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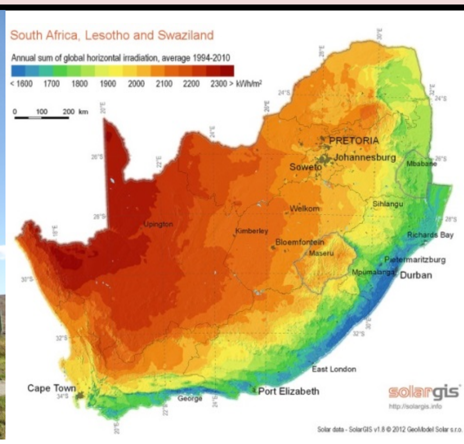
Sustainable solar energy for rural development in South Africa



Project Stakeholder Report July 2013

Project Team

Professor Cheryl McEwan, Principal Investigator, Department of Geography, University of Durham, UK
cheryl.mcewan@durham.ac.uk

Dr. David Bek, Research Associate, Department of Geography, University of Durham, UK
david.bek@ncl.ac.uk

Dr. Neal Wade, School of Engineering and Computer Sciences, University of Durham, UK
n.s.wade@durham.ac.uk

Dr. Marek Szablewski, Department of Physics, University of Durham, UK
marek.szablewski@durham.ac.uk

Dr. Douglas Halliday, Department of Physics, University of Durham, UK
d.p.halliday@durham.ac.uk

Andrew Crossland, School of Engineering and Computer Sciences, University of Durham, UK,
andrew.crossland@durham.ac.uk

Oghenetejiri Harold Anuta, School of Engineering and Computer Sciences, University of Durham, UK
o.h.anuta@durham.ac.uk

Zaitun Rosenberg, Research Assistant, Stellenbosch, Western Cape, South Africa,
zaitun.rosenberg@gmail.com

Executive Summary

Background

This pilot project, funded via the Durham Energy Institute's interdisciplinary small grants scheme, examined the potential contribution of solar power to development in South Africa's rural areas, where many of the country's poorest people reside. The project methodology involved interviews with a variety of institutional actors involved in renewable energy projects and investigations at case study sites in the Western and Northern Capes. In addition, OWL energy monitors were deployed alongside a household survey form in order to elicit technical data which was analysed by engineering experts.

Key research questions

- What is the long-term potential of the renewable PV energy options being considered in South Africa?
- What are the technological, financial and socio-cultural challenges in developing renewable options for rural electrification?
- What are challenges and potential solutions for fostering enhanced consumer adoption of renewable solar technologies?

Key findings

- Household/community level PV systems work best where there is a strong sense of ownership amongst the end-users
- Solar PV projects at the community/household level are often proving problematic due to local socio-technical issues.
- Insufficient prior engagement with beneficiaries generates an array of problems, such as a lack of understanding of how best to manage the system in order to maximise the lifespan of the components.
- Significant problems result from mistakes in configuring the technical specifications of solar PV systems.
- Provision of hot water via solar heater systems has strong backing from government with plans to implement 5.6 million household systems by 2020
- Eskom policies and tariff structures can militate against the viability of renewable projects.

Key recommendations

- Household level solar PV projects should be underpinned by thorough participatory consultation processes amongst the beneficiary community.
- Fully costed, long-term management plans must be implemented as part of the initial project design
- It is vital that solar PV systems are designed correctly and are compatible with the projected demand patterns of the end users.
- Where a reliable connection to the grid is available this should be the first option for providing domestic electricity. Other renewable options should also be considered such as solar geysers and eco-cooking solutions.
- Eskom tariff structures and related policies need to be reviewed in order to unblock constraints which are currently prejudicing the effective rollout of renewable energy projects.
- More co-ordinated monitoring and evaluation of projects, backed by effective knowledge dissemination systems, is required to improve project design and implementation.

Sustainable solar energy for rural development in South Africa

Project background

The 'Sustainable solar energy for rural development in South Africa' project was funded by EPSRC (grant number EP/K503368/1) via the Durham Energy Institute's interdisciplinary small grants scheme at Durham University, UK. The project ran from November 2012 until March 2013 and included 4 weeks of fieldwork in the Western Cape and Northern Cape of South Africa. The fieldwork was undertaken by Dr. David Bek (Geography Department) with local field assistance from Zaitun Rosenberg. The full project team included: Professor Cheryl McEwan, Principal Investigator (Department of Geography); Dr. Douglas Halliday and Dr. Marek Szablewski, (Department of Physics); Dr. Neal Wade, Andrew Crossland and Oghenetejiri Anuta, (Department of Engineering and Computing Sciences).

Project aims

(1) Map the current drivers of renewable PV technologies in South Africa;
(2) Quantify the effectiveness, sustainability and likely long-term potential of renewable PV energy options being considered in South Africa;
(3) Identify the technological, financial and socio-cultural challenges in rural electrification;
(4) Identify challenges and potential solutions in fostering consumer adoption and to test the current user-technology interface (assessing user control, the information presented to users, and the choices users have to change their energy usage);
(5) Establish a network of partners for international collaboration to expand the research.

