ACKNOWLEDGEMENTS

The authors gratefully acknowledge the valuable assistance given to them by staff of the many organizations listed in the report; a number of people went to considerable time and effort to assist.

Special thanks also to Mr Jim Hogg of Anglian Region of the Environment Agency and Dr Suzanne Evans of ETSU.

CONTENTS

GLOSSARY

Datalogger	device for monitoring and recording signals from sensors such as water levels, rainfall, etc.
Grid-connection	cabling and interface (possibly requiring a transformer) to connect electrical equipment at a remote site to the nearest mains power lines
Micro-hydro power	small scale hydro electric installation, of less than 100kW rated power.
Mono-crystalline (PV module)	the active part of a solar electric (photovoltaic) power system, where photons are converted into electrons, is the semiconductor material. The most common form consists of thin slices of silicon substrate cut from a single silicon crystal. Such cells are known as "mono-crystalline" and are the most efficient means to convert sunlight into electricity
Navaids	short for navigation aids – devices such as lights placed to indicate a navigable channel, radio beacons, etc.
Pointing lock-gate	a pair of lock gates hung like conventional doors or gates from each side of the lock basin which when closed form a pointing "Vee" in the upstream direction.
Poly-crystalline (PV module)	see also 'mono-crystalline' – a PV cell sliced from a "poly-crystal" (a number of crystals grown in one lump); generally less efficient than monocrystalline cells (so a larger array is needed for a given power level) but cheaper, which compensates for the greater size.
Pump-out	installations on the river or canal bank for emptying and receiving the sewage from river craft
PV – solar photovoltaic	a semi-conductor based device with the property of producing electricity when light falls on its active surface, the electricity production being generally in proportion to the intensity of the light
PV Module / Array	a PV module is the basic building brick for a solar PV system; it is a single panel consisting of glazed and weather-sealed solar cells. A set of solar modules can be mounted as an "array" on a frame and wired so as to sum either the current or the voltage from the individual modules to the required level.
Telemetry	transmission of data by radio (eg. from a datalogger)
UPS	Uninterruptible Power Supply: a battery and battery charger with sensing devices so that if the mains (or some other

	primary power supply) fails, the UPS instantly senses this and switches the battery in as a temporary substitute to maintain an electricity supply for some essential purpose.
Vertical lock-gate	a form of lock gate that slides up and down vertically like a sluice gate or guillotine; these are made of steel and counterbalanced and they are raised and lowered by a mechanical drive mechanism which may be manually or electrically actuated. These gates are most common in Anglian Region of the Environment Agency and are generally paired with a pair of pointing lock gates at the upstream end of the lock.
Windcharger	a commonly used term for a small windmill which generates electricity (usually to charge a battery – hence the "charger")

ABBREVIATIONS

BW – British Waterways

DoE – Department of the Environment

PV – (solar) photovoltaic

UPS – Uninterruptible Power Supply

EXECUTIVE SUMMARY

This report describes a Market Study following on from the National R&D project of the Environment Agency E01(95)03: *Alternative Energy Sources for Navigation Services*.

The R&D Project investigated the use of renewable energy systems to power various applications required by the navigation services in the Anglian Region of the Environment Agency, particularly lock gates and pumpouts, in situations where the cost of a grid connection would be prohibitive. The study considered solar PV (photovoltaic), small wind turbines and micro-hydro power as possible options.

The resulting analysis indicated the feasibility of using solar PV (photovoltaic) panels to charge a battery bank which, through an inverter, could supply power to standard lock gate actuators. A similar power source and energy storage could be used for the small electric pumps used for sewage pumpouts. Solar PV was preferred because the energy availability happens to match the demand, systems can be "packaged" in a standardised way that is non-site-specific, and the system could be competitive in financial terms with even quite a close grid-connection.

Following from this, it was decided to investigate the broader market for stand-alone power systems of this kind, not just in the Anglian Region but throughout the inland waterways of England and Wales. To do this involved contacting all the other Environment Agency regions, together with British Waterways, the Broads Authority and other potential private sector users of such systems. This report gives details of the results of this market survey.

The information sought was geared initially to the hypothesis that there could be a significant market for powering lock gates and pumpouts using renewable energy power sources. Hence it was aimed to gain basic statistical data of relevance to those applications. Such information would include numbers of unpowered lock gates, level of river usage (to determine the number of lock transits to be expected), numbers of pumpouts, etc.

It was soon found that the market as originally envisaged does not really exist for the following main reasons:-

- there are few lock gates outside Anglia Region of the Environment Agency which are planned for mechanisation and which are away from the grid
- it is commonly assumed that the private sector (marina operators) will provide all necessary pumpout facilities, and in general pumpouts are placed where there is both mains sewage and mains electricity available (such as at marinas)

However, it became apparent that there is a market for renewable energy equipment but that it is rather different and more specialised than expected. In short:-

- There seems to be widespread interest within the Environment Agency, British Waterways and the Broads Authority in the general use of small renewable energy sources, in particular for data acquisition and telemetry but also for such purposes as remote operation and monitoring of sluices. Apart from any practical issues of operational convenience or cost-effectiveness, it should be noted that several respondents mentioned the desirability of being "seen to make use of renewables" as part of the general need to demonstrate sound environmental practice.

