IMPROVING THE SUSTAINABLE OPERATION OF A WORLD HERITAGE SITE: INCREASING ENERGY EFFICIENCY AND IMPLEMENTING A RENEWABLE ENERGY SYSTEM ON ALDABRA ATOLL, SEYCHELLES

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ABSTRACT
The UNESCO World Heritage Site of Aldabra Atoll is an important conservation and research area but its remoteness makes management a major logistical challenge. Using diesel generators for electricity resulted in high fuel and transport costs, and was environmentally unsustainable. In 2008, the Seychelles Islands Foundation started investigating ways to increase energy efficiency, and developing a renewable energy system; aiming to reduce operational costs. Following an energy audit, renewable energy options and their applicability were assessed, alongside research into energy efficient measures. Findings were subsequently implemented, and a 25 kW_p hybrid photovoltaic-diesel energy system was set up. Demand reductions were a prerequisite for successful implementation of the renewable energy system. Energy efficient measures reduced electricity demand by 57 per cent. 38,171 kWh of solar electricity was generated in the first year of operation, covering 94 per cent of the station's new demand. This has avoided a total of 97,523 kg CO_2 per year. Since implementation of the photovoltaic system, diesel demand has decreased by 97 per cent and operational savings of up to €68,000 are projected, resulting in system payback in only three years. Investments into both energy efficiency and renewable energies are required for environmental and financial sustainability.

KEYWORDS: energy audit, renewable energy, efficient, Aldabra Atoll, Seychelles, hybrid photovoltaic-diesel

INTRODUCTION

Seychelles, an island nation in the south western Indian Ocean (figure 1) belongs to the group of Small Island Developing States (SIDS). The country's dependence on fossil fuels makes the fragile economy particularly vulnerable to increasing oil prices. Seychelles has a negligible impact on global CO_2 emissions but, as an island nation, is hugely vulnerable to the effects of climate change. Even without legal obligation under UNFCCC and its Kyoto protocol to reduce CO_2 emissions, Seychelles has a clear objective to decrease its dependency on fossil fuels and minimize CO_2 emissions (Energy and Environment Partnership - Southern and East Africa, 2012). Implementation of renewable energy projects to achieve a 15 per cent share of renewable energies in electricity production is the national target for 2030 (van Vreden et al., 2010).

Aldabra Atoll, part of the Seychelles archipelago, is one of the largest raised atolls in the world and considered part of a global biodiversity hotspot (Conservation International, 2013). Aldabra hosts many threatened and endemic species and is a valuable scientific research area of high international repute for marine, coastal and terrestrial ecosystems.

Historically, Aldabra's ecosystems were threatened both locally by overexploitation and internationally by a proposal for a military base. Aldabra was nationally designated as a Special Reserve in the late 1960s and inscribed on the UNESCO World Heritage list in 1982. These designations facilitated the preservation of Aldabra as an undisturbed natural treasure. Since 1979, the atoll has been managed and protected by a public trust, the Seychelles Islands Foundation (SIF). With the exception of a small research station (ca. 15 people) established for monitoring, research and protection, the atoll is uninhabited. Aldabra's ecosystem remains fragile and requires continuous protection. Since the establishment of the research station in the 1960s all

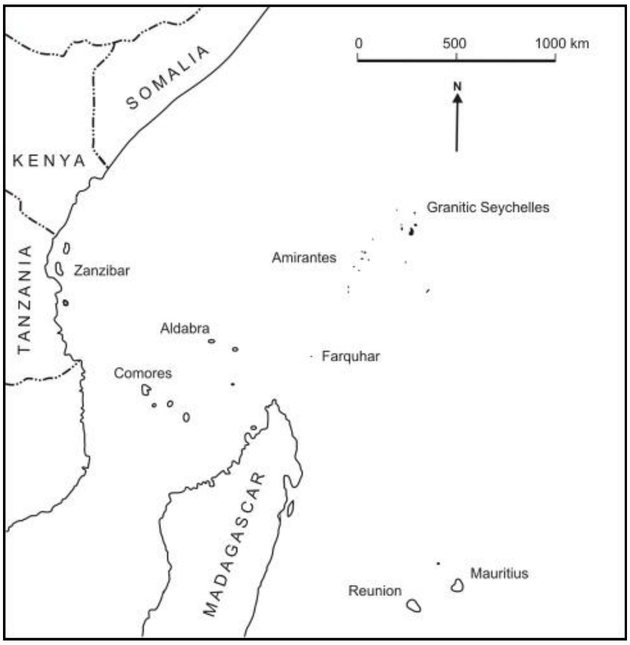

Figure 1: Seychelles island archipelago in the Western Indian Ocean (modified after Hill & Currie, 2007, p.5)

