



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss State Secretariat for Economic Affairs SECO
Swiss Agency for Development and Cooperation SDC
Swiss Federal Office for the Environment FOEN
Swiss Federal Office of Energy SFOE

REPIC

Renewable Energy &
Energy Efficiency
Promotion in
International
Cooperation

Final Report:

Solar Competence Centre (SCC) Arbaminch University, Ethiopia



Authors:

Pohl, Max; Sahay Solar Solutions GmbH
Chianese, Domenico; University of Applied Sciences and Arts of Southern Switzerland (SUPSI)

Report date: June 2012

Country: Ethiopia	Technology: Solar Energy/Photovoltaic
Project Duration: April 2010 until June 2012	Category: Capacity and Market Building

Written by:

Sahay Solar Solutions GmbH

Habsburgstrasse 42, CH-8400 Winterthur

Tel: +41 612818717; info@sahay-solar.com, www.sahay-solar.com

University of Applied Sciences and Arts of Southern Switzerland (SUPSI)

Istituto sostenibilità applicata all'ambiente costruito (ISAAC)

Campus Trevano, CH-6952 Canobbio

Tel: +41 (0)58 6666356, Fax: +41 (0)58 6666349, isaac@supsi.ch, <http://www.supsi.ch/isaac/>



On behalf of:

REPIC Platform

c/o NET Nowak Energy & Technology SA

Waldweg 8, CH-1717 St. Ursen

Phone: +41(0)26 494 00 30, Fax: +41(0)26 494 00 34, info@repic.ch / www.repic.ch

Mandated by:

Swiss State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Swiss Federal Office for the Environment FOEN

Swiss Federal Office of Energy SFOE

The author(s) of this report are alone responsible for its content and conclusions



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss State Secretariat for Economic Affairs SECO
Swiss Agency for Development and Cooperation SDC
Swiss Federal Office for the Environment FOEN
Swiss Federal Office of Energy SFOE

REPIC

Renewable Energy &
Energy Efficiency
Promotion in
International
Cooperation

Contents

0.	Summary
1.	Objectives
2.	Technical Solution / Applied Method
3.	Results
4.	Impacts
5.	Future Prospects
6.	Conclusions
7.	References

0. Summary

The overall aim of the *Solar Competence Center (SCC)* Project at *Arbaminch University* in Ethiopia was to build self-sustaining structures for capacity and market building in the solar sector in Ethiopia.

The cooperating partners are *Arbaminch University (AMU)* in Arbaminch (Ethiopia), *Institute for Sustainability applied to the Built Environment (ISAAC)*, part of the *University of Applied Sciences and Arts of Southern Switzerland (SUPSI)* in Lugano (Switzerland) and *Sahay Solar Solutions GmbH*, a not-for-profit organisation from Winterthur (Switzerland).

The first step in the overall concept was the foundation of an Ethiopian centre of competence for solar energy at AMU as well as the training of local students and technicians, in order to build local capacity in the field of solar energy. Based on these structures, the aim was to develop a social business model to realise solar electrification projects to create an increasing number of future-oriented income opportunities for the trained solar professionals and enable a sustainable development of the initiative independent from external donors.

Prior to the support of the REPIC platform, Sahay Solar initiated the first activities at AMU in 2009 by installing the first step of the AMU solar laboratory including an off-grid solar system for teaching and demonstration purposes, enabling a train-the-trainer program in cooperation with SUPSI in Switzerland for Dr. Ashamo Erenko - a senior staff member of AMU and founding chairman of the project in Ethiopia - and creating a first agreement of cooperation with AMU.

After this initial starting phase, the funding of REPIC formed an important part of the budget for the realisation of all activities regarding the development of the AMU SCC since 2010.

The main results since then include the institutional establishment of the AMU SCC within the university structures as well as the realisation of the first commercial projects.

An extended version of the solar laboratory as well as a newly installed photovoltaic (PV) testing system now form an integral part of the teaching and research structures at the engineering department of AMU and have enabled the partners to reach the objectives of knowledge transfer, skilled professionals and basic research. The creation of three part-time positions at the AMU SCC strengthens this establishment and its importance within the existing structures, and the recruited professionals are the first skilled professionals able to work independently on solar projects.

Furthermore, around 70 staff and students of AMU have attended two theoretical and practical solar trainings by experts from SUPSI and Sahay Solar in 2011 and 2012, demonstrating the great interest in the technology as well as forming an important part of the awareness building efforts.

Moreover, the installations of off-grid solar systems in five rural village schools were an important achievement and have enabled not only a practical experience gain for all parties involved, but also directly supplied electricity to more than 6000 school children and their communities, creating awareness of the possibilities of solar energy in a region, where it matters most.

Last but not least, so far this awareness has led part of the villagers from one project village to purchase small Pico solar systems from Sahay Solar, and many more requests are expected due to the newly installed systems in 2012. As the latest achievement, the skilled professionals of AMU SCC have installed an off-grid solar system at a Hotel Lodge in the Arbaminch region as the first real commercial project solely realised by local professionals with locally purchased solar equipment.