- In the Anglian Region there is the sole significant potential for powering vertical gate locks (about 10 to 20 such installations). In addition to this, both Thames and Anglian Region could make use of a renewable energy powered sluice gate mechanism (perhaps up to 200 installations) which comes under the aegis of "Flood Defence" rather than "Navigation".

- Common difficulties are already being addressed, such as finding suitably robust and reliable renewable energy systems, and in "packaging" the equipment in such a way as to resist vandalism, etc. Vandalism is perhaps the most significant market barrier to the take up of wind and solar powered systems for unattended use in remote areas and it has been found that any such systems deployed in the public domain need to be designed to cope with this problem.

- Although a number of Environment Agency regions and other agencies are working on solving almost identical problems, there is little communication between those working in these areas or even awareness of what others are doing. Hence it would help to increase the awareness of who is working in the same area, perhaps through a conference or workshop on the use of renewable energy power systems for remote systems and amenities in the UK. The Environment Agency might also consider setting up some form of internal networking between the regions on this topic.

- It is apparent that various UK specialist suppliers of remote power systems have been developing the market for renewable energy power supplies for navaids and data acquisition systems as a matter of course, to the extent that most navaids these days are solar PV or wind powered. This know-how could be of value in associated applications which have yet to be taken up, such as powering sluice gates or locks.

- Another related application, not within the terms of reference of this study, is the utilisation of weirs and locks for the generation of low head hydro-electric power on a large enough scale to be of commercial value in displacing bought-in electricity. It became apparent during the study that there are a number of potential applications and there is some interest within both the Environment Agency and British Waterways in seeking to exploit this energy resource if it can be exploited economically.

KEY WORDS

Renewable energy
Alternative energy
Navigation services
Remote power supplies
Solar power
Wind power
Hydro power

1. INTRODUCTION

This report describes a Market Study following on from the National R&D project of the Environment Agency E01(95)03: *Alternative Energy Sources for Navigation Services*.

The principal aims of the first phase of work were to investigate the use of renewable energy systems to mechanise various applications required by the navigation services in the Anglian Region of the Environment Agency, in situations where the cost of a grid connection would be prohibitive. Specifically, the key applications studied in detail were the provision of power for both lock gates and for pumpouts (the latter are installations on the river or canal bank for emptying the sewage from river craft). This study considered solar PV (photovoltaic), small wind turbines and micro-hydro power as possible options.

The resulting analysis indicated the feasibility of using solar PV (photovoltaic) panels to charge a battery bank which, through an inverter, could supply power to standard lock gate actuators. A similar power source and energy storage could be used for the small electric pumps used for sewage pumpouts. Solar PV was preferred because the energy availability happens to match the demand well (i.e. maximum need for energy is in the summer) and such systems can relatively easily be "packaged" in a standardised way that is relatively non-site-specific. It is estimated that the proposed "packaged" renewable energy system would be competitive in financial terms with even quite a close grid – connection, and probably will be cheaper than most grid connections.

Following from this, it was decided to investigate the broader market for stand-alone power systems of this kind, not just in the Anglian Region but throughout the inland waterways of England and Wales. To do this involved contacting all the other Environment Agency regions, together with British Waterways, the Broads Authority and other potential users of such systems. This report gives details of the results of this market survey.

2. METHODOLOGY AND RESULTS OBTAINED

The information sought was geared initially to the hypothesis that there could be a significant market for powering lock gates and pumpouts using renewable energy power sources. Hence it was aimed to gain basic statistical data of relevance to those applications. Such information would include numbers of unpowered lock gates, level of river usage (to determine the number of lock transits to be expected), numbers of pumpouts, etc. In the event, as will be explained, the market as envisaged does not really exist for the following main reasons:-

- there are virtually no lock gates outside Anglia Region of the Environment Agency which are planned for mechanisation and which are away from the grid
- it is commonly assumed that the private sector (marina operators) will provide all necessary pump-out facilities, and virtually all of them also already have access to the grid and mains sewage
- it became apparent that the main market for renewable energy equipment is rather different and more specialised than expected.

Hence, interviews were conducted on a more *ad hoc* basis to suit the differing apparent interests and needs of the interviewee's organisation so as to try and build up a picture of the experience with renewable energy systems so far and the potential for using such systems in the future. A complete listing of the key contacts is given in **Table 2.1**.

The survey was conducted by interviewing relevant officials by telephone, although in some cases actual visits were made, either due to the potential complexity of the discussions or because there were specific relevant technical applications to look at. Due to difficulty in obtaining consistent results through telephone conversations, a standard letter was faxed to all the Environment Agency regions giving a list of specific questions for which an answer was sought (***Annex 1*** includes a copy of the letter). In a few cases this yielded a positive and useful result but in most cases a further telephoned follow-up was needed. In the end the quantified data obtained was limited, mainly for the reasons outlined in the previous paragraph, but the discussions which will be summarised later, gave a good indication of the level of interest in using renewable energy for off-grid applications.