electricity for the station was produced by diesel generators. Aldabra is 1,100 km away from the Seychelles' main island of Mahé and ensuring that the atoll was supplied with sufficient fuel for up to several months was a major logistical and financial challenge. High operational expenses resulting from increasing diesel and transport costs were making the atoll's operation financially unsustainable. Aldabra's income sources have always been limited to small-scale but high-end tourism. The situation worsened in 2009, when the piracy threat in the Western Indian Ocean restricted yachting tourism and trips to the outer islands were severely curtailed. The operation of the atoll is heavily subsidised by income from the Vallée de Mai, Seychelles' second UNESCO World Heritage Site which is also managed by SIF. Due to these financial and logistical difficulties, and to ensure long-term conservation of the atoll, it became a priority for SIF to reduce the energy demand of the station and to replace the inefficient, unsustainable and outdated energy system with an environmentally and financially viable solution.

In 2008, a project was launched with the overall objectives of increasing the environmental and financial sustainability of Aldabra station, minimising CO_2 emissions and reducing dependency on fossil fuels. To achieve these aims, the following specific objectives were to:

1. increase energy efficiency of the station;
2. identify the most feasible and sustainable renewable energy source for Aldabra's conditions; and
3. plan and implement a reliable renewable energy system.

METHODS

A holistic approach comprising several preparatory steps was required to address the diverse issues involved in improving the sustainability of Aldabra's operations. The different stages were conducted in sequence as follows:

1. *Comprehensive energy audit* - to serve as a baseline study evaluating energy demand and electricity costs.
2. *Workshop with local energy experts* – to ensure involvement of local capacity and applicability of the work.
3. *Energy efficiency assessment* - Including a scenario analysis considering opportunities to streamline future electricity consumption and costs.
4. *Cost-benefit and SWOT analysis* – based on the results of the energy audit to assess operational costs. As well as a literature review and other research into renewable energy systems to assess different options (Quanz, 2009).

1. Energy audit

Aldabra is an off-grid location so baseline data on energy consumption was collected by making a detailed inventory of all electrical appliances and measuring electricity consumption for key consumption groups such as air-conditioning (AC) units, household appliances and computer equipment. The total consumption was calculated to be 95,664 kWh per annum with an average 15 people on the atoll. The biggest share was from the AC systems (52 per cent), followed by office equipment (16 per cent), and chilling facilities (fridges and deep freezers, 13 per cent) (figure 2, Quanz 2009). With an average annual consumption of 6,300 kWh per head the demand was more than twice as high on Aldabra than on Seychelles main islands (3,100 kWh per head) (National Statistics Bureau (ed.), 2012).

The costs of electricity on Aldabra were determined by the price of fuel, transportation costs and the efficiency of the generators (produced kWh per litre diesel). Fuel costs only resulted in an electricity price of €0.43 per kWh. However, high transportation costs, including hiring a supply boat, purchasing and filling fuel drums, loading and unloading fuel drums increased the electricity price to €0.61 per kWh. It should be noted that the supply boat also delivers food supplies and therefore only 50 per cent of the cost was included in the transport cost calculation (Quanz, 2009).

These energy calculations were based on 2008 figures. In the following years, both transportation and fuel costs increased substantially on the global market which immediately affected fuel costs in Seychelles, making the economic gains from renewable energy investment even more pressing.

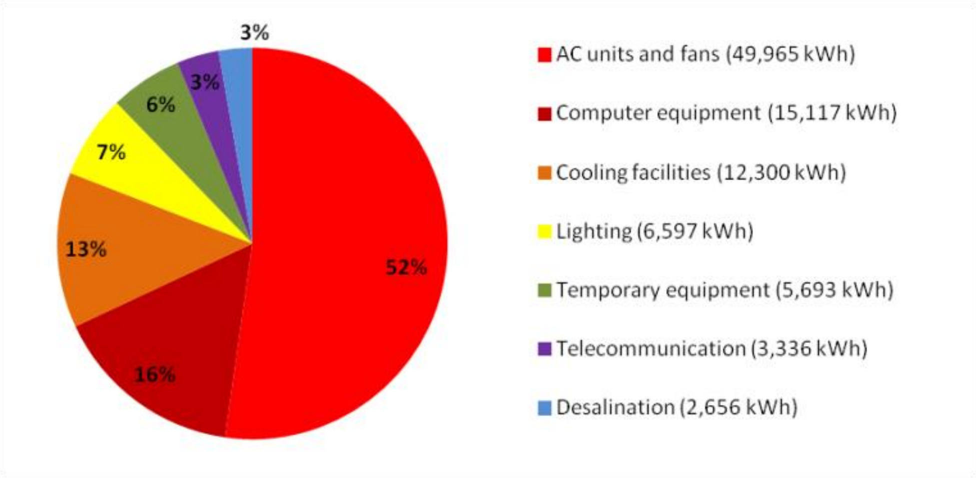

Figure 2: Shares of different energy consumer groups in Aldabra's energy consumption 2008 (Quanz, 2009)

