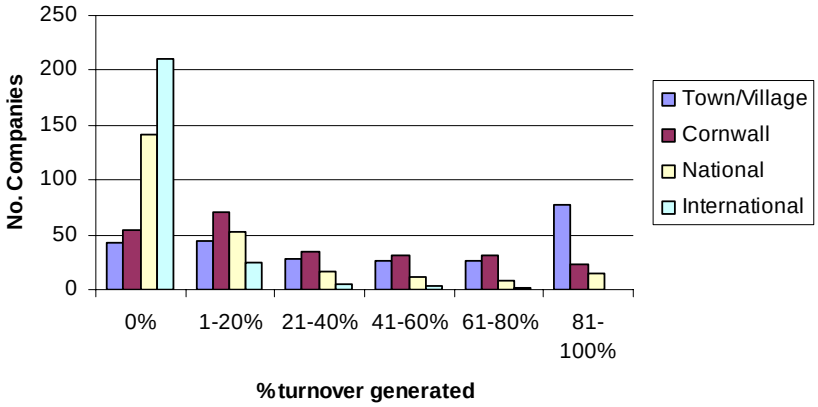


Fig 3: Graph showing turnover generated in the different market areas of Kerrier companies

The above graph shows where CPR companies trade, by showing the turnover in different areas. As shown, the largest profits are made in and around the local area. For a renewable manufacturer, there would be a much greater national and international market, as the overall renewable market is relatively small.

However, in order for a renewable manufacturer to compete internationally where labour and materials can be cheaper, the product could compete by offering different benefits. British engineering and parts could be promoted, as this would be seen as a quality product which would last. Some people are also more likely to buy local products over imports, in order to help local people.

This would give renewable manufacturers a balanced market to which they sell to. There would still be a Cornish trade, as there are a number of renewable installers and the Cornish have a good understanding of renewable energy. CSEP also aids this and other aspects of renewable energy public relations through its initiatives.

3.5: The Renewable Energy Sector:

Renewable energy is energy from a sustainable source. Having been exploited for hundreds, if not thousands of years, renewable energy is being looked to as a

way of meeting increasing demand for cleaner energy. The industry is still very much in development, yet technologies are often based on old designs. Modern wind turbines are not very different from the windmills that were used to grind grain, and not for the first time solar gain is being incorporated into building design.

Renewable technologies are being developed together with other environmentally conscious technologies, in line with national targets. One of the most known of these is a 20% reduction below 1990 levels of carbon dioxide (CO_2) by 2020 (Kyoto agreement), and the South West's target of 30%. Other relevant targets are:

- The Renewables Obligation: 10% of electricity to be produced from renewable sources by 2010.
- The Draft Regional Spatial Strategy and the SWRE strategy set a second milestone of 20% by 2020.
- The REvision 2010 target for Cornwall is to generate between 93 and 108 MW of electricity generating capacity by 2010. For the region as a whole there is a 509-611 MW of electricity on shore, 56 MW offshore and 105 MW of heat.
- The REvision 2020 target is currently only set for the region, and is at 847 MW onshore electrical generation, 400MW offshore and 503 MW of heat from renewable technologies.
- SW Woodfuel Framework, which aims to highlight the potential of wood fuel, develop a wood fuel industry in the southwest and to increase the sustainable management of woodlands with wood fuels.
- The Regional Renewable Energy Strategy for the SW; which highlights deploying of renewable projects, developing skills and awareness, and building the southwest renewable energy industry.

Sub-Sector	Occupation	SSCs with joint responsibility
Biomass	Team Leaders, Rate of Burn Technologists, Electrical/Instrumentation Technician; mathematical modelling within IT skills	Energy & Utility Skills Lantra (supply chain) SEMTA SummitSkills
Hydroelectric	Engineers – Mechanical, Electrical and Electronic; Civil Engineers (construction); low skilled manual workers	ConstructionSkills ECITB Energy & Utility Skills SummitSkills
Photovoltaic	Electricians; Electricians with design skills	Energy & Utility Skills SummitSkills
Solar	Carpenters, Plumbers, Electricians; Electricians with design skills	ConstructionSkills Energy & Utility Skills SummitSkills
Geothermal	Electrical Engineers, Electricians; Electricians with design skills, Electronic Technicians; pipe and systems laying; mathematical modelling within IT skills	ConstructionSkills Energy & Utility Skills SummitSkills
Heat pumps	Heat Pump Installers, Plumbers, Electricians	Energy & Utility Skills SummitSkills
Wind	Service Engineers, Fabrication Engineers, Structural Engineers, Site Wardens, Installation Engineers (large scale)	AssetSkills ConstructionSkills ECITB Energy & Utility Skills SummitSkills

Source: ECOTEC summary of consultations with employers, key stakeholders and interest groups

Fig 4: Table showing Key occupations in the different RE sectors

The above table, taken from The Occupational and Functional Map of The UK Renewable Energy Sector, highlights the specific skills needed for each sector. Some of these are more specific, and would likely already be part of any company looking to manufacture in Cornwall. Others such as plumbers, electricians, manual laborers, etc, could possibly be found from the area, which would aid in the set up of a manufacturing base in the area.

