

**REPIC**

Renewable Energy &  
Energy Efficiency  
Promotion in  
International  
Cooperation



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 of Energy SFOE

**Final Report:**

---

## **Swiss Contribution to IEA PVPS-Program Task 9**

### **PHOTOVOLTAIC SERVICES FOR DEVELOPING COUNTRIES (PVSDC)**

#### **Phase Report, Working Period 2013/2014**

---



**Author(s):**

Alex Arter, Dr. Thomas Meier GFA Entec AG

<b>Date of the Report: February 2015</b>	<b>Contract Number: 2013.06</b>
<b>Institution: GFA Entec AG</b>	<b>Country: International</b>

Prepared by:  
**GFA Entec AG**  
**Teufener Strasse 25**  
**CH-9000 St. Gallen**  
**Switzerland**

<http://www.gfa-entec.com/>

With the Support of:  
**REPIC Platform**  
c/o NET Nowak Energy & Technology AG  
Waldweg 8, CH-1717 St. Ursen  
Tel: +41(0)26 494 00 30, Fax: +41(0)26 494 00 34, [info@repic.ch](mailto:info@repic.ch) / [www.repic.ch](http://www.repic.ch)

The REPIC Platform is a mandate issued by the:  
**Swiss State Secretariat for Economic Affairs SECO**  
**Swiss Agency for Development and Cooperation SDC**  
**Swiss Federal Office of Energy SFOE**

The author(s) are solely responsible for the content and conclusions of this report.

## Swiss Contribution to IEA PVPS-Program Task 9

# PHOTOVOLTAIC SERVICES FOR DEVELOPING COUNTRIES (PVSDC)

## Phase Report, Working Period 2013/2014



Report prepared by Alex Arter and Dr. Thomas Meier

submitted to REPIC, February 4, 2015

# Contents

<b>1</b>	<b>Background to IEA PVPS and Task 9</b>	<b>3</b>
1.1	Important Publications by Task 9 prepared under the Workplan 2010-2014	5
1.2	Important Dissemination Events by Task 9 under the Workplan 2010-2014	7
<b>2</b>	<b>Swiss Contribution to the Task 9 Work Plan in The Reporting Period</b>	<b>10</b>
2.1	Objectives according the Contract with REPIC	10
2.2	Subtask 5B - Innovative Business Models and Financing Mechanisms	11
2.3	Subtask 6 – Deployment and Outreach	16
<b>3</b>	<b>Outlook</b>	<b>18</b>

## 1 BACKGROUND TO IEA PVPS AND TASK 9

The IEA PVPS programme is one of the collaborative R&D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the application of photovoltaic conversion of solar energy into electricity.

The overall programme is headed by an Executive Committee (ExCo) composed of one representative from each participating country, while the management of individual research themes (Tasks) is the responsibility of Operating Agents.

Task 9 'Photovoltaic Services for Developing Countries' (PVSDC) commenced in late 1999, with the objective "To increase the overall rate of successful deployment of PV systems in developing countries." Under its new workplan for the period 2010 to 2014, Task 9 is now going forward with a broader focus on the deployment of PV services for regional development centered on two main activities:

- Implementation of key partnerships with carefully chosen relays or « international megaphones » able to foster the deployment of PV solutions. These partnerships would enable the sharing of PVPS' knowledge acquired over the past 10 years with key decision makers in emerging regions: policy makers, funders, and the industry.
- In close cooperation with other concerned PVPS tasks: disseminate conclusions, lessons learnt and recommendations on highly relevant topics like penetration of PV in the urban environment, PV hybrids, very large scale PV plants and high penetration in grids, as well as work on PV applications for rural services. This dissemination process, implemented in cooperation with the « megaphones » consists of participation in conferences, the organization of workshops, awareness and training seminars.

The work has been structured into eight sub-tasks:

### **SUBTASK 1: PV for Water Pumping**

The purpose of this subtask is to foster an interdisciplinary expert dialog in the field of PV and drinking water supply. The objective is to provide guidelines to decision makers, to ensure that PV powered drinking water supply systems are implemented where they are the most sustainable option, building on past experience.