In the light of these developments, the set objectives have been mainly achieved, especially with regard to the establishment of sustainable structures for local capacity building in the field of solar energy. While the set-up of such structures has proven to be more complex in terms of the entrepreneurial ambitions, the implementation of the first commercial projects on the other hand has shown that the basic ideas are possible to realise but require more time, effort and funding in the near future in order to scale the activities onto a self-sustaining level including the foundation of a local company.

Due to the positive evaluation of the project progress by the responsible partners, the cooperation between AMU, SUPSI and Sahay Solar will be extended in the future, and a first letter of intent about the future extension of the efforts has been produced as the last official task of the current project phase.

1. Objectives

The main objective of the SCC project at Arbaminch University was to lay the foundations for a long-term distribution of solar energy solutions in non-electrified rural areas of Ethiopia. The partners aim to play an important role in making solar energy available to a local mass market, help people to integrate this technology into their everyday lives and to catalyse various socio-economic developments through the supply of basic electricity. Hereby, the creation of income opportunities in the solar sector for local professionals is an important aspect, too.

As yet, awareness, skilled professionals, distribution channels and availability of solar equipment are still very limited or not existent in Ethiopia, especially in regions that are distant to the capital Addis Ababa. Therefore, the REPIC-funded foundation of the AMU SCC was an important step in building the basic structures required to work on the distribution of solar energy in a sustainable way.

The main focus was hereby to enable the systematic training of skilled professionals, transfer specific knowledge readily available in Switzerland to a region where it can serve great needs and to build widespread awareness about the possibilities that solar energy can offer to the Ethiopian people. Based on this institutional competence centre, the aim was - and still is - to establish a self-sustaining local business and integrate the local professionals in the creation of market structures needed for a long-term distribution of solar energy. Hence, in one sentence, the aim of the project might be best described as *“capacity building for market building”*.

To explain the objectives in more detail, the aspect of education and training with regard to solar and renewable energy technology was aimed to be institutionalised by integrating specific teaching modules into the existing curricula of the electrical engineering courses. Furthermore, the first set-up of the solar laboratory installed in 2009 was meant to become an important pillar for practical teaching, and the aim was to successively extend the PV-system and other technical equipment to increase the teaching and demonstration options.

The objective hereby was to enable engineering students to plan, realise and maintain small solar-based electrification projects after completing their university studies. The initial expectation was that around two or three students per semester would choose to specialise in solar energy, which would enable around 10 students to become potential employees of the planned local solar company by the end of the current project phase.

As the current project was devised with an entrepreneurial focus in mind, the realisation of actual solar projects played an important role. The objective was to realise both social as well as commercial solar projects with the help of the students trained at AMU SCC as early as possible. While also enabling the project team to gain real life experience from a management and logistics point of view, these early projects were mainly meant to serve as part of the capacity building efforts to build a team of future solar engineers through practical experience on actual solar system installations.

Last but not least, one objective was to devise a concept for a specialised chair for renewable energy at AMU to further strengthen the efforts of establishing the university as a country-wide competence centre for solar and renewable energies. This objective was commonly adjusted by all partners as it goes beyond the currently available resources of AMU and is not seen as the decisive task in further developing the AMU SCC. The integration of theoretical and practical teaching into the current curricula as well as the options created through the installation of the PV-laboratory can serve this purpose very well in a much more efficient and sustainable way. Hence, we adjusted the initial objective in the light of the local situation towards a more practical approach.

Overall, aside from focusing on the conception of a specialised university chair for renewable energies, the initial objectives are still the focus of our on-going efforts and have been strengthened substantially by the experiences made during the current project.

2. Technical Solution/Applied Method

According to the Worldbank, Ethiopia is one of the fastest developing countries in Africa with GDP growth rates above 10% for the last few years. It also has the second largest population of all African countries after Nigeria, according to official figures reaching around 90 Million people in 2012. One major challenge for both industry and private households is the lack of secure electricity supply or the complete lack of an electricity grid in rural areas. More than 92% of the current grid-based power supply is generated by hydro power plants, with large efforts to increase the current capacity of 3000 MW.

However, the Ethiopian government has ambitious plans to export the green energy to its neighbouring countries such as Djibouti, Sudan and Kenya as an export good to decrease their trade deficit and generate income for the country. This situation results in a potentially unlimited demand for electricity, where the government has to find a balance between satisfying the sharply rising national demand and fulfilling the ambitious plans to export part of the available electricity. As a result, Ethiopia will continue to suffer from a limited electricity supply even though large efforts are made on the national level. In addition, according to official numbers, around 80% of the population in Ethiopia live in rural areas, which are not connected to the existing electricity grid and where the extension of the grid is not economical due to the widespread distribution of settlements in these regions. Here, decentralised solutions for electricity supply are required on a personal or community based scale.

Solar energy, the technology Sahay Solar Solutions and SUPSI are aiming to develop in Ethiopia, is ideally suited for these very different needs and can play a major role in the required diversification of the national energy supply by complementing the grid-based hydro power plants and potential future wind parks.