4. Manufacturing RE Technologies:

4.1: Methodology:

Each of the existing renewable technologies has been looked at in detail, with analysis included in the appendixes. It was important to narrow down the number of technologies to investigate, by looking at which would be suitable for being manufactured on a small to medium scale, as these could then be incorporated into CPR renewable energy clusters.

Technologies were discounted if they were still in research and development, if they were built on a large industrial scale, or if there was little/no market due to each installation being individual. Discounted and suggested technologies are covered in the following subsections.

4.2: Technologies Still In Research & Development (R&D):

Though renewable sources have been looked at for hundreds of years for generating energy, it is only recently that this has been on a large, commercial

scale for electrical and heating generation. This means many of the renewable technologies are still in the R&D stage:

- Micro CHP: Though CHP systems have been installed and used for several years, micro CHP systems are still in development. This is because instead of primarily generating electricity like larger systems, the micro's work on primarily generating heat. For more information on this technology, please see the appendixes.
- Tidal Stream and Wave: There has been R&D into these technologies for years, due to the huge potential, especially for the UK due to high wave resources. However only one technology has begun being installed commercially; there needs to be more development before this becomes a manufacturing potential. For more information on these technologies, please see appendixes.

4.3: Technologies Specific to Their Surroundings:

Some of the renewable technologies are built specifically around the site, which use the physical properties of the area to generate energy. These technologies would be unsuitable for a manufacturing base as the market would be too small, and the company would have to act as an installer/manufacturer, instead of a pure manufacturer. These technologies are:

- Tidal Barrages: built in certain coastal areas where the surrounding geography is suitable. More details are found in the appendixes.
- Hydro Electric: runs streams of water through a turbine in order to generate electricity. Each installation is different, so manufacturers would have to work closely, if not the same company, as installers. Growth in this sector has also slowed in recent years within Cornwall and the UK as a whole.

4.3: Technologies built on a large scale:

Some technologies are built on a larger scale, which is seen as unsuitable for the CPR area. This is because high levels of industry would be unsuitable for small clusters of renewable developments. This would also clash with any plans for promoting the CPR area as a tourist attraction. These technologies are:

- Large Scale Wind: the larger wind turbines used in wind farms use specialist equipment and manufacturing techniques. For instance; Carbon/glass fibers (not fiberglass) and epoxy resins are used for the blades, large masts are needed with access for maintenance. For more information, see appendixes.
- Photovoltaic (PV): generally use high-grade silicon, which they melt down and then draw crystals slowly out of the solution. These processes are industrially intensive, on top of which there is a shortage of high-grade silicon. For more information, see appendixes.

- Waste to energy: there is a large section of renewables, which uses waste to create energy, such as landfill gas plants, gasification and pyrolysis plants, and anaerobic digesters. They are generally built large scale specifically for each area, and are not of a manufacturing nature.

4.4: Technologies suited to cluster manufacturing scale:

Four of the renewable technologies have been identified as being able to be built on a small to medium scale, which would match the CPR Regeneration plans for setting up clusters of renewable energy businesses. Covered in detail in section 5, these are:

- Biomass
- Ground Source Heat Pumps (GSHP)
- Micro Wind Turbines
- Solar Thermal Hot Water

5: RE Manufacturing for the CPR Area:

In the previous section, four technologies were found to suit smaller scale manufacturing, suited for the development of renewable energy clusters. The purpose of this is to ascertain how suited they are to the CPR area. This has been done by:

- Looking at the skills required, compared to the skill base of the local area.
- Breaking down the technologies into components, to find whether they can be sourced locally within CPR/Cornwall or would need to be imported
- Assessing the possible market, by looking at popularity of the technology, existing companies and other market issues surrounding them

Technologies were researched to find which materials and components are used in the production. Companies were then phoned to check whether components could be supplied. The general responses were enthusiastic at the possibility of becoming a renewable manufacturer, as this may boost their sales. Obviously buying from local manufacturers is good for regeneration, however doing this may add to costs. Local suppliers of components or companies, which could aid in the design or component supply, are listed in the appendixes. It must be noted most could not confirm they could supply the component, as it all depends on the precise design which would be company specific, but these contacts are hopeful they can supply the desired product.