Part of the reason for the difficulty in gaining a clear response is that it transpired from this study that little thought has so far been given to using renewable energy stand-alone systems in this context, so most of the people questioned had no strong views one way or the other; there were no specific plans that could be quoted and there were no easily obtained quantified data on applications.

It is proposed to summarise the results of the discussions with the various key respondents in the section that follows.

Table 2.1 Listing of contacts consulted

Environment Agency Southern Region
John Morgan (responsible for Navigation) (01732 875587)
David Oliver (Flood Defence) at the Rye office (01797 223256)
Greg Smith (Flood Defence) at the Worthing office. (01903 832075)
Environment Agency Thames Region
John Waters (Navigation on 01189 535521)
Colin Platt (Navigation on the upper Thames – Wallingford office) (01189 533334)
Roger Sturgess, Operations Manager, Thames Region West (01189 533345)
Environment Agency Anglian Region
Roger Valentine (Navigation) (01733 371811)
Jim Hogg (Flood Defence) (01733 464104)
Environment Agency NE Region
Ken Barton (Flood Defence) (0113 244 0191)
Environment Agency NW Region
Andy Fitton (ME Services) and (01925 653999)
John Cottam
Environment Agency Midlands Region
John Fitzsimmons (Flood Defence on 0121 711 2324)
Peter Cornhill (E&M Engineer, Litchfield on 01543 444141)
Martin Freeman (Engineer Planning; Solihull). (0121 711 5907)
Environment Agency Wales Region
Geoff Bayliss (01222 770088)
Ron Clark, Flood Defence Manager
Environment Agency SW Region
Richard Horrocks (01392 444000) (Regional Flood Defence)
Jim Barlow (Flood Defence at Bridgewater – 01278 457333)
Environment Agency National Centre For Environmental Data And Surveillance
Nick Holden & Wesley Irving (01278 457333)
British Waterways
Stuart Sim, Operations Director at BW HQ, Watford (01923 201446)
David Bligh, Engineering Manager, (01827 252000)
Ian White, Regional Manager NE (0113 281 6801)
Broads Authority
Alan Boswell (Safety and Liaison Officer) (01603 765710)
Inland Waterways Association (0171 586 2556)
Inland Waterways Branch Of The DoE (0171 276 0990)
British Marine Federation, Ted Waring (01784 473377)
Marina Services Ltd , Ted Waring, (01790 753153)
Hawkins Electrical (01754 610440)
Marlec Engineering Ltd ,Teresa Auciello, Sales Director, (01536 201595)
Castle Narrow Boats, David Tolliday, (01873 830001) Electric Boat operator
Pennmaritime Solar Co Ltd Michael Penny, (01344 89118)
BP Solar International, Andy Parr/ Mark Hammond (01932 779543)
On-site Power, Ian Thompson, (01553 636353)
Elam Actuators, Colin Mayger, (0117 963 3744 or 0802 330396)

3. SUMMARY OF INFORMATION COLLECTED

3.1 Environment Agency Regions

3.1.1 Environment Agency Southern Region

The following description is given in some detail, as it was found to typify the situation in many other Environment Agency regions, as will be summarised in the sections which follow below.

The only navigation is on the Medway. Flood Defence on this, the only major river in the region, involves the use of already mechanised radial gate weirs, which are automated using float chambers. There are 10 manually operated pointing gate locks on the Medway. All these locks have mains power close at hand should it ever be decided to mechanise them, however there are no plans to mechanise any of the locks. There are also "several hundred" manually operated sluice gates in the region. The Medway Navigation has three pumpouts in a distance of 31 km and no more are proposed. There are no plans to power any locks or sluices.

The use of a Marlec Windcharger for some unspecified application at Rye Harbour was mentioned. On further investigation it transpired that this is something a local wild life sanctuary are working on, in order to pump water from one pond into another and is nothing to do with either navigation of flood defence. It seems they built a home-made windpump and are now looking to replace it with a commercial unit, but are unsure what to get.

Discussions were carried out with Flood Defence officials in Rye and Worthing offices. The data collection functions for the region use a number of data logging "kiosks" mainly to monitor water levels; these also involve telemetry of the data. There are 30 or 40 such installations, with some variations in the power requirements. Most involve the use of lithium battery packs which are replaced annually but a few are higher powered and involve 12V 110Ah batteries which need to be replaced at three monthly intervals. The larger batteries are apparently costly and sometimes awkward to carry into inaccessible locations, so there is interest in using solar photovoltaics with rechargeable batteries. To this end they have had a "large" solar PV system running for two or three years (this involves an array "4 ft square" - presumably one or two modules). This ran well until last year when it was destroyed by vandals who smashed the solar panels. Nothing has been done yet about replacing it as they are still thinking about how to deal with this vandalism problem. A much smaller PV powered system was introduced in March 1997 (using a 10 or 20W module built into the lid of the data logger; and this is expected to be relatively "low profile" in terms of avoiding attracting the interest of vandals). If this performs well through the next winter then they may consider introducing further units.