With respect to the particular situation of Ethiopia and lessons learned in other African countries, the flexibility of solar energy solutions together with the rich abundance of sun light, make this technology an ideal pillar of the future energy supply, not only in Ethiopia. Solar power can be used both for grid-connected power supply in the long-run and on a large scale by means of solar thermal or photovoltaic power plants. But at the same time, it can be applied at a very small scale for individual households in rural areas, where already basic lighting and mobile phone charging or small radios etc. are already able to greatly improve the situation of the local people.

In comparison, the technology itself is still at a rather early stage, so that technical improvements and a reduction in prices can be anticipated. At the same time, the technology is well approved, reasonably simple in its functioning, application and maintenance and small systems, such as Pico solar systems for basic lighting and mobile charging, are at a moderate price level. It is therefore also a suitable technology for the financially limited local market which can be extended with future market growth.

It has been stated that the Ethiopian government has ambitious exporting plans and invests seriously in the extension of its hydro power production capacity. However, all these efforts are aimed at areas that are in fact connected to the electricity grid, therefore leaving out a large part of the population that currently lives in rural areas without power supply now and in the near future. Here, solar energy has great advantages compared to other technologies as it can be applied simply in a decentralised way, be it for individual households through single systems (e.g. Pico solar home systems) or small communities by the use of mini-grid systems.



Examples of Pico Solar Systems and a Solar home System (SHS)

As with all other innovations, a new technology requires skilled professionals that can apply and maintain the new products. Hence, the foundation of the AMU SCC provides the required platform to train these professionals. And in the light of the characteristics of solar technology, this training can be started with a focus on very basic solutions and can be adjusted according to the demand once larger, more complex solar solutions are used.

3. Results

The initially anticipated results of the AMU SCC project as stated in the project proposal have been widely reached. In the following section, an analysis of these different results will be presented, also taking into account potential adaptations during the course of the project.

3.1. Institutional establishment

One of the main aims of the foundation of a Solar Competence Centre at Arbaminch University was to include “solar energy” as a central topic within the institutional structures in the long term. The focus hereby was both on the theoretical level as well as on the practical level.

PV-Laboratory

On the practical level, the PV laboratory system, which was installed prior to the start of the REPIC support in August 2009 by Sahay Solar, has been successfully expanded and has been used on a regular basis both by local lecturers from the field of electrical engineering as well as during the PV-trainings offered by Sahay and SUPSI in 2011 and 2012. It allows for a real-life demonstration of the set-up, functioning and maintenance as well as the possibilities with regard to the use of autonomous solar systems. In addition, the system was used whenever power cuts at the University campus made it impossible for lecturers and students to use the facilities of the laboratory, again demonstrating the great opportunities of solar energy on a first-hand basis.

Inclusion of PV-teaching modules into existing curricula

On the theoretical level, the initial aim was to create a concept for a specific “chair of renewable energies” attached to the electrical engineering department (EED). However, during the course of the project and with a better understanding of the challenges and opportunities at AMU, it was decided to rather include specific courses and teaching of the topics *renewable energies* and *solar energy* in particular into the existing organisational structure of the EED. Hence, an analysis of the current curricula has been carried out and specific training content on solar energy was developed by SUPSI. These modules were used already for the solar trainings in 2011 and 2012 and have been provided to the responsible staff of the AMU EED for future use. Further on, two specific modules have been included in the EED curriculum for electrical engineering students specialising on *electrical power* in the 7th and 8th semester: *applied energy conversion* and *renewable energy and rural electrification*.

A separate chair for renewable energy technologies might prove a valid option at AMU in the future, however, currently the availability of a specific budget, skilled personnel as well as managerial and organisational requirements does not allow for the new foundation of this chair and can be compensated much more efficiently within the existing structures.

Official's support and part time position at AMU SCC

Overall, the degree of institutional establishment of the SCC at AMU can be regarded as very high. All relevant contracts and discussions have been carried out with the highest management level to secure awareness about and official back-up of the project and hence enable the long-term sustainability of the initial efforts.

Furthermore, for the successful implementation of the AMU SCC project, three official posts were installed at AMU: a project chairman, a technical manager and a technical assistant, all including a top-up payment to ensure a constant focus and continuing works on the SCC facilities. As the university has also received very positive attention from the local government and communities (e.g. through the social projects at schools, meetings with the major of Arbaminch), there is a strong desire from the officials side to extend the SCC project at AMU in the near future.

New EED building

With specific relevance to the future of the AMU SCC, the adjustment of the architectural plans for the new EED building, which is currently under construction, further demonstrate the high level of institutional establishment. Together with the responsible officials at AMU, it was decided to include a specific, flat concrete roof on the top of the building for the PV testing system, including roof access and two specific rooms, where the PV laboratory including testing facilities as well as space for teaching will be reserved. Moving the currently installed solar equipment to the new building upon its completion forms an important part of the near future of our efforts at AMU.

3.2. Knowledge transfer

Our aim here was to create awareness about the existence and opportunities of solar energy within the local communities in the Arbaminch region and to disseminate the corresponding technological knowledge to the professionals of AMU. The cooperation between AMU and SUPSI was aimed to enable the direct transfer of knowledge about solar energy from Swiss experts to Ethiopian lecturers and students.