There is a small section on market assessment, to look at how well the area is suited to each technology. One of the negative aspects of the area is location, due to Cornwall being in the corner of England leading to poor transport links.

There still will likely be some inter/national trade, but this is dependant on each technology.

5.1: Biomass:

5.1.1: Biomass Introduction:

Biomass in renewable energy terms is the harvesting of energy from recently living organic material. This can be waste products from other industries, such as scrap from timber mills, or it can be grown specifically. There has been much interest within Cornwall to set up a biomass base, and there have even been some biomass developments. These include an installed biomass boiler at the Eden project and a Bio Energy Steering Group.

It must be noted there are several different biomass technologies, but each acts by using biomass as the fuel. This can be as a liquid, in the form of bio diesel/ethanol/etc for use in combustion engines. It can also be used as a solid fuel for heating systems. Heating systems are the technology suited to technological manufacture, as liquid bio fuels are currently made to run on existing technology. A fuel processing plant could be an option, though this is not covered, as it is the synthesis of a fuel, rather than technological manufacture.

5.1.2: Biomass Skills:

Biomass for heating is used through a boiler system, using similar technology to conventional boilers, though a feed system (hopper) is needed. Fuel is often woody products as they are widely available. This is often processed into the form of chips or pellets, so they can be burnt more efficiently.
Biomass boilers do require more maintenance than conventional systems, due to the unreliable qualities and moisture content of the fuel. This can put people off as it means maintenance costs are higher. However, the idea of using a green fuel and other biomass benefits would likely offset this. Skills needed for the construction of these systems are:

- Thermodynamic Engineers
- Rate of Burn Technologists
- Boiler Manufacturing Experience
- Steel Fabrication (for feed construction)
- Instrumentation
- Electrical Engineers
- Mathematical/IT skills
- Generic Skills (basic manufacturing skills, leader qualities, etc)

Some of these skills may be found in the area, as there are steel fabrication, instrumentation, electrical engineers and the more generic skills to be found in existing companies. The more specialist skills however may be a problem, so sourcing them would most likely come from outside Cornwall. These include

thermodynamic engineers, rate of burn technologists and boiler manufacturing experience.

5.1.3: Biomass Market:

The Biomass market is dependant upon the supply of the fuel. In Cornwall Renewable Energy and South West Wood Fuels, BiCal and Wood Energy currently supply fuel. These companies can provide a small to medium supply, enough for existing projects and the potential for several more. However, as highlighted in the CPR Regeneration Energy Feasibility Study, this supply is not large enough to present a large number of installations. For this to happen, a supply would have to be grown locally.

Similar situations are found throughout the country; it is one of the biggest difficulties facing the biomass industry. The situation is somewhat a catch-22, quantity of burners being limited by the supply of fuel, and the supply of fuel limited by the demand of the burners. Each will gradually grow, but currently the market is too small to support many manufacturers.

Areas with a fuel source can create a fuel supply by setting up a plant to process the source into pellets/chips. Once there is a fuel supply, then there is a market gap for biomass systems in that area. This causes the market to be deeply competitive, demand limited to when and where fuel supplies are created. This results in a low demand for biomass nationally, which can only change once the industry has grown.

The best way to combat this slow growth would be a grant funded scheme for individual areas, to set up a local supply for the area of boilers and fuel. This would also have to ensure a continuing market for the fuel, by installing a certain number of boilers to begin with to create a fuel demand. Due to this relationship, in areas where biomass is used there is little trade for biomass boilers as the demand is already met.

5.2: Micro wind:

5.2.1: Micro Wind Introduction:

Micro Wind is the technology for harnessing of wind energy on a small scale. Unlike the larger turbines, construction methods aren't so complicated. Micro wind turbines have been used in the marine industry for quite some time, yet the micro wind turbines for use on land are relatively recent. Their size and their use of existing manufacturing methods/products means they suit small scale manufacturing.

5.2.2: Micro Wind Skills:

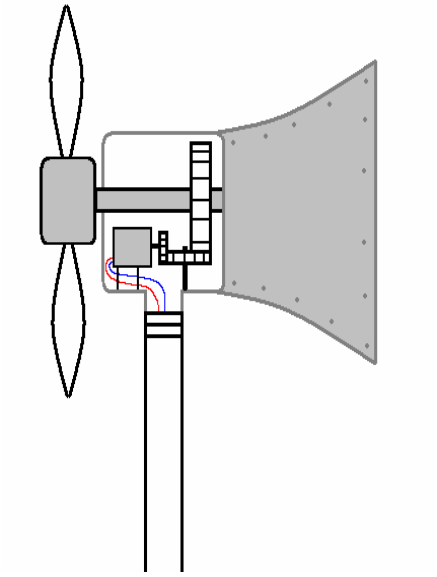
Only one component in the manufacture of micro wind turbines is specialist, the rest should be able to be sourced locally or from existing UK companies. This component is the blades; modelling skills with fibre glass or light metals (such as aluminium) are required, which fortunately can be found locally. Engineering and aerodynamic skills are needed for the design, but a company would have this before it set up a manufacturing base.