2. Workshop with local energy experts

The baseline energy study culminated with a workshop on Mahé attended by local experts in renewable energies, electricity generation and island operation. The workshop aimed to verify the initial energy calculations and generate ideas on implementation of the renewable energy system. A key recommendation was the need to renovate the single phase overhead electrical distribution system with three-phase underground cables, to facilitate the efficient operation of the future energy system.

In addition, site visits were undertaken to other protected areas in Seychelles that had attempted to meet their electricity demands with a PV system, but had encountered critical problems. Experiences were shared to avoid similar problems on Aldabra. These exchanges allowed for a realistic analysis of costs, such as allocated budget for spare parts and rewiring.

3. Energy efficiency assessment

Energy demand is an important factor to determine the optimal size of a renewable energy system and decisive for the required investment costs. During the last few decades the market has been revolutionized with increased options for energy efficient appliances. Replacing existing equipment with the latest technology makes it possible to realise remarkable savings in electricity consumption, lower peak load demand and reduced CO_2 emissions. Opportunities included low consumption or alternative powered AC units, energy efficient certified household appliances, energy star labelled office equipment, compact fluorescent (CFL) or light emitting diode (LED) lights. Table 1 compares energy consumption, percentage of total energy demand and electricity expenses for the respective consumer groups for 2008 and a future energy efficient scenario. For example, the introduction of the most efficient AC units reduced the energy demand of this consumer group from 52 to 7 per cent of the total energy demand. By maximising energy efficiency measures, energy demand could potentially be reduced by 74 per cent to only 25,021 kWh per year (Quanz 2009).

Investment costs to implement energy efficiency measures were estimated at €36,000 (including transport). Energy efficient appliances were sourced directly from overseas as they were not available in Seychelles. With annual electricity savings of 74 per cent, equalling €40,850, the investment was projected to be recouped within one year. Applying energy efficiency measures was a prerequisite for increasing financial sustainability by reducing Aldabra's operational costs.

A protocol was developed to complement the energy efficient infrastructure by ensuring prudent use of electricity by the staff. The overall project success depended on the support and cooperation of all, therefore it was vital that staff were an integral part of the project and felt ownership of the new system. Staff benefits helped to achieve this; for example, the reduced energy consumption of energy-efficient fridges made it possible to equip all houses with a fridge. In contrast, however, inefficient appliances, such as electric rice cookers, toasters and cookers were removed from the island, which had to be explained to all staff.

	2008			Energy efficient scenario		
Electricity consumer	**kWh/a**	**%**	**€**	**kWh/a**	**%***	**€**
Air-conditioning & fans	49,965	52	30,479	*7,000*	*7*	*4,270*
Computer equipment	15,117	16	9,221	*3,370*	*4*	*2,056*
Cooling facilities	12,300	13	7,503	*3,135*	*3*	*1,912*
Lighting	6,597	7	4,024	*1,487*	*2*	*907*
Temporary equipment	5,693	6	3,473	5,693	*6*	*3,473*
Telecommunication	3,336	3	2,035	3,336	*3*	*2,035*
Desalination	2,656	3	1,620	*1,000*	*1*	*610*
Total	**95,662**	**100**	**58,355**	**25,021**	**26**	**15,263**

Table 1: Estimated potential energy (kWh/per annum) and financial (€) costs application (energy efficient scenario) of energy efficiency measures for different energy consumer groups used on Aldabra Atoll.

*** Percentages of the consumer groups for the future scenario are displayed as percentages of the original figures for 2008**

4. Cost-benefit and SWOT analysis

An in-depth literature review and cost-benefit analysis of all available renewable energy sources was undertaken, to allow an informed decision as to the most appropriate system on which to base Aldabra's power production. Through integrating external and internal factors, a holistic strategy can be realized (Fuerst & Scholles (ed.), 2008: 505). A SWOT analysis was applied to potential renewable energy sources, namely photovoltaic (PV), concentrated solar power (CSP), wind power, ocean energies (e.g. tidal power, ocean thermal energy conversion) and biomass (Table 2 shows the SWOT analysis undertaken for PV power; Quanz, 2009).