Geographical Context

South Africa has great potential for solar energy due to relatively high levels of insolation. The South African Government has set a target of 42% of new electricity generation capacity to come from renewable sources – excluding hydropower – by 2030. Solar energy will be critical in enabling it to meet this target, and for tackling rural poverty in a context of climate change challenge. Many of the poorest people in South Africa do not have access to a regular supply of electricity, and as a result are often deprived of electric lighting, adequate clean water supplies, and other basic services. Most of these people live in remote rural areas, which are difficult or uneconomical to reach with conventional electricity infrastructure, and use alternative, high-polluting fuels (e.g. kerosene or gas) for basic power needs. Furthermore, conventional electricity prices are rising rapidly in South Africa so there is an imperative to seek low cost, sustainable solutions. While emerging economies like South Africa have begun to invest in PV research, development and deployment, more needs to be done to foster rural electrification and capacity building.[1]

Methodology

1) Secondary data collection in the form of journal articles, press releases and reports relating to solar PV and renewable energy rollout in South Africa.
2) Identification of projects and key informants for field investigation.

[1] http://www.iea.org/publications/freepublications/publication/pv_roadmap.pdf

3) Interviews in South Africa with a range of informants including: case study stakeholders; members of university research institutes; government and private sector representatives.
4) Site assessments involving piloting of a 'PV Survey Form'. Data from this survey form was relayed back to project team members in the UK who provided technical assessments to the field researchers which enabled further on-site analysis to be undertaken.
5) Collection of energy usage data via OWL Monitors. Data was collected from households connected to solar PV systems and emailed back to UK-based project team members who processed the data and provided feedback to the field researchers. This data enabled precise usage patterns to be identified which could then be assessed in terms of the capacity of the solar PV system.

The following **case studies** were visited:

- **Boomplaas community**, Keimoes, Northern Cape. 16 households which have received 480W solar PV systems.
- Households on **North Island Eksteenskuil**, Northern Cape – two households which have initiated their own systems.
- **Elim Project**, Nuwejaars River Nature Reserve, Agulhas Plain, Western Cape – 4 wine cellars which are part of a project using renewable energy in grid tied systems.
- **Wortlegat Outreach Trust**, Stanford, Western Cape – a rural based centre which has established its own solar PV system backed by a diesel generator in the absence of a grid connection.
- **Chargo Trust**, Kakamas, Northern Cape – a farm which has invested successfully in solar water heaters for its worker houses.

Key Findings

1) Household/community level PV systems work best where there is a strong sense of ownership amongst the end-users over: (i) the process of implementing a system; (ii) the equipment itself: (iii) the ongoing management of the system.

2) Solar PV projects at a community/household level are proving problematic. However the problems tend not lay with the capacity of the technology itself but more with the institutional structure within which the projects are implemented and socio-technical issues at a local level. Sadly, the problems noted within this research are nothing new. Previous solar PV systems in South Africa and in other countries have foundered in similar ways and it is unfortunate that lessons are not being learned or disseminated through appropriate channels.

3) The following problems were observed in relation to the PV systems analysed during this research:
   a) Insufficient (or non-existent) prior engagement with beneficiaries results in (i) a lack of buy-in to the project; (ii) a lack of understanding concerning the system's capabilities; (iii) a lack of understanding of how best to manage the system in order to maximise the lifespan of the components.
   b) It is all too easy for problems to occur in relation to the technical specifications of systems. Matching the relative capacities of the panels, inverter and battery bank is not straightforward, not least as the system design ideally would take into account; (i) annual insolation patterns in the location concerned; (ii) the precise usage patterns of the end-users. For example, whether a household will largely

use the system in the day or at night is but one factor which can affect the optimum specification of the equipment.
c) However, installing an inappropriately matched system will significantly reduce end-user satisfaction and the lifespan of the system.
d) Theft and vandalism are significant problems for accessible small-scale installations.
e) There is a severe shortage of expertise within local government in relation to renewable energy systems. This applies to elected members as well as departmental officials. This creates problems in terms of developing appropriate specifications for systems and ensuring that appropriate budgets are made available.

4) Power generation via solar systems is developing rapidly in South Africa. A number of multi-MW solar parks are currently being planned or constructed. For example, a 5GW Solar corridor is being planned for the Northern Cape starting with a 1GW installation at Prieska.[2]

5) Provision of hot water via solar heater systems has strong backing from government with plans to implement 1 million household systems by 2014 and 5.6 million by 2020.
   a) Solar water heaters offer an effective way of reducing electricity demand at a household (and thus national) level.
   b) Electricity cost savings can be significant for rural householders, such as farm workers.
   c) It is important that maintenance of systems is costed into project implementation.

6) Eskom policies and tariff structures can militate against the viability of renewable projects.
   a) Eskom does not (officially) permit householders to feed power back into the grid, citing safety concerns. However, this is standard practice in other countries and is an important incentive for small-scale installations.
   b) Eskom's tariffs in relation to pricing electricity produced via small-scale renewable systems are not conducive to encouraging such production.
   c) Municipalities derive substantial income from the sale of electricity locally. Indeed, electricity revenue subsidizes the provision of other services. However, this means that municipalities are disincentivised from engagement with non-grid tied schemes; energy saving schemes and feed-in schemes.
   d) Long-term contracts between Eskom and users can contain exclusive supply clauses, which also stymie the implementation of renewable schemes.

7) Solar is creating many business opportunities in South Africa both in terms of production and installation.
   a) There are several component manufacturing plants within the country for making panels and inverters. However, according to sources interviewed in this study these units are operating well below capacity. There is a significant oversupply of these products globally and therefore there is strong competition.
   b) Various interviewees noted that variable component quality can be a problem and that the sheer range of products available within the market makes it very difficult for purchasers to assess whether or not they are getting value for money.