3.1.2 Environment Agency Thames Region

There are 45 sets of locks and weirs on the Thames, of which 31 have the grid available (3 phase) and rest are manually operated "and will stay like that". All are traditional pointing gate locks. The larger locks on the lower Thames are all permanently manned by lock keepers (who live beside the locks) and electricity is available on-site since the lock keepers' houses

are all electrified. The locks on the upper Thames are all of nineteenth century origin and it is not considered either feasible or necessary to mechanise them.

There are only two new pumpouts required at present; both are on sites with mains sewage and three-phase mains electricity close at hand, so no requirement for renewable energy powered pumpouts can be envisaged.

Emergency backups are used for powered locks, consisting of small petrol engine generating sets; these are sometimes problematic so they are considering use of UPS type battery backup. There are 48 weirs in region with perhaps 8 gates per site on average – hence around 320 sluice gates in total. Of these, some 50% are already powered so this implies a need for around 150 to 200 more power units. Most however are close to the grid as there are generally lock-keepers living at the location with mains power to their homes. Vandalism is a big problem.

The Operations Manager for Thames Region West has responsibility for 30 lock/weir complexes involving 98 weir structures and over 200 sluice gates, most of which are manually operated. Funds have been requested for mechanising most of them. A few historical types of sluice gate will not be interfered with. Lock keepers normally operate the sluices. Easy estimates of the cost of grid connections could not be given as each and every site is different; the grid is usually within 100m or so, but sometimes a connection may be difficult. Therefore if a packaged renewable energy sluice gate power system became available it would be of potential interest.

3.1.3 Environment Agency Anglian Region

Anglian Region has a unique type of lock involving a heavy (but counterbalanced) vertical gate which is usually raised by a crank handle. These are quite difficult for river users to activate so the policy is to power these gates so far as is possible. The standard installation is a vertical gate together with a pointing gate; there is no plan to mechanise the traditional pointing gate, but there is considerable merit in electrifying the vertical gates. So far some 32 of the 68 locks in the region have been mechanised in this way, but many of the remainder are located too far for economic connection to the mains. 26 locks on the River Nene are of the difficult to operate vertical type, yet are still manually activated. The R&D project related to this study was initiated to look at the possibility of mechanising the remaining vertical locks in Anglian Region using renewable energy, and at least half of the non-electrified vertical locks could be candidates for this purpose. A design study has been completed as part of this project to quantify and detail the requirements for the electrification of these vertical locks using solar PV power with battery storage.

There are 8 pump-out facilities already available on the Anglian Region's navigations but 8 more are planned in order to achieve the necessary distribution of such facilities. In most (if not all) cases these will be located together with other facilities such as shower blocks and public toilets and they will also preferably be connected to mains sewage facilities, so the probability in most cases is that mains electricity power will also be close at hand. Therefore it is unlikely that more than one or two such facilities could require the use of renewable energy.

Approximately six new sluice gates are being installed per annum in this region, of which perhaps 3 or 4 might be located in situations where a mains connection would be particularly

costly. So if a suitably packaged renewable energy power package for sluice gates became available there would be a market for something like 3 or 4 per annum here.

3.1.4 Environment Agency NE Region

This region has no navigation and therefore is concerned with flood defence only. The main remote power requirement is for telemetry (from level indicators, etc.) but at present these are mostly mains connected, although a few have replaceable batteries.

There are a few sluice gates, but there is no real need to mechanise them. Therefore there is no great interest in new power supplies for sluice gates or for lock gates and there are also no pumpouts needed. However, there may be a need for further telemetry to monitor river levels and rainfall.

3.1.5 Environment Agency NW Region

There are 20 flood control sluice gates, all hand-operated with no plans to mechanise them and no lock gates within their jurisdiction. They are planning to replace two portable i.c.engine powered generators at present used at two river level measuring stations with mains connections.

They do use telemetry of water levels and have used 12 solar PV powered monitoring data loggers with telemetry. These are mainly 12V and 0.25A rated current and have proved reliable over about 5 years usage. A new one is about to be tried rated at 1A.

The Project Manager for Capital Schemes expressed an interest in the utilisation of hydro power from weirs in the region. In particular there is a plan to rebuild a 1.5m head weir on the Mersey and they have a need for electricity (for their workshops) in close proximity, so the thought of incorporating a small hydro installation as part of the weir renovation was apparently of interest.

3.1.6 Environment Agency Midlands Region

PV has been used for a couple of navigation beacons on the Trent – “Navcare” supplied the entire package. This was a “one-off” requirement on a tidal reach. Vandals destroyed the first array to be installed. All sluices gates have mains power close at hand. Lock gates are all manually operated and are the responsibility of British Waterways; moreover there are no plans to mechanise them. All pumpouts have mains power and there are no plans for new pumpouts.