### **SUBTASK 2: PV and Health Centers**

The goal of this subtask is to publish a compilation of good practice regarding PV for rural health facilities, and to facilitate the integration of the same into the work program of the Megaphones.

### **SUBTASK 3: Pico PV Services**

The aim of this subtask is to produce dissemination material on pico PV issues in developing countries, based on experiences from Germany and Australia. A comprehensive brochure had been produced by GTZ and will be used in dissemination activities.

#### SUBTASK 4: PV and Hybrid Mini Grids for Rural Loads

Given the specific context of developing areas where grids are often weak and unstable, where in remote areas, there is basically no better option than diesel based generation, PV now offers potential solutions, both technically reliable and economically viable. This sub-task will concentrate on producing adapted materials needed and on working with the megaphones in order to prepare the future markets in developing regions.

#### SUBTASK 5: PV in Urban Settings in Developing Regions

Developing the urban infrastructure in line with extremely fast population growth has become a huge challenge for city planners in developing regions. Today, building integrated PV has a relatively modest incremental cost and could mitigate the problem. Subtask 5 concentrates on the promotion of available technical solutions (Subtask 5A) as well as business models and innovative financing mechanism (Subtask 5B).

#### SUBTASK 6&7: Deployment and Outreach to “Megaphones”

This subtask is the operating arm to establish partnerships with “megaphones” and develop common work. Subtask 6 focuses on Asia and Subtask 7 on Africa.

#### SUBTASK 8: Operating Agent

The role of the operating agent is to coordinate Task activities and to provide administrative services.

**Table 1 Subtask Overview**

Subtask	Topic	Lead Country	Contributing Countries	
1	PV Water Pumping	Switzerland	Japan, France, Germany	} 2010-2012
2	PV and Health	Germany	Denmark	
3	Pico PV Services	Switzerland	Netherlands	
4	PV and Hybrid Mini Grids for Rural Loads	France	Germany, Sweden, Austria, Greece	} 2013-2014
5	PV in urban settings in Developing Regions Subtask 5A: Technical Innovations for PV in the Urban Environment Subtask 5B: Innovative business models and financing mechanisms	Denmark (by interim) Switzerland	Switzerland, Netherlands, Denmark, Japan Sweden, Netherlands, Denmark	
6/7	Deployment and Outreach	France / Switzerland	Japan, Switzerland, Sweden, Denmark	
8	Operating agent	France	Switzerland (Secretariat)	

## 1.1 Important Publications by Task 9 prepared under the Workplan 2010-2014

The various research results developed within subtask 1 to 5 in the period 2010-2014, were compiled in seven key publications. These publications contain valuable information and data which are relevant and useful to a range of different audiences and beneficiary groups. The publications contain, on the one hand, recommendations about the design of regulations and programs which are relevant for policy makers and donor organizations. On the other hand, they provide practical advice for development experts, entrepreneurs and system operators regarding the implementation of programs and the application of technologies in the field. The table below provides an overview of these publications.