Cornwall has a large boating industry, often using fibre glass for the hull of the boats. Recently this sector has seen difficulties in competing with cheaper imports and larger manufacturers. If micro wind turbines were to be developed in the area, this skill base of people with fibre glass experience could prove invaluable, and could help with design as well as construction.

The other skills needed are assembly skills, common in an area such as CPR which has manufactured products on a small to medium scale for many years. This may include some slightly specialist assembling skills, such as welding, depending on the design. As stated before this area has had a mining, engineering and ship industry, so there shouldn't be a difficulty in locating candidates with these skills.

5.2.3: Micro Wind Turbine Components:

Micro Wind Turbines are composed of a mast, on which the turbine is placed. The diagram below shows the basic wind turbine system:



Blades: *made of strong light material, often fibre glass*
Blade Hub
Gear Systems: *though not in all turbine designs, sometimes needed to alter rotation speed between blades and generator.*
Generator: *put simply, a motor run in reverse, though some are more suited than others.*
Electrical wiring
Casing
Guide Fin: *to guide the turbine to the desired direction.*
Coupling: *to allow the turbine to rotate to face the desired direction*

Fig 5: Simplified Diagram of a wind turbine

As well as the given components, an inverter is needed in order to convert the direct current (DC) to alternating current (AC), which is the type supplied by the

grid. An installer would most likely purchase this separately, unless the turbine manufacturer acted as an inverter supplier. Other parts can be assembled, or for some parts manufactured.

Those which will likely require manufacturing are the guide fin, casing, mast/tower and blades/blade hub. As stated, the blades/hub could be designed and manufactured using local boat/fibre glass skills. The guide fin and casing could be created using:

- Fibre Glass/light metal: using the same material as the blades and hub would not only produce a more aesthetic design, the same company who create the blades and hub could be used, lowering costs and increasing capability.
- If the blades/hub were bought as a unit from an existing company, plastic/metal moulding techniques could be used, such as those found in local boating industries.

If a gear system is needed in the design, this would likely need to be ordered in. though there are local engineering companies which could aid in design and single product manufacture, in order for many of these systems the renewable manufacturer would either have to manufacture the systems themselves, or work with an existing company. This would increase the scale and work needed to create the finished product. There are several companies in the south west providing this service, though the 2 in Cornwall supply the gearbox, rather than the gears. These companies should be able to supply the component, depending on ratio and dimensions desired (see appendixes).
The mast would need to be manufactured, but materials could come from local metal stockists, as listed in the appendixes. Metal working skills such as welding would be needed, but this shouldn't prove a problem as there are a number of Cornish welding companies, not to mention many ship builders would be trained. The coupling would need to be built to fit the tower, but is simple and a local engineering company could assist in the design.

Some electrical skills would be needed for connecting the motor and inverter, and any control systems which are used in this process. Electrical skills are in short supply throughout the UK and in Cornwall, but electronics in micro wind turbines are minimal. The generator motor can hopefully be sourced from local motor companies (see appendixes), though there are certain generators better suited to wind turbine generation which may have to be imported if they were desired, as most turbines work with a three phase system.

Most, if not all components can be sourced or manufactured locally. This does however depend upon the design. Inverters and specific generator motors may need to be ordered in, but it is likely a company could source from CPR/Cornwall. See appendixes for companies.

5.2.4: Micro Wind Market:

Due to the relatively recent history of micro wind turbine manufacture, there are still very few on the market, notable ones being:

- Swift
- Iskra
- Proven
- Windsave
- Rutland

Yet there is still a large demand for the technology, which is shown by wind popularity in surveys carried out (see below). Local surveys have shown that this is true for the South West too, with 54% strongly supporting the use of wind power, 30% tending to support, and only 4% opposing. Figures taken from Public Attitudes Towards Renewable Energy in the South West (see appendixes).