Key considerations, when identifying the most suitable energy source to cover or partly cover Aldabra's electricity demand, were its reliance, the energy output, operation and maintenance costs, the system lifespan and the start-up investment. Due to the remote location and logistical challenges a low maintenance solution was considered more important than low investment costs. The climate of Aldabra is harsh, particularly the problem of corrosion from significant exposure to the marine environment. Logistics are expensive and complicated, thus flying in technicians for regular maintenance or troubleshooting is not possible, especially during the south-east (SE) monsoon season (April-October), when no transport to the atoll is available. Therefore, a proven and reliable technology was needed, ideally with an option to remotely monitor and trouble-shoot the system. In addition, the lack of heavy construction equipment (crane, excavator etc.) limited the scale of the construction work that could be undertaken on the atoll. Aldabra is the most strictly protected area in Seychelles and limiting the environmental impact of the project was of paramount importance.

The initial SWOT analysis indicated that a hybrid wind-PV system would be the best option; PV because it is a proven technology with comparably low maintenance requirements, reliable output predictions throughout the year, readily transportable and easy to install, and with limited construction requirements. A vertical micro wind turbine was proposed, because of the relatively low start-up wind speeds required, lower noise level compared to larger horizontal wind turbines, smaller size making installation easier and their reputation of negligible

Table 2: SWOT analysis of photovoltaic power for Aldabra

SWOT Photovoltaic	**Helpful** ***to achieve the objective***	**Harmful** ***to achieve the objective***
Internal analysis (attributes of the energy sources)	**Strengths:** - modularity - higher irradiation increases efficiency - favourable for stand alone application - environmentally-friendly technology - long lifetime makes high investment costs worthwhile - commercially proofed technology - hybrid system possible	**Weaknesses:** - efficiency 10-18 % - with increasing operation temperatures efficiency decreases - increasing costs with higher efficiency - fluctuations in availability - storage facilities required - high investment costs
External analysis (attributes of the environment)	**Opportunities:** - harmless for environment - increased efficiency due to higher solar irradiation on Aldabra	**Threats:** - basic maintenance required for successful operation and full life-span

Unloading of construction materials on Aldabra © Michal Sur (December 2011)

impact on birds. There was, however, inadequate wind speed data for Aldabra, which was limited to a few years in the 1970s recorded at an unknown location and height. The old data ranged from 3 m per second during the north-west monsoon to 6 m per second during the south-east monsoon. With possibly insufficient year-round wind speeds being a concern, prior to investment in wind technology it was decided to obtain accurate wind speed data at an appropriate location and height. Further consideration of wind technology was put on hold until sufficient baseline wind data was collected to assess the suitability of this technology . The results from the wind study so far confirm that investment into a vertical wind turbine would not be an economically viable option.

IMPLEMENTATION

At the end of 2010, following the findings of the SWOT analysis and the data available, the decision was taken to implement a hybrid PV-diesel system. A hybrid system was opted for because it ensures reliable and efficient system operation, since PV power only would have had weather related fluctuations. The company, IBC solar, based in Germany, was selected on the basis of relevant experience, especially with off-grid systems in remote locations that have difficult logistics, and the professional services they offered including post installation service.

Initially SIF planned to phase the change from the conventional energy system to a PV-powered system. Following receipt of the initial quotations and planning, however, it was identified that costs for a phased conversion to the new power system would be substantially higher due to transportation, labour, construction and commissioning costs. It was ultimately more economical to design a completely new system, covering all power requirements, including the complete renovation of the electrical distribution system. Thus, instead of starting with a 10 kW_p system that would supply part of the station and be expanded later on, the plan was upgraded to the installation of a 25 kW_p system to meet all energy demands immediately. A battery backup system was incorporated to supply the research station at night. A new backup diesel generator was also included to ensure system reliability during bad weather periods and to enhance the life time of the battery system.

A web-based monitoring system was integrated, allowing online system control, thus supporting the smooth running of the system over its lifespan. The system allowed for possible future PV extensions and eventual integration of a small-scale wind turbine. By August 2011 the system design was finalised.

SIF staff on Aldabra assembling solar modules on mounting frame © Christina Quanz (March 2012)

The most challenging element of the project was the construction phase. The construction plans were produced by IBC solar and implemented by a local contractor in Seychelles. The delivery of construction materials was particularly demanding as all supplies had to be ferried from the supply boat using a smaller boat and then manually unloaded onshore. It finally required three supply boat trips before all construction materials were on Aldabra (see picture on previous page). The renovation of the electrical distribution system of the whole station with three-phase underground cables was undertaken by local electricians.