Awareness building in local communities

All parties involved agree that great achievements have been made regarding awareness building in the local communities. A major factor hereby was the realisation of five social projects in regional rural village schools, as well as numerous discussions with local opinion leaders including the presentation of solar equipment. The created awareness is an important factor in the long-term distribution of solar technology solutions to individuals and businesses in the southern region. The first result on a concrete level is an increasing demand for small solar home systems (Pico SHS) in villages, where the school projects were carried out. Villagers and small entrepreneurs can approach the staff of AMU SCC with requests of various solar equipment and Sahay Solar Solutions in turn aims to fulfil these requests with the help of the trained staff at university.

Solar training at AMU SCC

On an academic level, two “solar trainings” were offered at AMU SCC by a Swiss PV-expert from SUPSI as well as an Ethiopian-German engineer from Sahay Solar in 2011 and 2012. These trainings were offered to both students as well as staff of the EED at AMU and were attended by 43 and 70 people respectively, which was a great success and demonstrates the strong interest of the local professionals in the technology. The focus of these trainings was to build awareness for solar energy and a basic understanding about the technology as well as the applied opportunities, which off-grid solar systems can offer in the local circumstances. Therefore, a theoretical background as well as practical exercises and work with actual solar equipment was offered to the attendees over a three-day course. The content of these trainings has been supplied to AMU EED for further use within the current Bachelor and Master curricula.

Link to related Institutions

Another important aspect was to connect AMU to further initiatives in the solar sector in Ethiopia. As a first result, the *Deutsche Gesellschaft für internationale Zusammenarbeit* (GIZ, former GTZ) included AMU in the planning for their next train-of-trainer program: around five staff members of the AMU EED, who took part in the past solar trainings, will be invited to the program with the aim of teaching them the required skills to give courses on solar energy at the AMU SCC in the future. Further on, a cooperation with the further training institute (FTI) at Adama University in Ethiopia is also in preparation, linking the two institutions and their respective resources with regard to solar energy.



Solar training for staff and students at AMU SCC | New EED building under construction

3.3. Skilled professionals

As has been outlined in the previous sections, the availability of skilled professionals with a solid knowledge of solar energy technology and its application is an absolute key to the long-term distribution and set-up of market structures on a local level.

Social solar projects – bridging theory and practice

A well-known challenge when building human capacity is to transfer theoretical knowledge onto the practical level. Often, trainings and workshops are offered to local professionals without taking them “into the field” and offering “hands-on” experience. Therefore, as part of the aim of training professionals in solar energy to a level, where they can be future employees in the solar sector, actual solar projects in rural schools were realised. Overall, five autonomous solar systems with 555Wp installed capacity each, have been installed by the project team consisting of experts from Sahay and SUPSI as well as local professionals from AMU. Hereby, students could apply to take part in the projects and were included in planning, installation and also the maintenance of these social solar projects.

While the first two projects were mainly carried out by the Swiss experts and AMU staff and students were mainly in a supporting role, the last three projects in April 2012 were used to shift more tasks directly to the local trainees. Firstly, all three schools had been prepared by AMU staff and students with regard to the 230V AC side of the electrical installation, leaving only the 24V DC side (consisting of the installation of the actual solar equipment) for the project team to finish. Hereby, the technical manager of AMU SCC and his technical assistant as well as one engineering student with a background as electrician were given the task of the installation, closely mentored by the Swiss expert team. This practical training was very efficient, leading the prospective solar engineers to install the last PV-system at Zigite Marge school completely on their own. Hence, over the course of five PV-system installations, the new local project team has been put in the situation where they are able to install a medium sized off-grid solar system without external support.

This effective transfer of knowledge, first on a theoretical level, then followed by various practical experiences, is not only a great success from an educational point of view, but also forms an integral part for the future ambitions on an entrepreneurial level for Sahay Solar.

These social solar projects form the bridge between theory and practice as part of the AMU SCC, but most importantly also provide a direct improvement of the situation of the students and also the staff of these rural schools through the supply of regular 230V electricity. This enables various knock-on effects, e.g. evening classes for those who cannot attend school during the day (both children and adults), the use of computers for the school directors or the charging of mobile phones for the local community. The last case is also an example for the creation of income opportunities for the school through electricity supply, e.g. to cover maintenance and spare parts of the solar system in the future: the village population can charge their mobile phones against a small payment of 1-2 BIRR at the local school and this option has already become a central aspect in all five rural schools since the installation of the respective solar systems.

Last but not least, the installation of these solar systems also help disseminating knowledge about the technology to the people in regions where it matters most and which are hardest to reach. In rural regions of Ethiopia, the actual demonstration of such a new, yet unknown technology over time is fundamental to gain trust and interest and finally a demand for the personal use of solar energy solutions.