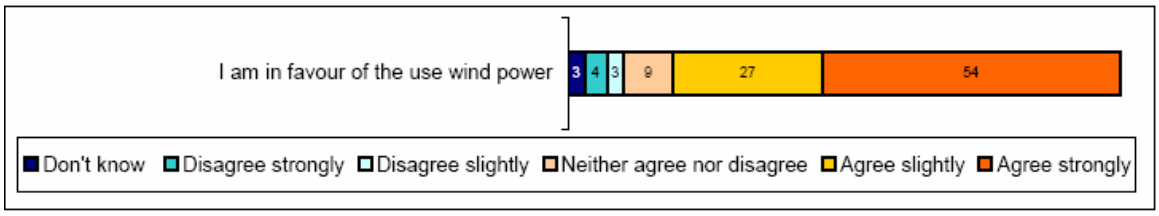


Fig 6: UK views on wind power, taken from Renewable Energy Awareness and Attitudes Research, DTI, May 2006

This suggests a relatively large market, compared to other renewable technologies. A manufacturer could expect to trade in both these markets, and may see some trade internationally if they grew a reputation.

5.3: Ground Source Heat Pumps (GSHP):

5.3.1: GSHP Introduction:

One of the fastest growing technologies within the renewable sector, GSHP provides an environmentally friendly solution to space heating. Using the earth as a heat sink, it collects thermal energy naturally heated from the sun to provide a temperature slightly above air temperature; this is then stepped up by a compressor within the heat pump unit to provide space heating for the home.

Though there is already a manufacturer, Kensa Engineering based just outside of Falmouth, there is still a large demand for heat pumps, and if Kensa did have a competitor as a manufacturer this would likely drive down costs, meaning more installers and installations. Approximate current costs of Kensa heat pumps, including all kit needed are £3,500 for the smallest installations, and £10,000 for the largest, taken from their 2006 Price List for use with underfloor heating. For more information on GSHP please see appendixes.

5.3.2: GSHP Skills:

The design of a GSHP unit will need some technical skill, such as thermodynamics, fluid mechanics, and design skills. For the manufacturing skills, simple plumbing and electrical skills will be needed. Plumbing and electrical courses are taught locally, at both Truro and Cornwall College.

A company could then train staff in any specific skills needed. More plumbing/electrical skills will be needed for any installation company, which may well run alongside a manufacturing company.

5.3.3: GSHP Components:

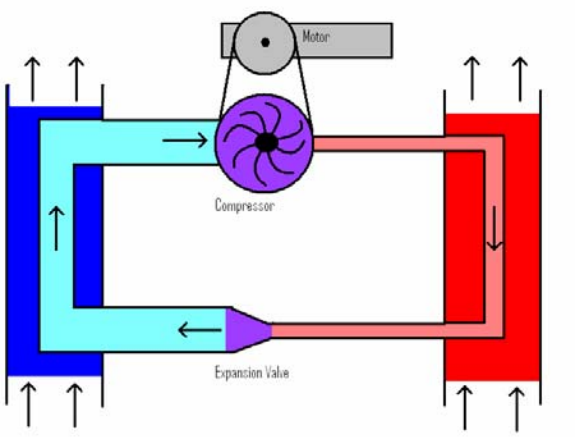


Fig 7: Simplified GSHP Unit

A GSHP unit can be split in to three parts. The first is the earth pipes, either horizontal or vertical which collect heat from the ground, displayed as blue on the diagram. Horizontal provide the most efficient and cheap option, a trench is buried where coiled lengths of MDPE piping (medium water piping) is laid, otherwise known as slinkies. For vertical pipes a bore hole must be drilled, and a vertical ground loop of pipe is used. Multiple boreholes are sometimes needed. As can be imagined, the drilling of the boreholes is what adds most to the cost for vertical systems.

For the heating of the house, a conventional radiator system can be used, but preferably underfloor heating, which can be installed by most plumbers/heating installers, and there is also a specific underfloor heating company within Cornwall (see appendixes). The unit itself consists of:

- One/two heat exchangers between the 2 pipe networks; one is not always needed between the ground heat pipes and heat pump.
- A scroll Compressor, driven by a small motor, manufactured by Copeland. The nearest supplier is located in Exeter. Other small compressors could possibly be used, but Copeland compressors are used in most GSHP.

- 2 small pumps, powered by small motors for pumping each of the pipe networks.
- Plumbing and electrical fittings to join it all together, including an expansion valve.
- Refrigeration fluid for heat pump cycle, and an anti freeze solution for ground pipes.

All components should be able to be sourced locally, though it depends on the specific design. The exception to this is the scroll compressor, a compressor designed for working under small loads. After consultation with local companies, many of the pump companies were keen about this technology, as it could boost their sales. Pumps and motors to drive these can be purchased from the same supplier to ensure compatibility.