“Delta T” units are used for telemetry; these require replacement of the batteries regularly; usually every 12 months. There is therefore a definite interest in applying PV to telemetry and data acquisition.

A total of 52 sluices in the region were mentioned, of which at present 42 are unpowered. New schemes involving new penstocks/sluices generally require them to be powered but there are no plans to power the older manually-operated sluices.

3.1.7 Environment Agency Wales Region

There is no navigation in the region, no experience with off-grid power and no real need either.

3.1.8 Environment Agency SW Region

They already use solar panels for telemetry but have no experience and no perceived need to use it with lock gates, or pumps outs. However the use of PV for data acquisition on gauging stations was of some interest "providing that vandalism is not a major problem".

Two or three small sluice gate sites tend to be refurbished every year and that given "favourable costs and a technically robust option, renewables could be considered." Concern was expressed about the general robustness of renewables and that a full risk analysis as well as life-cycle financial analysis would be essential before any decision could be taken.

There is also a requirement for a variety of small-scale end-uses for powering actuators, instruments, anti-condensation heating for electronic systems, as well as for lighting and security alarms and if a suitable power package based on PV or renewables became available for general small power applications it could be of considerable interest.

SW Region had also considered using windpumps for raising water levels but rejected them as lacking sufficient capacity. They have frequent enquiries from private land owners regarding hydro power.

The consultants were referred to a firm called Elam who sell hydraulic actuators (for sluice gates, etc) and who offer a solar powered hydraulic system. It transpired that Elam are planning a possible solar powered hydraulic actuator in response to a requirement in Abu Dhabi for valve actuators for use by the petroleum industry and they would be interested in considering UK applications for powering sluice gates too. However at this stage the renewable energy power supply has not been designed or tested although they are convinced of its technical feasibility.

3.1.9 Environment Agency National Centre For Environmental Data And Surveillance

The National Centre is responsible for monitoring river and coastal water quality (among other environmental variables). They use extensive remote sensing from satellite imagery and from aerial surveys using sophisticated laser scanning of the ground to build up numerous digitised maps that can reveal many crucial environmental effects.

Their main experience with renewables is with PV and small wind turbines for both data loggers "on-shore" which are often temporarily placed to monitor some specific problem and for data collection buoys used both in rivers and in coastal waters (eg. measuring pollution from sewage outfalls, power stations, industrial effluents, etc).

They have problems with the power supplies for their buoys which are proving inadequate to keep the batteries charged. It transpired they are using rather outdated Solarex polycrystalline modules which are "US Coastguard Approved". It was suggested they consider using the more modern types of mono-crystalline modules which are 50% more efficient for the same area of module. They could probably swap their present 30W modules for modern 75W ones which are probably no more than 50% larger. Details were provided to them of the new BP

Solar 75W PV modules. They tried wind-turbines, but these proved both fragile, dangerous to the installers and caused the buoy to heel excessively in strong winds (made it top heavy). They expressed interest in a marine current power source, and a wave power unit as used by Trinity House and the Irish Lights was discussed.

They have considerable interest in renewables, but the main future need would be PV for powering dataloggers. Ideally they would like a small, but efficient module (say 20 watts mono-crystalline) to fix flush onto the lid of the datalogger. Present small modules tend to be inefficient and hence underpowered. Full size modules are more powerful than necessary for most shore-based data collection applications and tend to attract the attention of vandals.

3.2 British Waterways

BW has used solar PV for navaids (buoys) on the Caledonian Canal and solar PV has been used for actuating valves on a reservoir near Rugby.

There are plenty of already mechanised locks on the larger navigations, in particular where there is commercial traffic – eg. Severn, Trent, Caledonian Canal, and a number of mechanised bridges, but all have mains power and there are no plans for any new locks or for mechanising any others. However all powered locks have standby generators in case of mains failure, but might consider a large UPS instead.

There are no plans to mechanise old locks on most narrower canals as used by leisure boats. Virtually all are of the pointed gate type and do not lend themselves to powering and in any case there would be objections due to their historical nature, etc.

BW has a rule that pumpouts ought to be placed at no more than 4 hour intervals on navigations – i.e. 8 to 10 miles when there are no locks, closer when there are locks. BW only have half a dozen pumpouts so far, all of which are on the grid. They all use a "phone card" type system to receive payment. They only want to install pumpouts where there is mains drainage, and this almost always coincides with mains electricity.

The BW is interested in utilisation of canal drops, etc., for hydro power. Specific mention was made that the main BW workshop, (for lock gate repair, etc) which uses a lot of electricity, has a major weir right beside it (contact is Ian White, Regional Manager NE, on 0113 281 6801).

Electric boats were also discussed – there is a British Waterways Standard for recharging points - and the consultants were referred to Castle Narrowboats who run an electric boat hire fleet (see section 3.5.7).

3.3 Broads Authority

The Broads Authority have no unpowered lock gates or sluice gates within their jurisdiction and just one powered lock at the exit from Oulton Broad.

They have no record of the exact numbers of pump outs available on the Broads, but estimated that about 70 of the hire boat companies would have pump out facilities. Future development of pumpouts will be left to private operators, as at present.