Three part time positions created

The initial goal of training around 10 specified solar engineers as one “outcome” of the AMU SCC could unfortunately not be realised due to various reasons. Job security, the desire to move to the capital Addis Abeba or abroad for study or work purposes and a lack of sufficient demand for solar products as yet, act as strong motives for most students to choose established jobs e.g. in the telecommunication sector or at the national power supplier EEPSCO. Nevertheless, the AMU SCC has now three permanent staffs, which are in a position to do the planning, installation and maintenance of off-grid solar systems. The fact that all three professionals also earn an additional income through the top-up payment in connection with their job at the AMU SCC has helped immensely to increase the attractiveness and “value” of working with solar energy because up to now, solar energy was neither a topic of concern nor a potential income opportunity for young local graduates. During the course of the project, the project team has increasingly been approached by staff and students of AMU that are interested in working with us in the field of solar energy. Here, it is of great importance to increase the current efforts even more after having planted the first seeds to really convince the respective graduates of concrete, personal opportunities they can pursue with the help of the Sahay/ SUPSI team in the solar energy sector.

In section 3.6., the first commercial solar projects that were solely realised by AMU SCC staff and students will be described, highlighting that the basic idea of training professionals and sourcing solar projects to be realised by these staffs can and does work in reality.



Installation of PV systems at rural village schools in the Arbaminch region

3.4. Fundamental research

Besides capacity building and awareness generation, the possibility to carry out basic research in the field of solar energy builds an important pillar of the AMU SCC. The aim was to enable the university to carry out tests with actual solar equipment under the local environmental conditions at Swiss testing standards. With the installation of the AMU PV testing system in April 2012, this opportunity is now available and will be further developed.

As for now, data concerning sun irradiation levels, air temperature and PV module temperature as well as air humidity can be correlated with the characteristics of up to four different PV modules, measured by four precise *Maximum Power Point Trackers* (MPPT) that were developed by SUPSI.

This testing system can be regarded as the most advanced of its kind in Ethiopia and its neighbouring countries and puts AMU in a position to actually become the leading Ethiopian university with regard to solar energy. Sound instruction of the abovementioned AMU SCC staffs was an important part of the last visit in April 2012, as all maintenance and operation of the system lies in the hands of the local professionals. The gathered data is transferred to SUPSI on a regular basis to allow for a detailed analysis by the Swiss expert team and an automated data acquisition and transfer system via Internet is currently developed.



PV testing system, MPPT data acquisition box and PV laboratory at AMU SCC

3.5. Services

Testing service for foreign companies

Besides creating opportunities for fundamental research and B.Sc./M.Sc. - thesis works, the opportunities offered by the PV testing system at AMU SCC also give the university the possibility, to test solar equipment, currently PV modules, as a paid service for foreign companies. Hence, in the long-term, the aim is that all running costs of the AMU SCC including the created jobs can be covered by income generated by services of the PV testing system. In cooperation with SUPSI, AMU will establish this service and develop a business concept for the financing of the SCC through its testing service.

Quality standards

As the solar market in Europa is slowing due to cuts in subsidies, many companies are increasingly looking into new markets and Africa is seen as a potentially huge market in the coming decades. However, very limited data has been gathered locally and most estimates regarding the technical specifications of solar equipment are based on “theoretical” assumptions. AMU SCC here offers the companies to test their PV modules under real-life conditions, including important factors such as the effects of dust and extreme weather conditions on the performance of their products. In the future, these data can be used to adjust certain aspects of the technology to the local conditions or to make scientific tests between different PV module types such as polycrystalline or thin-film products. The testing system has the same quality standards as the one of SUPSI/ISAAC in Lugano, hence also enabling ISAAC Institute to offer this service to their existing customers.

After being tested for a certain duration (3/6/12 months), the PV modules will be used for charitable solar projects rather than being sent back at high costs, again offering practical experience gain for the local students while serving the local rural communities.

3.6. Social business

Sahay Solar Solutions GmbH was founded with the aim to help fight the energy crisis in Ethiopia by developing a sustainable business model for the distribution of solar energy solutions on a local level. As has been explained in the previous sections, some factors that are required for such a business model are currently lacking in Ethiopia, hence leading to the focus on capacity building as the first step within the overall long-term concept.

In the on-going discussions about global development aid, it has become clear that simply externally funded projects can serve certain purposes very well, but are limited in many ways, e.g. in terms of the scalability of the initiatives. As in the case of the current project, offering the young graduates concrete job opportunities and helping them to build a personal future in the solar energy sector is absolutely crucial to avoid that all training efforts are lost once it comes to the decision of the graduates in which job to engage after completion of their studies.

Therefore, the aim of the future efforts is still the establishment of a local solar business company to create local jobs, while following the social business approach as proclaimed by Nobel peace prize laureate Muhammad Yunus: “to solve social problems with entrepreneurial concepts”.

Sales of Pico SHS

The demand for solar energy in Ethiopia is huge on various levels; however, one of the main challenges for a company in this field is the lack of trained professionals. Since the efforts at AMU SCC have now enabled Sahay Solar to work with a small number of well-skilled technicians, the first commercial projects have been realised in April 2012. Based on the awareness that was created through the electrification of the local village school in 2011, the inhabitants of Danbile village contacted the local project manager at AMU and asked him to supply them with small Pico SHS. We managed to buy the systems at a local company in Addis Ababa and sold them to a number of people in the village for ca. 60\$ each. The money was always paid in cash which shows that a substantial amount of people can actually afford the purchase of such solar systems, despite the fact that in the future, micro credits will also be needed in order to reach the greatest number of people possible with this life-changing technology.