5.3.4: GSHP Market:

The ground source heat market is rapidly growing, as the technology becomes more popular. Currently when asked about electricity micro generation, people tend to think of solar, hydroelectric and wind. Partly due to these technologies being around for longer, also these are the renewable sources which are easily noticed. This is shown in the graph below:

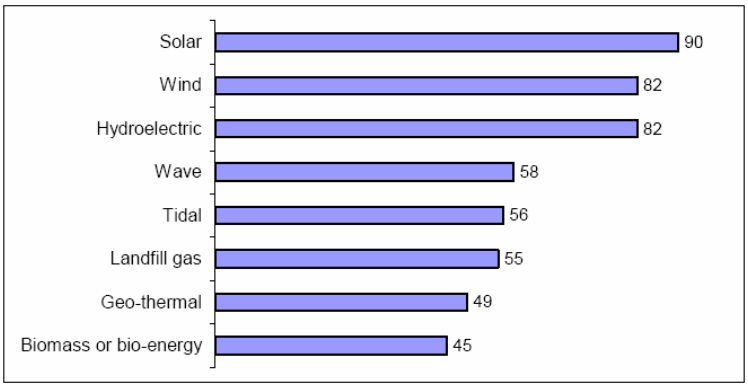


Fig 8: % Awareness of different RE technologies

GSHP are a renewable form of heating, which provides an economically viable competitor to non-renewable heating in off-gas areas, which includes large parts of Cornwall. In an on-gas area the technology will also be taken up by people who have concerns about the environment, who may be interested by other renewable technologies. This is one of the few forms of renewable heating (biomass is another). In the future micro CHP systems may provide a good on-gas energy efficient heating system.

GSHP can be retrofitted (installations on older buildings), but is best installed in new builds, as it is usually easier to integrate with existing heating systems, which reduces costs. There would likely be a local trade, made more likely if the company acted as an installer too, or worked with an existing or new south west GSHP company.

A GSHP manufacturer would have to compete with Kensa, but as stated the market is growing rapidly, so competition would hopefully be kept to a minimum. This competition would be reduced further if the companies tried to occupy different niches. For example, if Kensa produced a high quality, yet more expensive models and another company produced more affordable products.

5.4: Solar Thermal Hot Water Heaters:

5.4.1: Solar Thermal Introduction:

Using the suns energy, it is possible to heat much of a home's hot water needs for 8 months of the year in the UK, and in some countries is used as the hot water supply all year round, even in parts of Europe such as Greece. Though immediately in the UK, due to the need for a conventional boiler as well as the solar unit to meet all needs, they are one of the cheapest renewable technologies.

There are 2 standard types, solar evacuated tubes, acting in a similar way to a thermos flask, allowing the sun's rays to penetrate the vacuum and be absorbed by the dark inner tube. This thermal energy can't travel through the vacuum, so heat losses are minimal. The simpler alternative is flat plate panels, which act in a similar way, but without the vacuum. Instead of being in tubes, they are generally a single dark tube spread out like a radiator, incorporated into an insulated flat panel enclosure, with a glass front.

The system is then fitted, usually to a roof, and connected with the hot water tank. A small pump is usually needed, unless the system can be installed at about 18 inches below the tank, to allow for thermal conduction.

5.4.2: Solar Thermal Skills:

Like many renewable technologies, the design of the system does need some technical understanding, in particular thermodynamic and fluid mechanic skills. However, once the design is created, the manufacture of the technology should only need basic assembly skills.

These assembly skills will likely cover basic electrical skills for installation of motors to drive the pump, some plumbing skills for fitting and production of pipes, and more plumbing skills needed if an installation service if offered. Some basic modelling/carpentry skills would be needed for construction of the enclosure.

5.4.3: Solar Thermal Components:

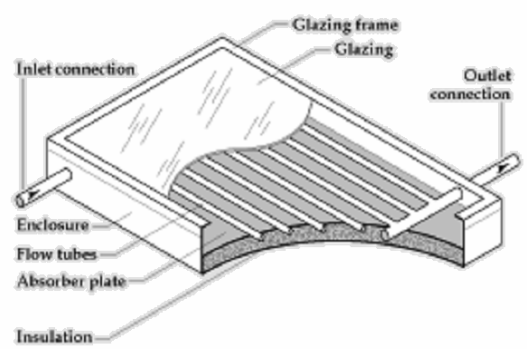


Fig 9: Flat Plate Collector

Above is a diagram of a flat plate collector, showing the different components. Unlike the collector, solar evacuated tubes need more intensive, large scale industry not suited to cluster manufacturing. As can be seen, flat plate collectors are quite basic, and it should be possible to source components locally, depending upon the design. Pipe work and fittings can be sourced from local plumbing suppliers. The enclosure can be constructed from a number of materials, none of which are specialist, but should be insulated to avoid heat loss. The absorber plate is usually copper or aluminium, though any material with good thermal conductivity can be used.