By early 2012, 22 t of solar equipment, accessories and efficient household appliances were delivered by IBC Solar and finally unloaded on Aldabra. Aldabra staff then assembled the mounting structure, placed the PV modules (see picture above), inverters, communication and energy control devices and connected the batteries and modules. At the end of March 2012 two engineers from the solar supplier arrived for the final commissioning of the system and staff training.

DISCUSSION: RESULTS AFTER FIRST YEAR OF OPERATION

Increased energy efficiency

Initially increased energy efficiency was achieved by changing from outdated inefficient office equipment (e.g. cathode ray screens) to energy star labelled laptops, changing the lighting system to CFL bulbs and implementing a protocol for conservative use of electricity on the atoll. The first results were visible in 2010, when it was confirmed that the daily energy consumption had fallen by 20 per cent to 76,650 kWh per annum. Since early 2012 the new energy-certified fridges and freezers, combined with implementation of other energy efficient measures, have so far reduced Aldabra's electricity consumption by 57 per cent (from 95,664 to 40,867 kWh per year) compared to pre-project levels. In addition the required peak load demand has dropped from 25 kW to 5 kW and electricity costs have been reduced by 85 per cent (figure 3). Further reductions in electricity demand will be achieved with the installation of the new inverter-type AC system which

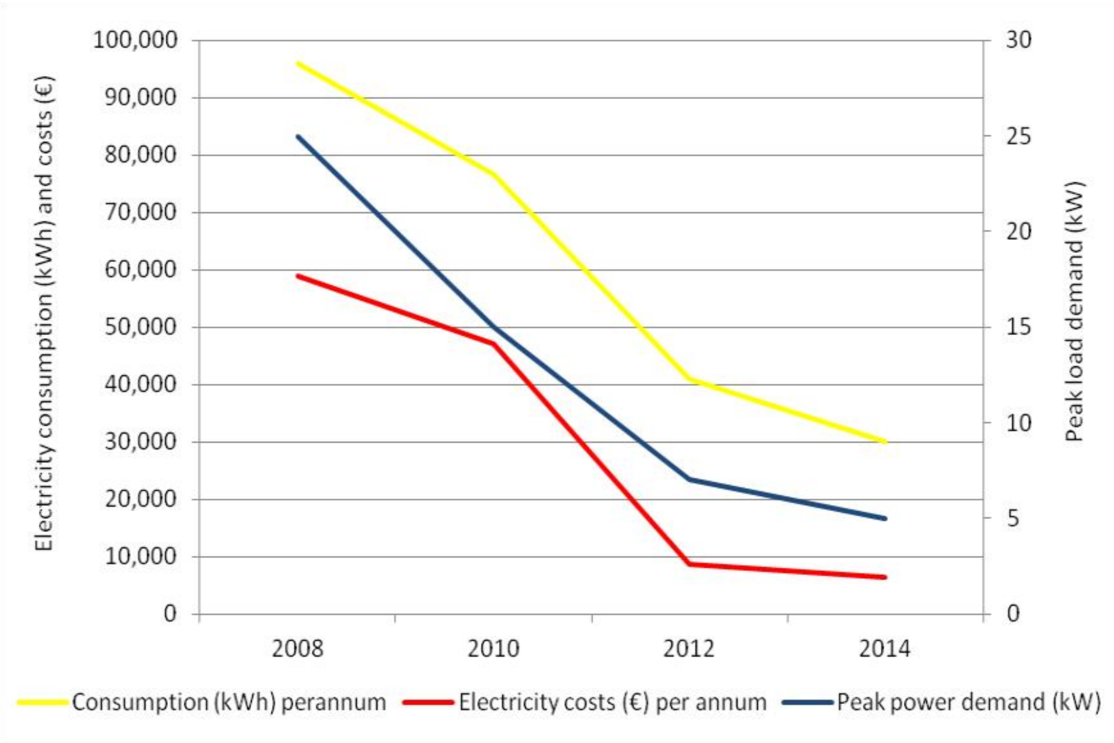

Figure 3: Decrease in energy demand, electricity costs and peak load demand

has the highest available efficiency rates (expected to be completed by the end of 2013). This should help to approach the 74 per cent reduction in energy demand which was projected at the start of the project.

Successful implementation of renewable energy system

At the time of writing, the new PV system has been functioning effectively on Aldabra for 18 months. During the day, the entire research station runs on solar power (12 staff houses, offices – including six AC units, shop, library, laboratory, research facilities, as well as the desalination plant and water pumps). Overnight, a battery backup system (charged by the solar panels during the day) supplies the research station's energy needs, and the new diesel generator is only required occasionally (ca. 15 hours per month). Successful operation of the conventional AC system on PV power was previously considered impossible due to its high power demands but has now been achieved on Aldabra.