Also, the right distribution system will have to be devised in order to have a certain amount of stock available locally and the right approach must be chosen to bring the systems to the customers as an income opportunity for some of the trained professionals from AMU SCC.

Installation of PV-system at Lodge building | commercial solar projects

Besides these successful sales of the first Pico SHS in the rural village of Danbile, a second project gives great hope for the future prospect of establishing a local solar company. As a result of our numerous talks with local business owners and opinion leaders, the owner of a newly built Hotel/Lodge at Dorze Village, a 45min drive from Arbaminch, requested a solar system for the supply of lighting as well as mobile phone and camera battery charging. Since the project team had to leave back to Europe at this point, the project was carried out solely by the local team of the AMU SCC, which had the experience of two solar trainings as well as five solar projects at village schools during the course of the last 12 months. Hence, we could experience at first hand the results of the capacity building efforts at the university. As the team was also paid directly by the customer, they experienced the personal possibilities they could have by working with solar energy, which is a major aspect of motivating the professionals to engage in this area under the difficult local circumstances.

Furthermore, the equipment was purchased solely at local companies in Addis Ababa, making this the first completely Ethiopian solar project during the course of the AMU SCC project. It can be considered a great success in the light of the limited resources and time of the initiative and again gives great hope for the future expansion of the entrepreneurial efforts.

Cooperation with local businesses

While it was the initial aim to have a local private limited company (PLC) established during the course of the AMU SCC project, it has become clear that such a foundation cannot be the starting point of the business due to the reasonably high capital and organisational requirements it entails. We will extend the business side in cooperation with individual local holders of business licenses up to the point where the activities allow for a first team of professionals and administrative staff to be actually employed. Also, an European investor requires an initial capital of 50-60.000\$ for a joint venture, so even if the capital could be attracted, we still require a trustworthy local counterpart. Overall, the risk at this very early stage is still too high for the foundation of a separate PLC. in Ethiopia as yet.

The efforts for the establishment of a local PLC. will be increased successively in the near future and in section 5, some of the currently planned next steps in this regard will be highlighted.



Installation of a PV system at Dorze Lodge by locally trained professionals from AMU SCC | Sales of Pico SHS in Danbile

3.7. Technology transfer

Import tax uncertainties

Recalling the challenges that complicate the widespread distribution of solar energy in (rural) Ethiopia, one aspect is the current lack of available solar equipment. Currently, only a few single players in the market import solar equipment in very small numbers and limited range. One reason is that there is a great uncertainty about the issue of tax exemption for solar equipment: certain Pico solar systems, that have been granted the *Lighting Africa* label of the *Worldbank*, as well as single PV modules are supposed to be officially exempt from import tax in order to catalyse the developments in this sector. However, this issue is more complex in reality. Some of the major local companies, which have already imported items and/or are working on this issue, such as Solar23, Stiftung Solarenergie or Lydetco PLC, which we have all met, all share similar experiences and challenges. While the governmental support for this renewable energy is very strong in theory, the reality still leaves room for great improvements that are important for companies to make sound calculations and reliable offers for their customers.

During the current project phases, most of the solar equipment has been imported as donations via air freight. This was due to the relative small load of each individual sending and in order to stay within the overall time plan as far as possible. Nevertheless, with increasing amounts of equipment, the goods will have to be imported either by sea freight via Djibouti or on the road via Kenia. Finding a

long-term solution for the import of solar equipment together with already acting partners is one priority for the future.

Local availability

However, for the last social solar project in April 2012, it was possible to purchase the first Ethiopian made solar batteries through an Ethiopian supplier in Addis Ababa as a test for future use. If these prove to adhere to good quality standards, a major component of future SHS can be bought locally, hence supporting local businesses while saving a substantial amount of money on the freight costs.

In addition, all components of the commercial solar projects in Danbille (Pico SHS) as well as the Hotel Lodge in the Arbaminch Region were sourced locally. Though requiring some flexibility, it was possible to buy all the solar equipment needed at local companies in Addis Ababa and we are in close contact with some of these firms to increase the availability of the most common products in the near future. Overall, our specific goal is not the import of solar equipment but rather the installation and maintenance of the technology. But it is difficult to project whether European companies will be able to secure a good supply of their products in Ethiopia or whether this area will be filled by the rising Chinese corporations that already engage in an increasing number of business sectors in Ethiopia.

4. Impacts

While it is a major component of a social business model to create value not merely on an economic level, but also on a social and ecological level, these impacts are often more difficult to quantify. Even though, the supply of independent electrical energy with the use of solar systems has a huge potential to create large socio-economic impacts: job creation, improvements of the living situation of villagers and extension of their working time, reduction of CO₂ emissions caused by petroleum lights, positive health effects compared to fossil fuel options and the use of modern means of information and communication via TV, Radio or even Internet. Some of these effects have been created already in the current case and will grow with an increasing spread of solar energy solutions.