The absorber plate is covered with a selective coating, having high absorptive properties. This may be the only specialist component; black paint can be used, but efficiency is increased greatly if this coating is used. The standard material for this is black chrome plating, which nearest producer is Alderney Plating Ltd in Poole, Dorset. A manufacturer of (black) chrome plating could be set up more locally if there was a market, or possibly as part of a solar thermal plate manufacturer. Regular nickel plating can be used, but this loses efficiency.

Other materials can be sourced locally, and so a company would need to sell the units. It could also stock the pipes, fittings, heat exchangers and pumps needed for connecting the system to the water tank as a DIY/plumbers product, or run an installation service of its own. A heat exchanger is needed, as to avoid freezing an antifreeze solution is used, so heat is transferred to the tank, instead of using the water itself. This is not always needed, as in drain back designs, etc, the water is emptied

5.4.4: Solar Thermal Market:

The big drawback to solar thermal collectors which will affect the market is that in the UK they do not provide all our hot water needs throughout the year. However depending the price of a unit is low enough, they will pay themselves back through energy saving. This means they may not have mass appeal, but people who are interested in renewable energy and environmental issues would be possible consumers.

Similar to all renewable technologies, as more are isntalled in an area, they will become more popular, so a company could expect an S curve in sales, starting slow, peaking together with popularity, and then slowing down as the market is filled. There should be some national trade, certainly as the manufacturers reputation grows. A large part of the market will likely be local, working with trained installers, or running an installation service of their own. The company could offer a training program to plumbers if they were unwilling to carry out the installations themselves.

6: Conclusions:

6.1: Technological Conclusions:

Three technologies are believed to be suitable to manufacture in the CPR area, matching local skills and having the possibility of sourcing materials/components locally. Manufacturers could work together with other renewable installation companies, or provide an installation service of their own. Current renewable energy companies in the Cornwall area are listed in the appendixes.

As each technology provides a different type of energy, competition between them should be kept minimal; the solar collector providing hot water heating, the GSHP providing space heating and the micro wind turbine providing electrical generation. This allows for more than one to exist in the area. Competition from outside sources such as Kensa for GSHP, and solar installers for a solar collector manufacturer will have an affect on the market..

Micro wind turbines are likely to have the least direct competition, as there are so few manufacturers of the technology, and only a few installers, such as Aeolus Power based in South Gloucestershire and Segen based in Hampshire. The technology will more likely be in competition with other, cheaper renewable technologies. This technology is the least developed, so it provides the highest risk, but largest potential.

	Benefit	Drawback
GSHP	• Proven Technology: design shouldn't prove a problem/risk. • Many components can be sourced locally. • Local area has some electrical/plumbing skill base. • Provides efficient and cheap heating in off gas areas	• Local competition from existing GSHP. manufacturer Kensa • Scroll Compressor will need to be ordered in. • Condensing boilers are similar efficiency but cheaper (need gas). • Technology not as recognisable as others.

Solar Thermal	• Proven Technology: design shouldn't prove a problem. • Many components can be sourced locally • Simple design, construction shouldn't be too complicated • One of the cheapest renewable technologies	• Absorber plate coating may need to be sourced outside CPR. • Large competition from existing larger manufacturers. • Won't provide all of hot water needs
Micro Wind	• Emerging Technology, so little competition. • Popular technology. • Many components can be sourced locally • Can use local skills, in particular fibre glass experience found within boating industries.	• Design may prove complicated and risky, due to different styles. • Technology causes slight visual/sound impacts, affecting planning and market. • High cost technology.

The three technologies each have their own risks and benefits, as highlighted above. GSHP and solar collectors will face competition both locally and nationally, but the technologies are proven, so most of the risk is in the market size. This smaller risk does mean smaller benefits.
In comparison, micro wind is an emerging technology. Designs vary between each model, from simple characteristics such as horizontal/vertical axis and up/down wind, to more complicated features such as which gearing and braking systems are used. This presents more risk in the design, yet if a successful design were to be produced, the benefits would be much greater.

6.2: Biomass Conclusions:

Although the manufacture of biomass boilers may not be suited in the current situation, due to a small local market, skills which are needed but not in the area and transport issues for increasing the market size, biomass still has potential. If biomass as heating was chosen, a large amount of support and aid would be needed for the sector to be set up. Fuel would need to be grown, and there would need to be grants to aid the growing. As more systems are installed, the market gap in Cornwall would increase to eventually provide a niche for a biomass burner manufacturer.

The growth of fuel could provide regeneration and income for local farms, which could manage and harvest the fuel. Already there has been test planting of crops such as miscanthus, so it is possible to grow a fuel supply in Cornwall. These could work in conjunction, if not be part of a larger company which would provide a supply and installation service.