[2] http://social.csptoday.com/emerging-markets/south-africas-5-gw-solar-park-energy-focus-moves-prieska

c) At a local level there has also been a reported growth in companies offering to design and install systems. Anecdotal evidence suggests that expertise is lacking within some of these firms leading to the installation of inappropriate and costly systems.

Key Recommendations

1) Household level solar PV projects should be underpinned by thorough participatory consultation processes amongst the beneficiary community. The objectives of such participation include: (a) the conduct of a full assessment of householder priorities in relation to power needs; (b) ensuring that householders are aware of the limitations of solar PV systems; (c) ensuring that the project has 'buy in' from the community.

2) Fully costed, long-term management plans must be implemented as part of the project design. It is advisable to build in a realistic payment mechanism from the households which will contribute to the aftercare of the system. Some community members should receive training which will enable them to service the systems to at least a basic level. Ideally, the support provided by these individuals should be remunerated.

3) It is vital that solar PV systems are designed with components that are mutually compatible, as well as compatible with the projected demand patterns of the end users. High quality products should be used in order to reduce systems failures and medium term maintenance costs. This also applies to solar geyser projects.

4) Where a reliable connection to the grid is available this should be the first option for providing domestic electricity. Other renewable options should be considered such as solar geysers and eco-cooking solutions.

5) Government official and politicians require training and support in order to help them make effective decisions about the appropriateness and viability of solar PV projects.

6) Monitoring and evaluation programmes need to be implemented to ensure that lessons are learned and disseminated from renewable energy projects.

7) Eskom tariff structures and related policies need to be reviewed in order to unblock constraints which are currently prejudicing the effective rollout of renewable energy projects.

Case study 1: The Boomplaas Community Household Solar PV System

Technical details

Boomplaas, a small informal settlement in the Northern Cape, was the chosen location for the implementation of a household level solar PV project during 2012, costing ZAR 1 million.[3] Each household is connected to a small ‘power station’ containing two 240W solar panels, a 1000W inverter and six 2V batteries (see figures 1 and 2 below). Each household also received internal wiring, including the fitting of pull switch lights and plug sockets for attaching appropriate appliances. The project was conceptualised and delivered with backing from senior provincial politicians.

Figures 1 & 2: The Boomplaas power stations and the equipment inside the bunker

Project outcomes

Most households report that the project has brought **benefits**, particularly in terms of the provision of lighting, the ability to charge cell-phones, and access to audio-visual entertainment, i.e. t.v. and CD players. There is no usage charge for the electricity generated. Several householders described the benefits as ‘life changing’.

However, an array of **problems** has been noted:

1) Some of the systems have failed and do not work or only work intermittently;

2) All community members are disappointed by the low capacity of the system. They claim that they had been led to believe that the system would possess similar functionality to grid power;

3) Current usage patterns, which result from ineffective prior training of users and technical weaknesses in the project design, are prejudicing the longevity of the systems (see figures 3 and 4 below). In particular, the batteries are being poorly managed (see figure 4 below), which means they will die much sooner than necessary. Hence the system will no longer operate.

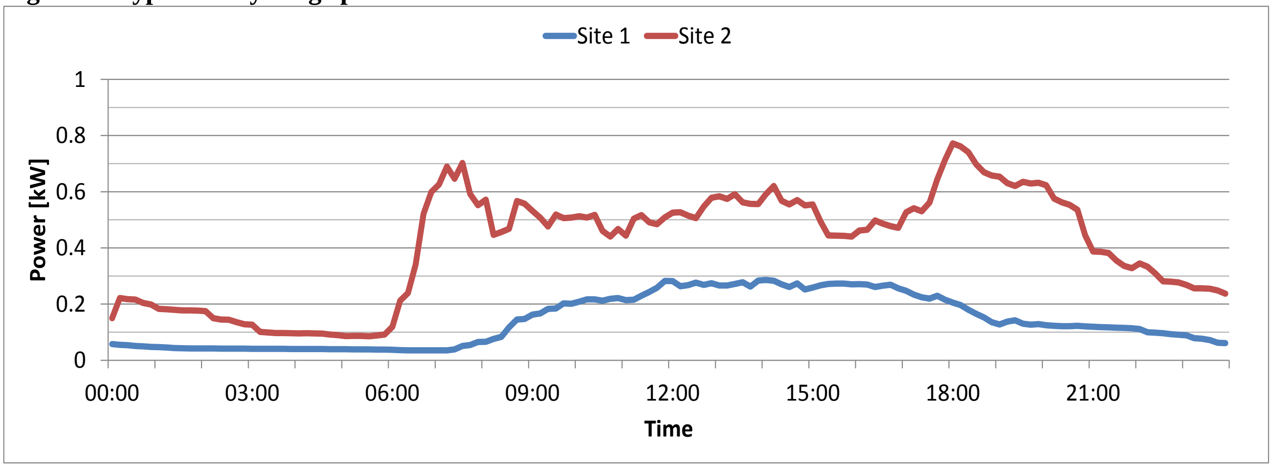
4) Due to the relatively low power capacity people’s priorities in terms of needs are not being met. The ability to cook and use a fridge would make the most significant difference to their quality of life but these needs are not provided for;

5) It is a ‘drop and go’ project. There was no mechanism put in place to provide the on-going maintenance and support which such an engineering project requires. Instead, two community volunteers (who were under the impression that they would be paid) are doing their best to manage the system. But without financial backing or advice services this is an impossible task.