Barber shop and mobile phone charging: Job creation through energy supply

Local appreciation and job creation

From the point of view of AMU, its objective of offering community service to the local people was supported strongly by the realisation of the solar projects in five rural village schools. While the university gained great appreciation from local ministries and decision makers for their efforts, the officials highlighted specifically the creation of jobs in the rural villages through the supply of solar energy: in Danbille for instance, the first barber shop was opened by a young entrepreneur, who now pays the school a monthly fee for using their electricity supply and who can generate an income through offering his service to the local people. In addition, in all five schools one person was employed to manage the charging service for mobile phones, which, against our expectations, has proved to be a fundamental aspect of the newly gained electricity supply. Local villagers, who used to walk for several hours only to charge their mobile phone, can use their time for other, more important tasks only by paying a small amount to the school for each charge. So, besides creating income opportunities for the schools, they in turn also offer the chance to local people to create jobs based on the supply of electricity. It will be interesting to analyse the future developments, which the technology has already triggered, and help to create even more job opportunities based on solar energy.

Besides these indirect effects, the creation of three part-time positions at AMU SCC and the positive developments on the business level give hope, that with an increasing scale of our initiative, it will be possible to create even more directly related jobs for professionals working with solar energy, too.

Institutional establishment

Looking at the impacts directly at AMU, the institutional establishment of solar energy can be seen as a major step, as the topic is now an integral part of the teaching structures of the AMU EED. Once the new EED building will be completed, the solar laboratory and the PV testing system will further strengthen this specialisation, potentially leading interested candidates to study and work at AMU as far as possible, too. As yet, more than 100 staff and students have directly benefited by receiving training in solar energy only by the expert trainings and many more have gained a basic insight as part of their B.Sc. studies.

Social benefits

From a social point of view, the installation of five solar systems in rural village schools has directly impacted the lives of up to 6000 school children and the respective local communities. As has been stated, these communities have taken strong ownership of the electricity supply and first concrete effects have been observed. However, we expect to see increasingly more directly visible impacts such as newly created jobs, but also developments, which are harder to observe: the supply of electricity to these remote areas has, according to village elders, increased the attractiveness for school teachers to choose those schools, as working in rural areas is not always regarded as the first choice for many teachers due to the lack of basic comfort and teaching opportunities.

Experience gain and reliable workers

An important side effect of the efforts regarding the AMU SCC for Sahay Solar was an immense experience gain, especially due to the actual installation of the social solar projects. These experiences as well as a (basic) understanding of the general situation and the current status of the development of solar energy in Ethiopia are important foundations for the future focus on our business goals. Further on, it was possible to connect with various important organisations and individuals that are actively engaged in the development of a market for solar energy in Ethiopia, which is also an important step in the build-up of a reliable and powerful local network.

Besides this experience gain, finding good professionals with a motivation and the skills to engage in a career in solar energy can be regarded as a central "side-effect" of the AMU SCC project for Sahay Solar from an entrepreneurial point of view. As has been stated, the first local project team is now working at the AMU SCC and in a position to realise solar projects. But, this is not only a question of training certain individuals, but also a question of their mentality, general abilities and personal motivation and hence finding these professionals is an on-going challenge in setting up a local workforce.

5. Future Prospects

Financial support for AMU SCC | Establishment of testing service

In order to reach the common goals of all partners in the future, the first step will be to secure further financial support for the operation and extension of the AMU SCC. We seek to find a sponsor who can cover the running costs, as it will require some time to operationalize the testing service for PV - modules, which should cover these costs in the long-term. As the AMU SCC can be regarded as the centre and basis for all further activities, finding the support for its operation is the highest priority in the short-term. The standardisation of testing, data acquisition and data transfer procedures for the PV testing system is currently in progress and will also form an important activity in the close future to be able to offer this service to external customers as soon as possible.

Theoretical and practical training

Once this support is secured, we will extend the current activities at AMU SCC including the training of an increasing number of local students as well as staff members. This will be carried out with an increasing focus on integrating outstanding individuals into the business concept of Sahay Solar. We expect to provide further trainings by Swiss experts on a regular basis as well as trainings by the local professionals such as the technical manager of AMU SCC and other staffs, which are attending e.g. the GIZ train-of-trainer program in September 2012.

Social projects | Mini-grids

As part of the training and capacity building efforts, further social solar projects will be carried out, as this activity has proven a great success on all levels and for all parties involved. To extend the knowledge and experience gain, one of the next projects will be the set-up of a mini-grid electricity supply for three villages on the island Gidicho at Lake Abaya, close to Arbaminch. This project will be a great challenge and help to include the idea of mini-grid solutions on the practical side of the training, as this type of electricity supply will play an important role in the large-scale electrification of rural areas in general.