During the first 12 months the PV system produced 38,171 kWh of solar electricity, supplying 94 per cent of the station's energy demand with solar power. Diesel consumption decreased by 97 per cent to only 87 l per month. Savings in operational costs (fuel and transport costs) of up to €68,000 annually increase the financial sustainability of Aldabra's operation.

Avoided CO_2 emissions contributing to climate change mitigation measures

CO_2 avoidance (in kg) is calculated using the generated electricity (kWh) multiplied with the specific CO_2 factor (kg/kWh). The CO_2 factor indicates how much CO_2 is produced for every kWh of electricity generated in the country (SMA Solar Technology AG, 2012). To determine the exact CO_2 factor for Aldabra, the CO_2 emissions prior to the project start were calculated using the emission factor of 2.67 kg CO_2 per litre diesel consumption. Based on the former diesel consumption of 37,600 l per year, CO_2 emissions equalled 100,392 kg per year. To obtain the specific CO_2 factor for Aldabra the CO_2 emissions are divided by the produced electricity (95,664 kWh per year) resulting in 1.049 kg CO_2/kWh as specific CO_2 factor.

By increasing energy efficiency the electricity demand was reduced by 54,797 kWh per year (Table 3), resulting in 57,482 kg of CO_2 avoided. In addition, the annual PV production of 38,171 kWh avoids a further 40,041 kg of CO_2 per year. The combination of energy efficiency measures and use of renewable energies avoids a total of 97,523 kg of CO_2 per annum. An investment of €36,000 increased energy efficiency, reduced the electricity demand by 57 per cent and avoided 57,482 kg CO_2 emissions in the first year of operation at a cost of €0.63 per saved kg CO_2. The installation of the PV system

	Electricity demand	CO_2 avoidance*
Pre-project (2008)	95,664 kWh	0
After energy efficiency measures and implementation of Renewable Energy system (2012)	40,867 kWh	
Avoided	54,797 kWh	57,482 kg
Annual PV production	38,171 kWh	40,041 kg
Total		**97,523 kg**

Table 3: CO_2 avoidance by increased energy efficiency and implementation of renewable energy system on Aldabra Atoll

***Calculation based on specific CO_2 factor of 1.049 kg CO_2 /kWh)**

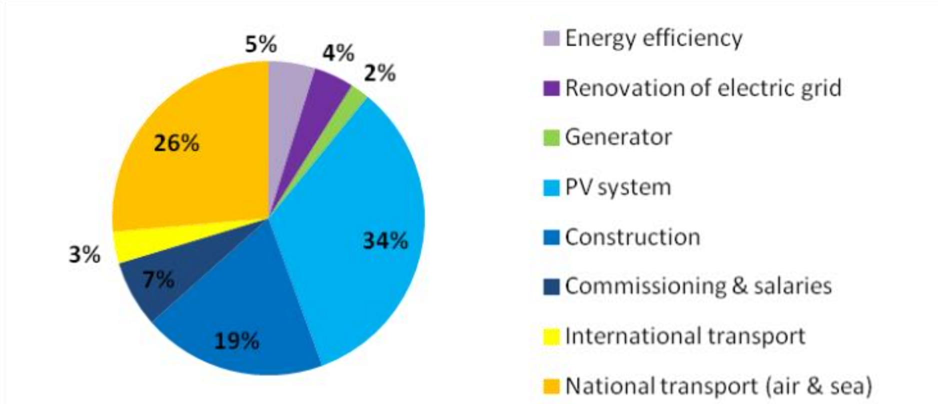

Figure 4: Breakdown of project costs

reduces the CO_2 emissions by further 40,041 kg at a cost of €160,000 (€4 per saved kg CO_2). Investment into energy efficiency is therefore extremely important to consider as the most economical way to reduce CO_2 emissions. Energy demand reductions in this case were six times more cost effective than PV-system installation and should always be considered as the first step in a sustainable energy project.

FINANCIAL ANALYSIS OF THE PROJECT COMPONENTS

The PV system has a predicted life expectancy of 20 years and the investment (€160,000) is predicted to be paid back in only three years of operation. The most expensive part of the PV system was the battery backup system (36 per cent), followed by the modules (21 per cent). Inverters accounted for 15 per cent of the costs followed by additional equipment (cables, electric control and distribution boxes, tools, etc). It should be considered that the lifetime of the battery system is 8-12 years, depending on environmental conditions, which is considerably lower than the remaining system parts. Therefore it would be wise to include battery replacement in the future budget. Together with PV system components, testing and commissioning, overall project costs, including investment into energy efficiency measures, rewiring, diesel generator, transport to and within Seychelles, construction work and materials, labour and tools, amounted to €500,000. The PV system constituted the greatest investment, at 34 per cent of costs, followed by local transport, illustrating the difficulty in accessing Aldabra (figure 4). The current projected return of investment for the whole project is 8 years, which is expected to drop due to rising oil and transportation prices.