[3] £1=approximately ZAR 14.5

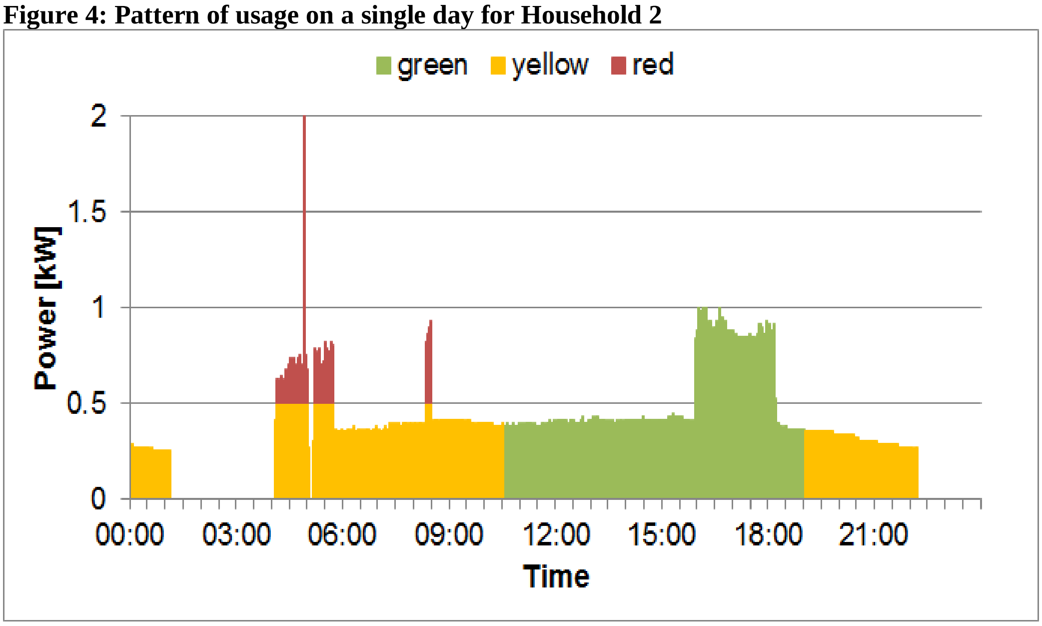
6) Divisions within households and within the community are being created. The demands placed upon the two volunteers are unreasonable, whilst householders are suspicious as to why some people's systems are working better than others.
7) Disaffection with government has been generated.
8) The reputation of renewable energy projects is damaged, despite the fact that the problems lie within the implementation rather than with the technology.

Figure 3: Typical daily usage patterns for Households 1 and 2



n.b. The data indicates the average usage for the given time of day during the 2 week study period.

Figure 4: Pattern of usage on a single day for Household 2



n.b. The data illustrates the actual usage on a single day. This enables short term spikes in usage to be identified, which would be smoothed off in daily average data.

Key:

(green)	**Batteries sufficiently charged to sustain appropriate loads**
(yellow)	**Battery charge levels borderline in relation to load**
(red)	**Loads excessive and a threat to battery health**

Recommendations in relation to the future of Boomplaas

1) The system requires a full maintenance check and review with non-working components being replaced.

2) An ongoing maintenance plan needs to be devised and put in place, including a payment mechanism for community members who look after the system.
3) A rigorous participatory process involving the community needs to be implemented to ensure that there is meaningful 'buy-in' to the project going forward. Without such buy-in or continual flows of external support, the project will become an expensive white-elephant.
4) Any further investments into the system itself need to be carefully thought through and be based upon a full technical assessment of the current system aligned to a detailed understanding of the community's electricity usage patterns.
5) With better training and some relatively minor technical adjustments/additions the system at Boomplaas could achieve much better outcomes for the community. The addition of a single extra solar panel to each system would appear to be the best technical option for improving the system performance and lifespan. One extra panel will provide enough power in the day to meet demand and also charge the batteries sufficiently to increase night/early morning availability.
6) It is important that lessons are learned from the Boomplaas experience and disseminated across government departments to ensure that future projects are more effective. In this sense, Boomplaas can be viewed as an important pilot project.

Summary of options for upgrading Boomplaas

Technical Option	Benefits	Management Issues
A. Add extra panel	• Will enable full battery re-charge • Improve life time of system. • Enable greater daytime usage	Need to maintain usage patterns at appropriate levels.
B. Add extra panel and battery	• Will enable full battery re-charge • Improve life time of system. • Enable greater daytime AND night-time usage	Need to maintain usage patterns at appropriate levels.
C. Replace 1000W inverters with 2000W inverters	• Will enable higher power rated load appliances to be used	Will lead to substantial reduction in longevity of batteries UNLESS **two** extra panels are added and a further battery added to the system.
D. Add solar geysers and appropriate tech options such as fuel efficient stoves	• Will reduce need for households to heat water thus taking pressure off the solar PV system.	
E. Do nothing	• No cost for funders	System will become obsolete without some form of constructive intervention

What wider lessons can be learned from the Boomplaas experience?

1) Such projects require considerable participatory engagement work with communities prior to inception, this was not the case in Boomplaas. It is particularly important that communities be made aware from the outset that solar PV systems will not offer the same level of utility as a connection to the Eskom grid.

2) It is essential that community members are provided with appropriate training to ensure that they are aware of the implications of mis-using the system. Technical mechanisms to prevent mis-use need to be built in wherever possible.
3) It is advisable to build in some realistic payment mechanism from the households which will contribute to the ongoing maintenance of the system.
4) Ensure that government officials managing such projects have received the appropriate technical training and that they have access to reliable third party technical advisers.
5) Ensure that there is a long-term management plan in place for looking after the system.
6) Where a connection to the grid is available this should be the first option for providing electricity to homes.[4] However, cost-effective and environmentally friendly renewable options, such as solar water heaters, should also be considered to improve the householder experience and lower the burden upon the grid. If grid connection is not an option then a survey of community needs should be carried out. It is possible that other renewable-tech options may be available which will meet people's needs more effectively (and cheaply) than solar PV systems, for example, solar geysers and eco-cooking solutions.