There is no experience of using renewable energy systems for any purpose.

There is some possibility for using solar or wind energy to power tide gauges and there was also mention of the possibility of providing for electric boat charging at locations remote from the grid. Another possible future application of interest is the provision of radar activated flashing speed limit signs.

3.4 Government Departments and Advisory Groups

3.4.1 Inland Waterways Association

The Inland Waterways Association is an organisation representing major waterway users. Their spokesperson recommended talking to the *Department of the Environment, Inland Waterways Branch* and to ask if the *Inland Waterways Amenities Advisory Council* had any preferences or views on the issues being studied.

3.4.2 Inland Waterways Branch Of The DoE

This is the government department with responsibility for inland waterway navigations; it finances British Waterways and parts of the Environment Agency. Their spokesperson explained that Flood Defence comes under the Ministry of Agriculture (MAFF).

The DoE also runs the *Inland Waterways Amenities Advisory Council*. This serves to consider issues relating to inland waterways. Apparently mechanisation of lock gates, provision of pumpouts, etc, has so far never been raised as an issue, so there is no official "position" on these topics at this time.

3.5 Private Sector

3.5.1 British Marine Federation

The BMF is a trade association for companies involved with both inland and marine navigation, including manufacturers of relevant equipment (including power systems), marina operators, etc. They could not give direct advice but provided a copy of their annual handbook with several suppliers of power equipment for marinas marked up.

Some of these suppliers were contacted, yielding the following responses:-

3.5.2 Marina Services Ltd

MSL provides power systems for marinas and caravan parks. They have national coverage, being among the market leaders (possible *the* market leader). Equipment supplied consists of meters, protection devices, payment systems, etc. Their sales manager suggested there is virtually no need for renewable energy power provision as all marinas have mains power. There are of course many moorings which lack mains power, but they are cheaper to rent and providing power, whether by mains or renewables would mean they would have to become expensive. Hence it was thought unlikely that there is any significant need for renewable

energy based power supplies for moorings as users are more concerned with the cost of moorings.

3.5.3 Marlec Engineering Ltd

MEL is one of the largest suppliers of small wind turbines and solar panels for boats and caravan parks. These are mainly fitted to the boats or caravans to eliminate the need for an external power supply. They could not give any examples of marinas using the technology except for very occasional special applications. They commented that installing a wind turbine or solar panel on a boats possibly offers the owner better value in the long run than renting a mooring with a power supply, as well as providing the advantage of an autonomous power supply for powering the bilge pump, security equipment and other electrical services.

Marlec have sold some small wind power systems for navaids to various harbour authorities, including Associated British Ports (Humber Group Services) and to the Port of London Authority. Anglian Water have also bought a number of Marlec windchargers to power telemetry type applications.

3.5.4 Penn Maritime Solar

PMS is one of the main suppliers of solar PV power systems for boats and marine applications. They confirmed that there is a significant shore-based market for power systems for data acquisition and telemetry but most of the systems go for use on board various vessels. Over 2000 vessels were carrying Penn Maritime power systems. Another major market is for navigation aids, especially on buoys and piles used to mark navigation channels.

3.5.5 BP Solar International

Various water companies including Yorkshire Water, NW Water and Wessex Water have bought solar PV power systems for telemetry applications and numerous other environmental monitoring applications were developing, for example small weather stations, monitoring noise levels around airports, etc.

3.5.6 On-site Power

On-site Power have been heavily involved in upgrading formerly gas powered buoys to solar PV power. Most have now been converted and the main business is in replacements. They also provide “lead light” navigation lights on the navigable waterways in and out of most East Anglian ports, plus power systems for tide meters and current meters used by Anglian Region of the Environment Agency. They indicated that vandalism is not necessarily as bad a problem as many seem to think, as, given good installations, there are not as many calls for replacements as would be expected if vandalism was a chronic problem. There was a problem with wild fowl hunters taking potshots at navaids and some have been mounted over a shallow steel tray designed to deflect or protect from any shots, which generally come from below.

3.5.7 Castle Narrow Boats

Castle Narrow Boats is a boat hire company on the Monmouthshire and Brecon Canal and is the only significant electric boat operation in the area. It has been operating electric narrow boats since 1982 and has a number of electric boat charging points which are encased in steel boxes accessible to legitimate users who have keys. The cost of electricity is included in the boat hire charge so no coins, tokens or smart cards are needed.

The boats are modified traditional narrowboats displacing 8 tonnes and powered by 5kW electric motors. They can cover up to 30 miles per charge. The technology is based on milk float equipment, mostly 72V DC. It is understood that BW are encouraging the spread of electric boats by installing charging points on various other canals, but there are problems with people mooring non-electric boats at the charging points: "it is essential that charging points are kept available for the use of electric boats only".