LESSONS LEARNED

Lessons learned which are applicable to other protected areas that are considering setting up renewable energy systems are:

- Include a comprehensive energy audit as a preparatory step.
- Consider and plan energy efficiency measures to reduce energy consumption. Demand reductions are more cost effective than investments into PV power and should be fully explored first.
- When defining your energy demand consider the implementation of energy efficient measures for an economical system size since the system size dictates your investment costs.
- Do not underestimate the resources and work indirectly required to install your system (e.g. construction work in terms of labour, material and logistics and expenses).
- Be prepared for the unexpected.
- Plan in as much detail as possible, and if not possible, be prepared to make alterations.
- Integrate the local community for long-term success of the project.

A historic moment: The Aldabra team, SIF CEO Dr Fleischer-Dogley and IBC Solar technicians after the commissioning of the PV system © Richard Baxter (April 2012)

- Build ownership into project implementation.
- Secure the majority of your investment prior to the start of the project.
- Investments into energy efficiency and renewable energies can increase sustainability of financing your operations.
- Consider the long-term maintenance of the system and select a reliable supplier who has a proven track record of implementation of similar projects and is able to offer post installation service.
- Remote monitoring options for systems in isolated places can substantially reduce maintenance costs.
- Publicity is vital to enlist support, disseminate information and galvanise efforts to initiate similar projects elsewhere – include presentations, posters, flyers, press releases.

The staff of Aldabra were integrated into the project from the beginning, with frequent presentations as well as being consulted on relevant issues. Through their involvement in assembling the system the staff gained invaluable experience and skills, which are still rare in Seychelles. In addition working with the local staff reduced installation costs since there was no need to fly in additional technicians. To ensure long-term successful operation, despite the high staff turnover, training in energy efficiency and PV-system maintenance will be mainstreamed in the new Aldabra Management Plan.

CONCLUSIONS

Bringing renewable energy to a site as remote and logistically challenging as Aldabra was viewed as unattainable for a long time. The outcome of this project demonstrates that it is not only possible but even more successful than predicted. The project showcases a highly effective environmental management solution in a protected area with economic benefits via substantial reductions in operation costs, thereby increasing financial sustainability.

The benefits of this project are not limited to a single protected area; other nature reserves in the country, as well as government agencies have shown considerable

Lagoon Island, Aldabra Atoll © Nancy Bunbury

interest in renewable energy systems. Successful project implementation has strengthened national and international collaboration by the integration of local experts in the planning process, such as the Seychelles Public Utility Company as well as linkages with international companies importing their expertise to Seychelles. Aldabra, as the first successful stand alone and largest off-grid PV system in Seychelles, encourages others to follow.

Recently a 6 MW wind farm became operational on Mahé, with a predicted output of 8 million kWh per annum covering 2.5 per cent of Seychelles electricity demand (Public Utility Cooperation (ed.), 2013). Other small nature reserves, e.g. Aride Island, have already followed Aldabra's example by installing PV power systems (Seychelles Nation (ed.), 2013). Many more projects are planned and needed to achieve the national target in terms of renewable energies. To facilitate this plan and to make renewable energies more cost effective, efforts are needed on a national level to promote the use of energy efficient appliances and general conservative use of electricity. SIF leads by example by importing equipment with highest energy efficiency ratings (EER) without existing legal obligations. The implementation of energy efficiency policies and a legislative framework to ensure import of highly energy efficient equipment would prevent Seychelles, like other African countries, from becoming a target for export of inefficient appliances (van Vreden et al., 2010).

The partnerships built through this project are likely to facilitate future ventures. SIF is currently planning the creation of a remote access visitor centre for Aldabra on Mahé, which will bring this unique site closer to the people of Seychelles and its visitors. Following the success of the renewable energy project on Aldabra, it is planned that this building will be state of the art in sustainable architecture and powered entirely by renewable energies.

The set up and operation of a renewable energy system on Aldabra is a successful example and inspiration for other islands within and outside Seychelles. The Aldabra energy story demonstrates that, with good planning and in combination with increased energy efficiency, the switch to sustainable energy can be achieved even on the most remote and inaccessible of islands. It is hoped that the success of this project will assist with galvanising efforts and the wider application of the most available and easy to harness renewable energy source, the sun.