Case study 2: Household Solar PV Systems – North Island, Eksteenskuil, Northern Cape

North Island is the collective name for a number of small islands formed from the braids of the Orange River near to Keimoes in the Northern Cape. The area is sparsely populated by small-scale farmers, who mainly produce grapes from vineyards using water from the river for irrigation. Service infrastructure is very poor with no tarred roads, no piped water or formal sewage system and only a few properties at the entrance to the area have access to electricity. The low population and the fact that the area is prone to sporadic flooding militates against investments in infrastructure.

Mr. Gert Titus

During 2010 Mr. Titus invested in a domestic solar PV system as he had come to realise that electricity was unlikely to be provided in the near future by the national electricity supplier, Eskom, despite frequent promises apparently being made by local politicians and community leaders. For Mr. Titus a solar system offered the promise of a cool drink after a long, hot day's work on his smallholding and a chance to watch the news and some sport. Mr. Titus contacted a local firm who fitted the following system at his house:

2 x 75W solar panels, a regulator, a 2000W inverter and 3x12V Batteries. The system cost approximately R20,000. This represents a considerable investment for a small-scale farmer.

However, the system brought few of the benefits that Mr. Titus expected. The fridge, initially ran only for a few hours, and the TV would cut out regularly. Much of the focus was on making the fridge operate as that was the most significant thing for improving the lives of Mr Titus and his wife. He reported the problem to the installers. Their response was to give him two additional second hand panels, each of different specification. Mr. Titus later bought a new, smaller inverter himself. The system scarcely works at all now

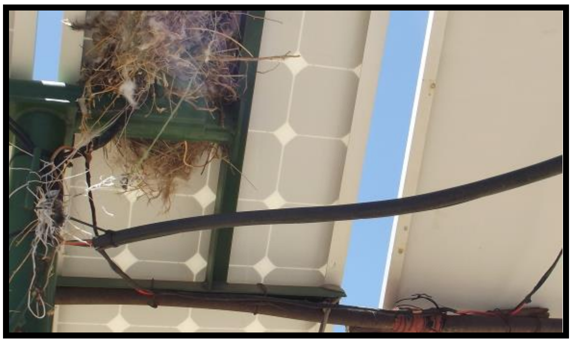
[4] This assumes that the grid network is reliable. In South Africa the grid is relatively reliable, however in other contexts the reliability of the grid is a factor that needs to be taken into account.

– the lights will work for a few minutes during daylight hours and phones can be charged during daylight hours. The batteries are dead. Mr. Titus feels that he made a big mistake with the investment, in particular putting his faith in agents. He had given up hope of gaining any benefits from the system. However, he is now considering trying to salvage something, perhaps removing the additional panels and experimenting with a car or truck battery. However, he does feel deflated knowing that the system will never be able to provide his biggest desire, which is to have a fridge.

Technical Assessment – why has Mr. Titus's system failed?

- The components of the system were mis-matched from the outset. The inverter was vastly oversized in relation to the capacity of the panels. This would have put undue pressure on the batteries.
- Furthermore, the battery capacity was also too great in relation to the productive capacity of the panels. The batteries would not have been able to fully charge up. Yet, they would have been drawn up heavily by the inverter and the fridge. Therefore the batteries would have run down too quickly their intrinsic health would have been damaged and consequently battery life was severely curtailed.
- In addition, the extra panels that were added to the system would have increased the inefficiency of the system rather than adding to its capacity. This is due to the fact that they are different to the original ones that were fitted (see figure 1 below).
- Furthermore, the system wiring is sub-standard which will also reduce the efficiency of the system (see figure 2 below).

Figures 1 and 2: Mr. Titus and his dysfunctional system and the panel wiring



Mr. September

Mr September lives in the far reaches of North Island, adjacent to Mr. Titus. He is a semi-retired raisin producer, who has in the past worked as an electrician. In approximately 2008 Mr. September decided to set up a mini-solar PV system himself. He bought a single 55W Watt panel, a 120W inverter and connected this to a car battery and a truck battery (both of which are in the bedroom and as such must pose a health hazard). He wished to be able to use the system to power some lights, charge his cellphone and run a radio. The system has worked well since he put it together.

The secrets to Mr. September's relative success appear to be his background as an electrician and his realistic ambitions in relation to the capability of the system.

Figures 3 & 4: Mr. September's innovative panel construction system

Case study 3: The Elim Project, Agulhas Plain, Western Cape, South Africa

Project Summary

The Elim Project involves four wine cellars within the Nuwejaars Wetland Special Management Area (SMA) on the Agulhas Plain. The Agulhas Plain itself is a site of biodiversity significance containing many areas of ecological sensitivity and importance. The Nuwejaars Wetland SMA is one such area. Sustainable use of electricity has been highlighted as a major focus area for the SMA. Wine cellars are highly energy intensive so a pilot project was devised, supported by funding from Germany (ZAR 1.4 million), to develop renewable power facilities at the four main wine cellars in area – The Black Oystercatcher, Zoetendal, The Berrio and Strandveld Wines (see figures 3 & 4 below).