Year	Titel / Abstract	Contributors	Target Audience
2012	<p><b>Policy Recommendations to Improve the Sustainability of Rural Water Supply Systems</b></p> <p>This paper introduces the link between water and energy and its importance for sustainable development. Examples of different set ups and applications of PV pumping systems are given. An overview of recent technology developments in the field of PV pumping is provided and the economics and experiences made with diesel fuel and PV operated water supply systems are compared. Based on these experiences, policy recommendations are made to improve the sustainability of water supply systems in off-grid areas.</p> <p>The paper demonstrates that there are various common problems experienced in rural water supply projects implemented by experts from the water and sanitation sector and those implemented by experts from the field of photovoltaic energy. A closer collaboration with and information exchange between the water and renewable energy sectors are called for.</p>	<p>Main Author: Dr. Thomas Meier, Switzerland</p> <p>With substantial contributions from Japan, France, Australia and Germany</p> <p>Report IEA-PVPS T9-11:2012</p>	<ul style="list-style-type: none"> <li>· Policy Makers</li> <li>· Donor Agencies</li> <li>· Rural electrification and rural water supply organizations</li> </ul>
2013	<p><b>Pico Solar PV Systems for Remote Homes</b></p> <p>Solar pico PV systems have experienced significant development in the last few years, combining the use of very efficient lights (mostly LEDs) with sophisticated charge controllers and efficient batteries. Noting that some 1.5 billion people have no electricity grid connection, this Task 9 report demonstrates that solar pico PV systems can help in providing a few essential energy services. The concept of pico PV systems and their application in real-world circumstances are explained and the market dynamics elaborated.</p> <p>However, the provision of this initial level of service with pico solar PV systems does not imply that these populations should be considered electrified. Governments should take a facilitating role in the area of pico PV services, focusing on quality assurance, reliable information and education. Donor bodies can also play an indirect but important role.</p>	<p>Main Author: Erik H. Lysen, Netherlands</p> <p>Report IEA-PVPS T9-12:2013</p>	<ul style="list-style-type: none"> <li>· Policy Makers</li> <li>· Donor Agencies</li> <li>· Development Practitioners</li> </ul>

2013	<p><b>Rural Electrification with PV Hybrid Systems</b></p> <p>With decreasing PV prices, PV/diesel hybrid minigrids attract significant attention from institutions in charge of rural electrification and donor agencies - to mitigate fuel price increases, deliver operating cost reductions, and offer higher service quality than traditional single-source generation systems. The combining of technologies provides interesting opportunities to overcome certain technical limitations. This publication aims to present the state of the art situation of PV/diesel hybrid systems for rural electrification and to highlight the main remaining issues – from the design, technical and implementation perspectives. (Publication available in English and French).</p>	<p>Main Author: Gregoire Lena, France</p> <p>Report IEA-PVPS T9-13:2013</p>	<ul style="list-style-type: none"> <li>· Policy Makers</li> <li>· Donor Agencies</li> <li>· Rural Electrification practitioners</li> </ul>
2014	<p><b>Innovative Business Models and Financing Mechanisms for PV Deployment in Emerging Regions</b></p> <p>Like other renewable energy technologies, photovoltaic (PV) systems face the problem of high upfront costs. This problem is particularly pronounced in emerging economies where limited purchasing power and a lack of suitable financial products constitute additional obstacles for a broader dissemination of PV technology. The publication presents a collection of case studies of business models and financing mechanisms which show possible ways how such obstacles can be addressed and overcome in innovative ways. The case studies underline that the development of a business model is not a simple task but often requires long preparation time and a lot of devotion to details. Business models evolve over time and there is a lot of creativity required from entrepreneurs to develop suitable packages for PV products.</p>	<p>Main Author: Dr. Thomas Meier, Switzerland</p> <p>Report IEA-PVPS T9-14:2014</p>	<ul style="list-style-type: none"> <li>· development practitioners</li> <li>· energy entrepreneurs</li> <li>· donor agencies</li> </ul> <p>Models and mechanisms are also applicable in the field of other renewable energy technologies</p>
2014	<p><b>PV Systems for Rural Health Facilities in Developing Areas</b></p> <p>This publication presents technical guidelines and recommendations on PV systems design and standards for rural health facilities. The demand and supply of energy in health facilities is analyzed, and international standards are presented. Technical and economic aspects of different power generation options are discussed. International experiences from past and existing projects are analyzed, the main conducive factors of PV supply are outlined and lessons learned from the field are highlighted, with the aim to enhance the sustainable operation of PV systems for rural health facilities.</p>	<p>Main Author: Adnan Al-Akori, Jemen supported by Germany</p> <p>Report IEA-PVPS T9-15:2014</p>	<ul style="list-style-type: none"> <li>· Decision makers</li> <li>· Development organizations</li> <li>· Engineers</li> <li>· Renewable energy practitioners</li> </ul>
2015	<p><b>A user guide to simple monitoring and sustainable operation of PV-diesel hybrid systems</b></p> <p>This paper provides a simple monitoring and evaluation guideline for PV-diesel hybrid systems. It offers system operators a better understanding of the key factors for sustainable system. It also gives suggestions to how to act if there are signs of unfavourable use or failures. The application of the guide requires little technical equipment, but daily manual measurements. For the most part, it can be managed by pen and paper even by people without prior experience with power generation systems.</p>	<p>Caroline Bastholm, Sweden</p> <p>Report IEA-PVPS T9-16:2015</p>	<ul style="list-style-type: none"> <li>· System Operators</li> <li>· Development practitioners</li> <li>· Donor agencies</li> </ul>