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ABOUT THE AUTHORS

Christina Quanz holds an MSc in Geography from the University of Halle (Saale), Germany. Following her MSc Dissertation on the sustainable energy system on Aldabra, Christina was recruited in 2009 as the Project Officer to implement the system. Prior to this she gained experience in island ecology and protected areas in the Indian Ocean during her studies at the University of La Reunion. Relevant working experience in the field of renewable energies was gathered in different consultancy positions in Germany during 2005-2008. Her special interest lays in sustainable development of small islands with focus in renewable energies and climate change mitigation measures.

Nancy Bunbury is a conservation biologist and was recruited by SIF in 2008. She is currently SIF's Science and Projects Programme Coordinator and has developed and managed a range of research, conservation, education and management projects for the organisation. She holds a PhD in avian conservation biology and a BSc in Zoology from the University of East Anglia, UK. Nancy was previously employed for five years with the Mauritian Wildlife Foundation as a project coordinator and fieldworker. Her main interests are in protected area management, particularly endangered species conservation and invasive species management.

Frauke Fleischer-Dogley is a trained conservation biologist with a PhD in the sustainable management of the Coco de Mer, from the University of Reading, UK and a diploma in plant conservation techniques from the Royal Botanic Gardens Kew. She has 15 years of experience in protected area management and is responsible for the management and protection of the Seychelles' UNESCO World Heritage Sites, the Vallée de Mai and Aldabra. She has a keen interest in environmental management practices and initiated the development of the Seychelles Sustainable Tourism Label. The implementation of the renewable energy system was led by her from inception to operation.

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RESUMEN

El atolón de Aldabra, sitio del Patrimonio Mundial de la UNESCO, es una importante zona de conservación e investigación, pero su lejanía hace de la gestión un gran desafío logístico. La utilización de generadores diesel para proveer energía eléctrica resultó en costos elevados de combustible y transporte, además de ser ambientalmente insostenible. En 2008, la Fundación de las Islas Seychelles comenzó a investigar formas para aumentar la eficiencia energética y desarrollar un sistema de energía renovable para reducir los costos operativos. A raíz de una auditoría energética, se evaluaron diversas opciones de energía renovable y su aplicación y se realizaron investigaciones sobre medidas de eficiencia energética. Los resultados fueron puestos en práctica, y se estableció un sistema híbrido fotovoltaico-diesel de 25 kW. La reducción de la demanda de electricidad era un requisito previo para la implementación exitosa del sistema de energía renovable. Las medidas de eficiencia energética redujeron la demanda de electricidad en un 57%. En el primer año de operación se generó 38.171 kWh de electricidad solar, equivalente al 94% de la nueva demanda de la estación. Esto ha evitado un total de 97.523 kg de CO_2 al año. Desde la implementación del sistema fotovoltaico, la demanda de diesel se ha reducido en un 97% y se proyectan ahorros operativos de hasta €68.000, con lo que la inversión en el sistema se recupera en tan solo tres años. Se requieren inversiones en eficiencia energética y energías renovables para asegurar la sostenibilidad ambiental y financiera.

RÉSUMÉ

Le site d'Aldabra Atoll, classé sur la Liste du patrimoine mondial de l'UNESCO, est une zone importante pour la conservation et la recherche, mais du fait de son éloignement, sa gestion est un défi majeur en termes de logistique. L'utilisation de groupes électrogènes à base de diesel pour alimenter l'île en électricité a entraîné des coûts élevés de combustible et de transport, sans parler du coût écologique. En 2008, la Fondation des iles Seychelles a commencé à s'interroger sur les façons d'améliorer son efficacité énergétique et de développer un système d'énergie renouvelable, dans l'optique de réduire ses coûts d'exploitation. Un audit énergétique a été mené, où les options en termes d'énergie renouvelable et leur applicabilité ont été évaluées, et les mesures d'économie d'énergie étudiées. Les résultats ont ensuite été appliqués, et un système énergétique hybride photovoltaïque-diesel de 25 kW_p a été installé. La réduction de la demande était une condition préalable pour une mise en œuvre réussie du système d'énergie renouvelable. Des mesures d'économie d'énergie ont permis de réduire la demande d'électricité de 57 pour cent. 38 171 kWh d'électricité solaire ont été produits pendant la première année d'exploitation, couvrant 94 pour cent de la nouvelle demande de la station. Au total, cela a permis d'éviter 97 523 kg d'émissions de CO_2 par an. Depuis l'installation du système photovoltaïque, la demande en diesel a diminué de 97 pour cent et on s'attend à économiser 68 000 euros sur les dépenses d'exploitation, ce qui permettra de rembourser l'installation en seulement trois ans. Il en ressort donc que des investissements dans l'efficacité énergétique et les énergies renouvelables sont nécessaires pour améliorer la durabilité environnementale et financière.