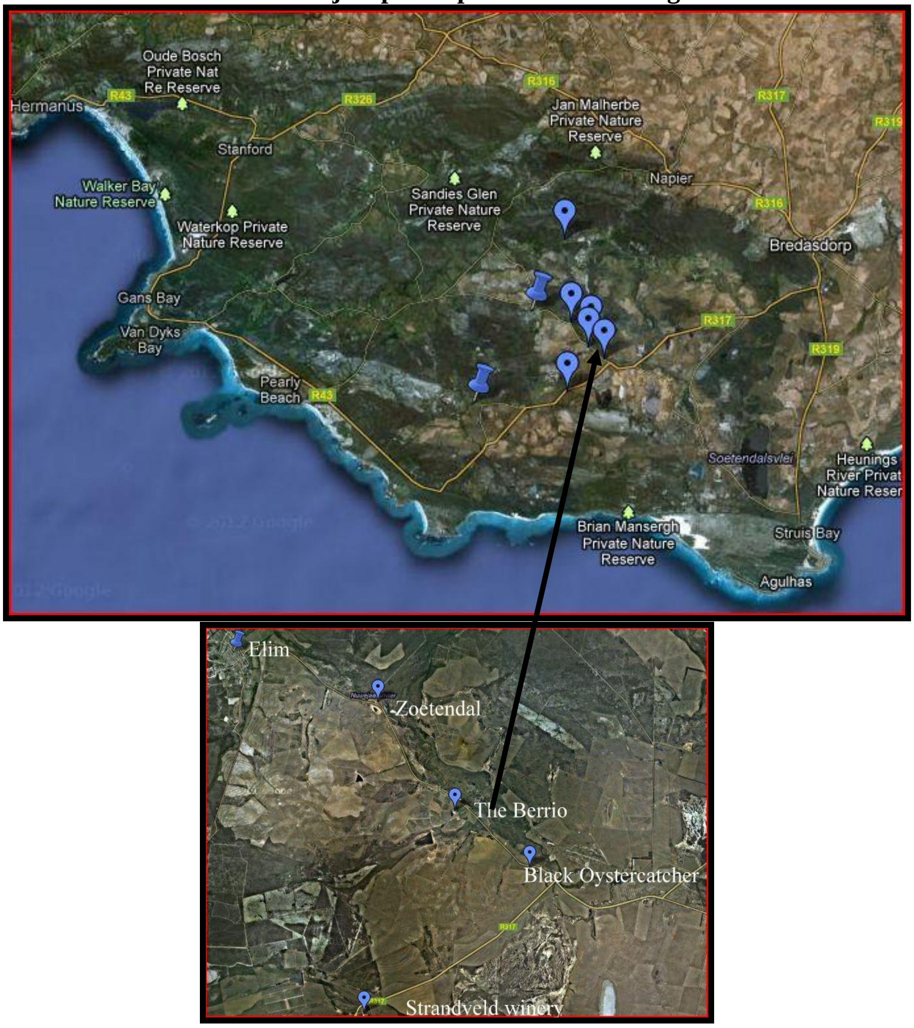
Various concepts were explored, including setting up a biomass project at Elim, which would benefit the local people. However, the scoping for the project indicated that this option would not be cost effective. After further consultation it was decided that renewable systems would be implemented on the sites of each of the wine cellars. Two of these are solar systems and two are hybrid systems incorporating solar and wind (see figures 1,2,5 and 6 below). The systems are incorporated into Eskom's national electricity grid. Electricity from the systems is used to power the wine cellars whenever sufficient has been generated/stored. The financial value of the renewable component is calculated using Eskom tariff structures and this money is paid into the account of a Section 21 Not-for-Profit company, the Nuwejaars River Nature Reserve. The money is used for conservation and social development projects.

Figures 1 & 2: Technical specifications and the front view of the system

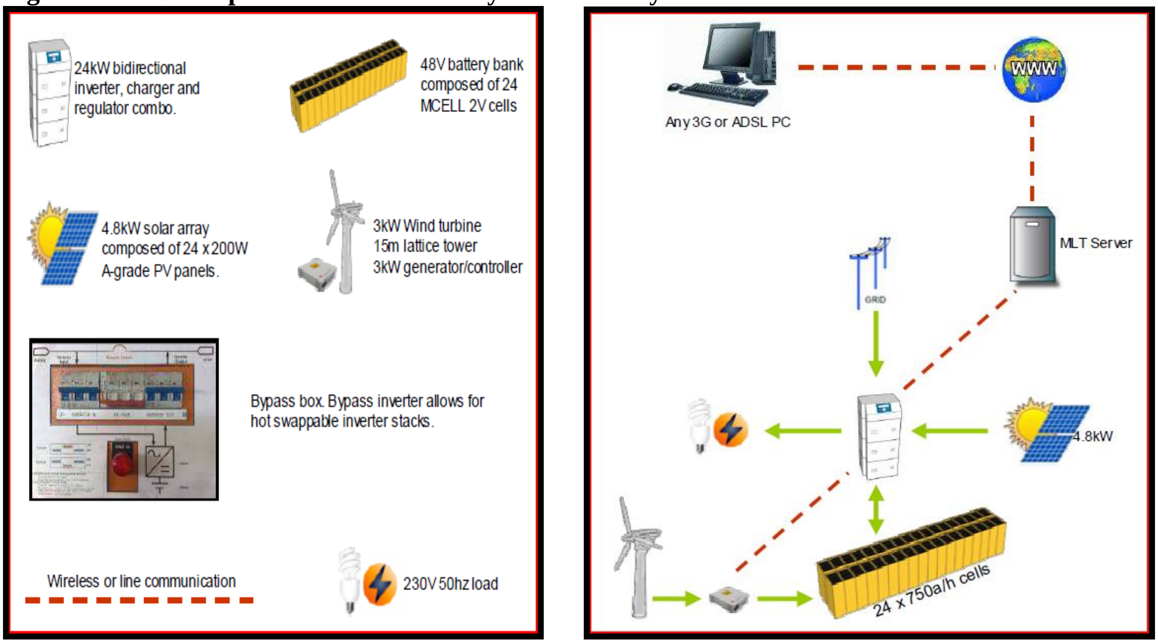
SITE A - Black Oyster Catcher
24kW bi-directional inverter
MPPT 100A solar regulator (built-into inverter)
MCELL-750 2V cell - 540a/h C5 750a/h C100
200 Watt MLT solar panels (A-Grade)
Bypass box
AC/DC isolators, fuses, etc
Combiner boxes, lightning protection, earthing
PV transport/insurance
Installation materials
3kW Wind generator
3kW wind generator controller 48Volt
15m lattice tower