At present the potential for renewables with electric boat charging does not seem to exist as it seems wasteful to use one set of batteries to charge another (and points with mains power can generally be found sufficiently frequently to meet the needs of the present limited fleet of electric vessels. However it is understood that new lightweight electric boats are being developed (displacing half the tonnage of the traditional ones) which might lend themselves to being wholly or partially recharged using "on-board" solar panels. It seems unlikely that this could totally replace river or canal-bank recharging but it may extend the range or reduce the amount of recharging needed by a sufficient margin to justify the costs; further more detailed studies would be necessary to establish the true potential.

4. CONCLUSIONS

4.1 Navigation Applications

There seems only limited potential for applying renewable energy systems to navigation applications, the two main ones being powering of lock gates and of pumpouts.

4.1.1 Lock gates

The scope for powering lock gates is limited because virtually all navigable rivers or canals with significant commercial traffic already have mechanised lock gates (and generally have resident lock keepers living on site with mains power available to them) while the vast majority of unattended locks on other inland waterways primarily used for leisure purposes are of the pointing gate type which neither lend themselves to easy mechanisation nor are they judged to need such a facility.

Anglian Region of the Environment Agency is exceptional in having vertical gate locks which are harder work for users to open and close manually and which also lend themselves reasonably easily to changing the hand-cranked gearbox for an electrically powered actuator. There are in total 68 vertical locks of which 36 remain un-powered. It seems therefore that the only scope for the provision of mechanised lock gates using renewable energy is in Anglian Region of the Environment Agency. Some 10 sites where this might most effectively be done were identified in the earlier report entitled "Alternative Energy Sources for Navigation Services: Second Interim Report", Nov. 1996.

4.1.2 Pumpouts

So far as pumpouts are concerned, most of the navigation authorities rely on private mooring owners and marinas to provide such facilities. Where the authority does provide them (eg. British Waterways) they prefer to site them at locations with mains sewage and, in general, such locations also have mains electricity close at hand. Hence it seems unlikely there is a realistic market for shore-based pumpouts off the grid.

4.1.3 Electric boat charging

Although there is some interest in achieving charging points "off the grid", for example on the Broads, this is an inefficient and hence a costly option since it involves charging batteries which are then used to recharge other batteries (batteries are generally only about 70% efficient, so this implies that some 50% of the electrical energy delivered from the renewable energy device, whether solar PV, wind or hydro, would be wasted in such a system). The more logical development in such situations would be to mount the charging system (a PV array) on the electric boats either to make them autonomous (at least in the summer) or to prolong their range without being charged from the mains. This of course would be a matter for the private operators rather than the navigation authorities.

One leading electric boat operator (Castle Narrow Boats on the Monmouthshire and Brecon Canal) was interviewed; their vessels are too heavy to lend themselves for powering by solar PV panels but there are plans to introduce lighter and much more efficient purpose-designed

electric boats and these may more easily benefit from the use of renewable energy as a power source. However recharging points would probably still be needed for situations when renewable energy is in short supply (i.e. cloudy periods or calm periods depending on the power system used).

4.1.4 Navaids

There has been some limited use of solar PV power systems to power navigation lights in a handful of cases, mostly at the interface between inland waterways and marine (tidal) navigation domains. While there is a widespread need for navaids around the coast and in estuaries where the edges of navigable channels would otherwise be hard to discern, especially at night, this is generally not a requirement with inland waterways. It is possible that if river traffic increases in the future some form of traffic lights may become necessary at busy locations, and similarly the Broads Authority mentioned a requirement for monitoring the speed of vessels and providing automatic signalling in the even of excessive speed being detected which may also be a feature of wider interest by other authorities. However it seems unlikely that the need for river and canal traffic control is sufficiently great at this time to encourage any significant effort or expenditure in this direction.

4.2 Flood Defence Applications

Strictly speaking Flood Defence was outside the original terms of reference of this study, but the generally negative results regarding the need for renewable energy systems for navigation applications and the fact that most of the officials consulted could readily advise on this too made it a marginal exercise to include enquiries in this area. Also technically the mechanisation of sluice gates, for example, is not dissimilar from the mechanisation of locks, although different factors apply (for example peak usage is generally in winter rather than in summer which may make hydro or wind power (for example) more economical and technically feasible in this context than solar PV power).

4.2.1 Sluice Gate Mechanisation

There is some potential for sluice gate mechanisation, although in most cases gates are already mechanised using a mains connection or there is no intention to modify hand operated gates.

The area with the greatest interest and potential for this is the Thames Region of the Environment Agency where something in the order of 150 to 200 sluice gates are due for modernisation. However a large (uncertain) proportion of these are probably close enough to the grid to permit easy mains electrification since in most cases the sluices are alongside a lock installation with a resident lock-keeper in an electrified house. A packaged renewable energy sluice servo system would be of interest if it proved easier and more economic to install than a mains connection, but two issues make this unlikely; firstly the numerous variations in the gates and their power demand patterns and secondly the often cited problem of vandalism or theft of any small windturbines or solar PV panels used for such installations. Hydro electricity could be a more robust option but this is difficult due to lack of suitable equipment on the market. Raising solar panels or small windturbines on a high mast could be one method for countering possible problems of vandalism, (this has been used in the Netherlands for a unique solar PV powered lock installation) but there may be objections due

to the considerable visual impact such an installation would introduce in areas often considered environmentally sensitive.