2015	<p><b>Trends in the market for PV diesel mini grids</b></p> <p>This publication has been written in response to the growing need for information on the worldwide trends in adding PV systems to existing or new diesel-powered mini-grids, including possibilities and limitations. The publication builds on the experience with PV hybrid systems gained over the last twenty years by various programmes and organisations active in this field. The application of PV hybrid systems in remote mini-grids has excellent potential, but should be done with care through planning, design, implementation, operation and support. This publication has been developed to be a useful guide in this process.</p>	<p>Main Authors:</p> <p>Erik Lyssen, Netherlands</p> <p>Anjali Shanker, France</p> <p>Report IEA-PVPS T9-17:2015 (expected in March 2015)</p>	<ul style="list-style-type: none"> <li>· Design engineers</li> <li>· Deployment oriented decision makers</li> </ul>
------	---	---	---

## 1.2 Important Dissemination Events by Task 9 under the Workplan 2010-2014

Outreach activities, targeting a wide range of key stakeholders have played an important role since the beginning of Task 9. Successful deployment of PV technology requires paying specific attention to non-technical issues, which clearly are a major barrier to the dissemination of renewable energy. Task 9 is developing institutional partnerships with regional organizations highlighting the crucial importance of experience sharing and networking. The following table shows in which dissemination events Task 9 experts have participated, which topics were addressed, and which audiences were reached over the period of the past workplan.

Year	Dissemination Event	Dissemination Focus	Audience reached
2011	<p><b>Forum of Rural Water Supply Network, Uganda</b></p> <p>Task 9, led by Switzerland, has participated at the RWSN Forum in Uganda in Nov. 2011. Besides operating an exhibition booth during four days, a half-day seminar on PV pumping was conducted. The successful seminar was attended by 40 people plus 10 presenters reflecting the big interest in PV water solutions by water experts.</p> <p>A Swiss PV contact group was established prior to the event consisting: Wirz Solar GmbH, Trunz Water Systems AG, Bern University of Applied Sciences (Dr. Andrea Vezzini) and Entec AG. The exhibition booth provided ample opportunities for these companies to promote their products and services.</p>	Photovoltaic Pumping Systems	<ul style="list-style-type: none"> <li>· Rural Water supply Experts</li> <li>· Donor Agencies</li> <li>· Development organizations</li> </ul>
2012	<p><b>International Off-grid Renewable Energy Conference and Exhibition (IOREC), Ghana</b></p> <p>IOREC is an annual conference organized by the International Renewable Energy Agency (IRENA). Thomas Meier participated in the 1<sup>st</sup> conference in Ghana and presented the paper 'Policy Recommendations to Improve the Sustainability of Rural Water Supply Systems'.</p>	Photovoltaic Pumping Systems	<ul style="list-style-type: none"> <li>· Policy Makers</li> <li>· Donor Agencies</li> <li>· Rural electrification organizations</li> </ul>