Network extension

Based on the already achieved cooperation with GIZ and Adama University, the aim is to connect with further initiatives both on the educational as well as on the business level. Organisations such as *Solar Energy Foundation*, *Solar23* or the GIZ subdivision *Centre for international Migration and Development* (CIM) could prove valuable partners in the further development of our efforts. However, this network building will not be limited to local partners in Ethiopia, but also include the cooperation with initiatives in Switzerland and Germany. One example is the newly founded *Institute for decentral electrification, education and entrepreneurship* at the University of Applied Sciences in Neu-Ulm, which specifically looks into the combination of education and entrepreneurship for the distribution of solar energy in developing countries.

Local Business | Pico SHS sales

In terms of the future entrepreneurial goals, two main areas of business activity can be distinguished: on the one hand, we plan to extend the sales of Pico SHS with the help of the trained professionals at AMU SCC as well as private business licence holders in the Arbaminch region. As the latest experiences have shown, the demand for such low-cost solutions for basic lighting and mobile charging is immense once people are shown the benefits, which solar solutions can provide in their everyday lives.

Local business | Installation of solar systems

Although this buy-and-sell business is not the long-term aim, it is rather attractive in the short-term, as it is possible with the existing structures and can be organised with the available resources. Our focus, though more complex, is the realisation of off-grid solar installations for small to large individual objects such as hotels, shops or restaurants that suffer greatly due to the unreliable supply of electricity or even its complete absence depending on their location. As the installation of a solar system at Dorze Lodge as well as many meetings with potential further customers have shown, the demands of the local customers are often very basic and hence well suited for the application of autonomous solar systems. With increasing availability of the required equipment and the related security in making reliable offers, we expect to be able to secure an increasing number of such solar projects. These projects will be planned in cooperation with experts from SUPSI and Sahay, but installation and maintenance will be carried out by the trained local professionals from AMU SCC.

Once both activities allow for the scaling of the business, the aim is to found a local private limited company (PLC) with an Ethiopian counterpart and to employ a first team of the local professionals on a full-time basis.

6. Conclusions

In conclusion, one of the main challenges within the AMU SCC project was to build a trustworthy, reliable and effective cooperation with the local partner AMU. Also, gaining insight and an understanding of the internal processes at AMU and the respective positions, which have to be involved in certain decision-making processes, was not easy during the first meetings. The somewhat complicated bureaucratic processes as well as the high fluctuation of individuals holding relevant positions further proved challenges for the project team.

However, the achievement of the majority of the original objectives can be regarded as a great success, especially in the light of the limited resources and short time period of the current project.

A major factor in the fruitful cooperation with our local partner AMU was in fact the successful set-up of a reliable working relationship, which was only possible due to the strong motivation of the local partner and the positive reception the activities of AMU received on the local level. Further on, a regular physical presence of the Swiss project team was seen as an important aspect in the build-up of this relationship, also on the basis of personal relations that were established and which build the foundation for a successful cooperation. The basis here was the dedication of a substantial amount of the overall budget to travel expenses, allowing regular visits of both SUPSI as well as Sahay Solar team members during this early project phase.

The creation of the three part-time positions at AMU SCC was also very important to demonstrate the “value” of working in the field of solar energy and the possibility to generate income for the local professionals, while at the same time leading to a much higher level of reliability and engagement of the individuals compared to a voluntary involvement.

Overall, during the course of the AMU SCC project, all partners have experienced on a first-hand basis the expected vast potential and great social, economic and ecological benefits, which the distribu-

tion of solar energy in rural areas of Ethiopia can deliver. Even though the large-scale distribution of this technology is still a major challenge, the structures that have been built during the last years can be a very good basis for this task if all parties involved keep up the good momentum, dedication and motivation to cooperate in the future. Based on the past developments and experiences, it is expected that the fruitful cooperation can be extended to scale both the efforts regarding capacity building as well as market building. A *letter of intent* signed by the representatives of AMU, SUPSI and Sahay Solar demonstrates the shared appreciation of the past developments as well as the strong motivation to take advantage of the created possibilities, use them most efficiently and extend the project in the near future.

Finally, we would like to express our greatest appreciation towards the valuable support of the REPIC platform and thank the responsible representatives for the trust and believe they showed towards the partners and the AMU SCC project. Without this generous support, the past developments in Ethiopia would not have been possible at this level and we are convinced that the money has been used efficiently and effectively and in line with the objectives of the REPIC platform.

7. References/Media coverage

- **Statements of participants at EGK Event, Addis Ababa, Nov. 2011**
<http://www.youtube.com/watch?v=8gNO7QRiEJc>
- **Ethiopian TV News coverage of EGK including interview with Max Pohl, Nov. 2011**
<http://www.youtube.com/watch?v=wW00laNAzV8>
- **Video documentary of the solar system installation at Danbile primary school, May 2011**
<http://www.youtube.com/watch?v=lqvKThmTStg>
- **Article in German Business Magazine “Brandeiins” about Social Entrepreneurs**
<http://www.brandeiins.de/magazin/die-bewegte-mitte/vergesst-sezuan-schaut-nach-horb.html>
- **The website page regarding the AMU SCC mentioning the support of REPIC**
<http://www.sahay-solar.de/ausbildung.htm>