Anglian Region of the Environment Agency could possibly require 3 or 4 new powered sluice gates per annum at locations where there is no easy possibility for a grid connection. This activity could readily be associated with a programme to mechanise the vertical lock gates in the region.

4.2.2 Data Acquisition and Telemetry

There is an already widespread (and rapidly growing) requirement for data collection. In the navigation and flood defence domain this is primarily to monitor water levels which give an indication of river flow rates, flood risks, etc. Increasingly there is concern over pollution of various kinds and this is leading to an increased need to monitor water quality and other environmental parameters of importance. The combination of new low powered electronic devices for data collection and telemetry makes it technically feasible (and economic) to power such systems using stand-alone power supplies. In the past the main approach has been to use replaceable batteries which in some cases can run for 12 months or more, but the more energy intensive devices require larger batteries which need much more frequent replacement, often under difficult circumstances. Therefore there is an increasing tendency to favour the use of solar PV power (or small wind generators in situations where power demand is high in the winter). Water companies have also been using such power sources for remote control of valves with Anglia Water (for example) having bought a number of Marlec windchargers recently for this purpose.

The main problem with the use of solar and wind power for data acquisition is widely cited as being vandalism (any "high profile" piece of equipment that can be messed around with seems to attract this kind of unfortunate attention).

It is difficult to quantify the market for renewable energy power sources for this purpose and in any case the suppliers of data monitoring systems are tending to offer renewable energy power supplies as part of the package to potential users as a matter of course, so there seems little need for any form of "official intervention" to encourage this natural evolutionary commercial process.

4.3 General Conclusions

- There seems to be widespread interest within the Environment Agency, BW and the Broads Authority in the general use of small renewable energy sources, in particular for data acquisition and telemetry but also for such purposes as remote operation and monitoring of sluices (apart from any practical issues of operational convenience or cost-effectiveness, it should be noted that several respondents mentioned the desirability of being "seen to make use of renewables" as part of the general need to demonstrate sound environmental practice) .

- In Anglian Region there is some significant potential for powering vertical gate locks (about 10 to 20 such installations). Both Thames and Anglian Region could make use of a renewable energy powered sluice gate mechanism (perhaps up to 200 installations).

- Common difficulties are being addressed, such as finding suitably robust and reliable renewable energy systems, and in "packaging" the equipment in such a way as to resist vandalism, etc.

- Vandalism is perhaps the most significant market barrier to the take up of wind and solar powered systems for use unattended in remote areas and any such systems need to be designed to cope with this problem

- Although a number of Environment Agency regions and other agencies are working on solving almost identical problems, there is little communication between those working in these areas or even awareness of what others are doing. Hence it might help to organise some way to increase the awareness among those with these common interests of who else is working in the same area, perhaps initially through a conference or workshop on the use of renewable energy power systems for remote systems and amenities in the UK? The Environment Agency might also consider setting up some form of internal networking between the regions on this topic.

- It is apparent that various UK specialist suppliers of remote power systems have been developing the market for renewable energy power supplies for navaids and data acquisition systems as a matter of course to the extent that most navaids these days are solar PV or wind powered; expertise in improving such systems is developing as experience is gained. This know-how could to some extent be of value in associated applications like powering sluice gates or locks.

- Another related application, not within the terms of reference of this study, is the utilisation of weirs and locks for the generation of low head hydro-electric power on a large enough scale to be of commercial value in displacing bought-in electricity. Again it became apparent during the study that there are a number of potential applications and there is some interest within both the Environment Agency and BW in seeking to exploit this energy resource (if indeed it can be exploited economically).

ANNEX A: TEXT OF STANDARD ENQUIRY LETTER

Dear

Application of renewable energy power systems "off the grid" for navigation and flood defence

You kindly advised me over the telephone recently in connection with a project we are doing for the Anglian Region of the Environment Agency and for the DTI on the above topic.

I should be most grateful if you could provide me with some further basic data that we need for our report as listed below. Please do not go to excessive trouble to obtain precise figures as a reasonable estimate will be perfectly satisfactory for our purposes and in any case a quickly returned estimate would be more useful than a delayed accurate set of figures. We realise that in some regions where for example the Environment Agency has no navigations, some of the answers are zero. What we would like to know is:-

1. Number of unpowered lock gates in your region
2. Number of unpowered sluice gates in your region
3. Level of river usage (typical mean and peak traffic per day)
4. Average numbers of pump outs per km of river
5. Planned future frequency of pump outs per km of river

Please could you also comment or advise us on the following points:-

6. Do you have any existing experience using renewable energy power sources?
7. Do you have any practical applications or needs which might usefully be met in future by using renewable energy power systems?
8. Do you have any general comments or suggestions regarding the use of remote power systems, (i.e. off the grid) ?

Thank you in advance for any information you can give us.

Yours sincerely,

Peter Fraenkel.