A solution more suited to the area is liquid bio fuels; in particular those that could be used in existing engines, such as bio diesel. There has already been work carried out locally by Camborne School of Mines (CSM, part of CUC) into setting up a mobile bio diesel production plant, and research into using bio-diesel on ships.

The research into its use on ships is due to the fuel not having to meet the British/European standard for bio-diesel (BS EN 14214), which sets the standard for bio-diesel in use of modern diesel engines. Ships tend to use older, larger engines which may prove to be more suited to using bio-diesel as a fuel. The standard requires 96.5% of the oil to be converted to methyl esters; this high value adds much to the cost.

It is possible to blend 5% of approved bio-diesel with conventional diesel for use in diesel engines, without it affecting the manufacturer's guarantee, as covered in the general diesel standard (BS EN 590), which would allow the fuel to be sold in garages. Bio ethanol is another liquid bio fuel. It would prove a less profitable product in the current market, due to its smaller market and the strict regulations over it, not only as it is a fuel but also the high alcohol content.

6.3: Manufacturing In The CPR Area:

As part of this project, local suppliers and manufacturers have been investigated, to see if a technology's components can be sourced locally. This would greatly aid the regeneration of the CPR area as a whole, but would likely add to costs, as buying from larger companies or importing from abroad can be cheaper. There may be a difficulty in encouraging a manufacturer to use these sources, unless incentives were put in place, such as funding for using these companies. It would however be up to the company whether it used local companies or not, dependant upon the design.

Due to the CPR location, it has good transport links within Cornwall, but national and international links are somewhat limited. This will affect which the type of company that sets up here, as the usual criteria looked for in a site would be good transport links in relation to materials, labour, market and also cheap land price so the facilities can be built at minimal costs. The CPR area does have a labour force, and land is cheap for Cornwall, but is limited on other criteria.

Manufacturing renewables in CPR would bring a lot of benefits to the area. Not only would there be a new employer, it is likely that there would be a gap for an installations company due to the local supply of the technology. The potential for sales outside Cornwall could bring money back in to the local economy.

7: The Future of CPR Renewable Manufacturing:

For optimum regeneration of the CPR area, the maximum number of people and companies must benefit from all projects set up. Locally sourced components and

labour would benefit the area strongly – creating viable revenue streams, whilst boosting the knowledge base, skill sets and local economy. There may be instances where the assembler of systems can purchase cheaper components from elsewhere, though the use of local components could be made more attractive by implementing financial and marketing incentives.

If a manufacturer of GSHP or solar collectors were set up in CPR, they would need strong marketing skills in order to compete. A micro wind manufacturer would need some good marketing skills in order to publicize their product, but more importantly they would need a well designed wind turbine to compete with existing micro wind turbines.

Micro Wind faces more design challenges than GSHP or solar, as the technology is emerging, and there are many differences in design. GSHP and solar have simple technology, so the design is unlikely to prove difficult or much different from existing technology. Micro wind will have differences in design, so it must have a working and efficient design in order to be successful, yet it will face less competition than the other 2 technologies, giving it greater potential.

In order for a biomass heating manufacturer to exist in Cornwall, there would need to be a secure fuel supply. Over time, it is likely that more biomass boilers will be installed, which in turn will lead to a greater fuel demand, and so the wood fuel supply chain will strengthen and grow. This could be sped up with financial grants to set up the growth of biomass crops and the installation of several community boilers. This would then provide a niche for biomass boilers to be manufactured here.

The other biomass option is bio diesel. This presents the opportunity for a bio diesel refinery within the CPR area, which would require fuel to be produced locally. This could use local farm land providing more regeneration to the area, regenerating rural areas of CPR. This provides a method for regeneration of rural land other than tourism, and also provides commerce for existing farming businesses. This scheme would need help with funding and marketing to get it off the ground, likely taking a few years to become financially independent.

To summarise, the major difficulty facing a renewable manufacturer or bio diesel refinery would be the funding of the project, and the marketing. Currently most grants and funding available are for the installations of renewable technology, so to aid the set up of a manufacturing base a source of funding would need to be acquired. This could come from agencies such as SWRDA, Convergence and the Carbon Trust.

Increasing the desirability of the product could be done at both local and national levels, especially if it was seen as ground breaking as in the cases of bio diesel and possibly micro wind. Publicity help could be carried out by CSEP, and the company promoting itself. The bio diesel potential should be investigated in the area, to analyse the benefits and costs such a development would bring.

Though not covered in this report, there are also gaps in R&D which could be filled using Cornish Potential. Though micro CHP is still in these stages, a more suited technology would likely be tidal stream and wave generation. There is research work being carried out in these fields, and this should be helped where possible and observed closely, as in the not too distant future there may be a market gap for these emerging technologies.