Note there are 24 panels and 24 batteries. The (fixed) solar panels (see figure 2 above) have been oriented to optimise the solar input in the middle of winter.

Figures 3 & 4: Location of the Elim Project participants within the Agulhas Plain



Figures 5 & 6: Components of the Black Oystercatcher System



Wind turbines have been added at two of the 4 sites (including the Black Oystercatcher). This area of South Africa (located near to the southernmost tip of the continent) has sufficient wind to make turbines viable. In fact there have only been four 24 hour periods in the last 10 years when the wind has not blown. The input from the wind element is important as it expands the system's generation time period beyond daylight hours.

Figures 7 & 8: The battery bank, inverter and regulator system

Beneficial outcomes

- The system produces electricity to the value of R1800 a month for investment into biodiversity projects.
- High visibility renewable projects can be a useful marketing tool for businesses with a biodiversity/sustainability component.
- This has been an important demonstration project for learning about the opportunities and challenges of implementing rural renewable projects.

Challenges

Rory Allardice, Nuwejaars River Nature Reserve:

The individuals got the systems for free to test it to see if it is viable in the long term. And we are finding that economically it is not viable. Even though we got it for nothing we will not be able to replace it under the present tariffs … and the present system for electricity generation. So, there are two problems: 1) Eskom's pricing structures. Though Eskom's price hikes do mean that in 2 to 3 years time this system might re-capitalise itself; 2) What is killing is the insurance side.
I have got a problem saying that we are using the capital in the most efficient way.

- Insurance is essential given the constant threat of theft. Insurance costs are approximately 4% of the replaceable capital (R1.4 million for all four systems). This is a significant ongoing cost to deduct from the project's income.
- There have been several instances of theft since the project was constructed. For example, 13 panels were stolen in October 2012 and a further 9 in December. Considerable efforts have been made to make the panels difficult to steal, for example by changing the ways that the panels are connected to the mainframe. However, the thieves are adept are finding ways of overcoming these changes. The activities of 'professional' criminal gangs are a significant problem in South

Africa. There are reported to be different trading routes for stolen panels. Some are exported via smuggling networks into Southern Africa, whilst others are broken down into their constituent parts, shipped back to China and the components used to make new panels. The ingenuity, motivation and propensity to violence of these outfits are a significant problem in terms of the viability of solar installations. The requirement to fit anti-theft elements adds to the costs of the systems. One firm has even gone to the lengths of devising a panel that cannot be broken down into its component parts without damaging all the individual parts

- The economics of the system represent a significant challenge to its viability. The fundamental problem relates to Eskom’s pricing structure. Eskom have agreed to place a value upon the electricity generated by the systems. However, this value only represents one-third of the total cost of each unit of electricity, as the remaining two-thirds are fixed ‘service fees’. Therefore the value that is paid back for the ‘green energy’ is substantially reduced. The net result is that income being earned from the scheme is significantly less than had been envisaged at the outset. Whether the tariff being paid is ‘fair’ or justifiable is very much open to debate. However, there is a strong case to be made that the Nuwejaars River Reserve SMA is receiving considerably less than the real economic value of the electricity they are producing. It can be concluded that Eskom’s complex tariff structures are a significant barrier to the rollout of renewable projects.
- Individual landowners face challenges in terms of the long term contracts that they have with Eskom. These contracts (which may date back a quarter of a century) may contain clauses prohibiting users from taking power from other sources or may include long term service fees. The bottom line is that the complexity of these agreements is perceived by landowners to be a barrier to the adoption of new renewable systems.
- Furthermore, Eskom insist that systems which connect to the grid must not feed power into the grid. They cite health and safety concerns as the rationale for this policy. However, other countries achieve this without concerns, so it is unclear as to why Eskom follows this practice. It does, however, represent a further structural barrier to the further rollout of renewable systems. For example, there would be no need to invest in expensive battery storage systems (which will eventually require replacement and also, do require ongoing maintenance) if the power could be fed straight into the grid.
- The wind turbines have been problematic. The turbine on Strandveld has never worked properly, whilst there are ongoing mechanical issues with the turbine at the Black Oystercatcher. Gaining maintenance support from the installers has proven difficult.
- There is a degree of dissatisfaction with the ongoing service from the installers. Specifically, there is a perception that reported problems are not always dealt with swiftly enough and that information flows from the installers (who are able to oversee the system 24x7 via computer linked data feeds) are insufficient. A great deal of information can be generated about the functionality and performance of the system (for example, levels of power generated on different days under different weather conditions), which is all important data for evaluating the potential ways of making more effective use of the system going forward. Yet, this information is not being readily provided.

The way forward

Consideration is being given as to the best way of using the equipment in the longer term. One option is to relocate the equipment to a single site, thus benefitting from economies of scale in terms of management. It may be possible to provide all the electricity requirements of that site from the larger system and thus become 'Eskom neutral'. The challenges of making such a move include: i) the terms and conditions of ongoing contracts with Eskom; ii) the need for a back-up mechanism in the event of a shut down within the renewable supply.

Lessons from the project

- If rural renewable projects at this scale are to be viable there needs to be significant changes in Eskom's tariff structures and the nature of their contracts with users.
- The technology itself is excellent and, apart from some problems with the wind chargers, has worked very well. As with any engineering system there will be issues that require ongoing management and maintenance. End users need to be assured that responsive and effective maintenance agreements are reached with installers.
- The risk of theft and resultant insurance costs are a significant burden for projects involving solar panels, especially where the panels are installed in a high visibility/accessibility area.

Case study 4: Solar geyser (water heater) projects, the Chargo Trust, Northern Cape

The installation of solar water heaters has been backed by government policy and various subsidy schemes run by Eskom. Indeed, the South African government has set a target for 1 million geysers to be fitted by 2014. As a result many poorer households across South Africa have had such systems fitted in the last couple of years. Installation within urban areas is occurring apace; for example, in October 2012 the City of Johannesburg announced a scheme to fit 110,000 systems.[5] These systems are being installed on many farms, even where there is already a connection available to the electricity grid. Below is a short case of the Chargo Trust, near Kakamas in the Northern Cape.

Figure 1: The entrance to the Chargo Farm near Kakamas

The Chargo Trust

The Chargo Trust comprises four farms which produce table grapes. Their markets include Waitrose in the UK. They employ 100 permanent workers and around 1200 seasonal workers during the harvesting period. All workers are housed in purpose built

[5] http://www.sacities.net/workwith/joburg/news/918-lehae-residents-to-receive-solar-geysers-

hostels. In 2011 a decision was taken to install 110 low pressure geysers in the housing units (see figure 2 below). An Eskom subsidy was available, which amounted to approximately 75% of the project cost – the full cost of each geyser was circa ZAR4400 including full installation. The continuing upward price movements of electricity was a significant factor in the farm's decision making, especially as these increases affect workers disproportionately. The farm allocates ZAR 35 a month of electricity to each seasonal worker and ZAR 70 for each permanent worker. The farm has also installed other energy management policies, including fitting of insulation within the worker housing units, which reduces extremes of temperature and roofs have been painted white to reflect heat. Obviously, there are occasional maintenance issues, such as broken tubes, but the farm has the infrastructure to deal with these problems quickly.

Figures 2 & 3: The geyser installations on worker housing units and the 'donkey' structure

Benefits

- The water is used for washing, cooking and even making hot drinks.
- Farm workers are using much less electricity as they no longer need to heat as much water. One office worker reported that her monthly electricity costs have dropped from R200 a month to less than R70 since the installation of the geyser. This represents a substantial saving.[6] Many farm workers are now not even using their full electricity allowance. Therefore, the farm is also saving money.[7]
- Workers no longer need to use the former system for heating water, known locally as the 'donkey' (see figure 3 above). This is a brick structure which houses a metal container and a space for a fire. Water is put into the container and heated via the fire. Water is then drawn off from a tap. However, this system was very labour intensive and also created health and safety issues.
- Farm management state that they were amongst the first farms in the area to install geysers and subsequently a number of others have followed suit. Furthermore, the geyser installation is part of a wider social investment programme at Chargo. According to management the success of this programme and their broader management practices can be seen in the relatively low staff turnover at the farm. There are reports that the installation of the geysers resulted

[6] The daily minimum wage for farm workers in South Africa is R105.

[7] Northern Cape farming enterprise, Karsten, is also in the process of installing 300 new solar water heaters to replace the electric geysers at its worker housing sites. These will save it the $4.95 it used to cost to run each geyser for just three days. Karsten's is a large enterprise and has the economies of scale to employ a dedicated energy manager. He notes that renewable projects, such as geyser installation, produce further benefits such as the creation of further on-farm work in terms of installing and maintaining the systems.
http://www1.ifc.org/wps/wcm/connect/region__ext_content/regions/sub-saharan+africa/news/south_africas_eco_friendly_exports

in an increase in applications to work on the farm. Furthermore, feedback via the worker’s committee has been very positive.

Challenges

- There is a problem with limescale build-up which requires regular maintenance.
- The ending of the subsidy programme for low pressure geysers is slowing the process of wider rollout.

Summary comments

The installation of solar geysers clearly represents an excellent way of using solar technologies. Once installed geysers produce a substantial saving on electricity bills for users and at the same time reduce the burden on the grid. For people without electricity in the first place solar geysers are a relatively cheap way of providing hot water, which in itself can significantly improve people’s quality of life. As noted earlier solar geysers are being installed widely across the country. Some people interviewed for this project did express concern about the quality of product and installation in some cases. Whereas a farm has the infrastructure to ensure ongoing maintenance of geysers, the same is not true of an urban informal settlement unless an appropriate system is put in place. Further concerns have been articulated concerning the fact that the installation of water heaters tends to lead to an increase in water consumption – which can have a cost for householders AND imposes greater pressures on the scarce water resource.

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