2013	<p><b>Rural Electrification Workshop: “ International Best Practices and Options for Policy Makers”, Myanmar</b></p> <p>The workshop was jointly organized by Asean Center for Energy (ACE), the Central Research and Development Center (CRDC, Ministry of Industry, Myanmar), GIZ, EUEI-PDF, and Task 9. The workshop was attended by participants from various governmental organizations, NGOs and private sector. The presentations covered a broad spectrum of rural electrification topics. PV was at the center of attention in three sessions where Task 9 experts were responsible for presenting and moderating. Switzerland, represented by Alex Arter, gave a key note address on Rural Electrification Policy and Planning. Further Task 9 presentations were given by Anjali Shanker (F), Erik Lysen (NL), and Brisa Ortiz (D). Peter Ahm (DK) and Erik Lysen acted as moderators.</p>	<ul style="list-style-type: none"> <li>· PV for Rural Electrification</li> <li>· PICO PV Systems</li> </ul>	<ul style="list-style-type: none"> <li>· Regional Decision Makers</li> <li>· NGOs</li> <li>· Private Sector</li> </ul>
2013	<p><b>PVPS Task 9 Open Event, Bangkok, Thailand</b></p> <p>Switzerland coordinated the organization of an open Task 9 Event in Bangkok, Thailand on April 6, 2013. The event was a collaboration between IEA-PVPS, and the Department of Alternative Energy Development and Efficiency of Thailand (DEDE).</p> <p>During the event, Alex Arter presented about PV Pumping and the results of the position paper prepared under Subtask 1. Erik Lysen presented the publication about Pico solar PV Systems prepared under Subtask 3.</p>	<ul style="list-style-type: none"> <li>· Photovoltaic Pumping Systems</li> <li>· Pico PV Systems</li> </ul>	<ul style="list-style-type: none"> <li>· Policy makers</li> <li>· Private Sector</li> <li>· Universities</li> </ul>
2014	<p><b>Sustainable Energy for All (SE4all)</b></p> <p>One of the primary ways in which SE4all drives action is through the formation of High Impact Opportunities (HIOs). HIOs provide a platform for stakeholders from the private sector, public sector, and civil society to work together on specific actions. Around 50 HIOs have been identified to date. Task 9 became a member of HIO on “Clean Energy Mini Grids”. The contribution of Task 9 has focused so far on the sharing of its work results and the reviewing of documents.</p>	<ul style="list-style-type: none"> <li>· PV and Hybrid Mini Grids</li> <li>· Business Models</li> </ul>	<ul style="list-style-type: none"> <li>· International and National Development Organizations</li> <li>· Development Banks</li> <li>· Large NGOs</li> </ul>
2014	<p><b>2nd International Sustainable Energy Summit (ISES) in Malaysia</b></p> <p>Anjali Shanker represented Task 9 in the biennial event ISES in Kuala Lumpur in March 2014. She presented the results of subtask 4 under the title : “Empowering Rural Autonomy with Mini Grids and PV Hybrids”.</p>	<ul style="list-style-type: none"> <li>· PV and Hybrid Mini Grids</li> </ul>	<ul style="list-style-type: none"> <li>· PV Industry</li> <li>· Regional decision makers</li> </ul>
2014	<p><b>Joint Workshops with Club ER in Africa</b></p> <p>Throughout 2014, France organized two workshops in cooperation with CLUB-ER, in Sudan and Senegal. The topic of the workshops was “Financing renewable energy for rural electrification”. The workshops capitalized on the materials developed by Task 9 and in particular on the publication “Innovative Business Models and Financing Mechanisms for PV Deployment in Emerging Regions.”</p>	<ul style="list-style-type: none"> <li>· Business Models and Financing Mechanisms</li> </ul>	<ul style="list-style-type: none"> <li>· Rural Electrification Authorities</li> <li>· Development Organizations</li> </ul>

2014	<p><b>6th World Conference on Photovoltaic Energy Conversion (WCPEC-6), Japan</b></p> <p>The IEA PVPS program conducted a joint workshop titled “Challenges and Promises to Large Scale PV Development” at WCPEC-6 in Kyoto, Japan on Nov. 25, 2014. The workshop was structured into 5 sessions during which around 20 presentations were made by members of different PVPS Tasks. Task 9 was represented by two speakers. Thomas Meier and Anjali Shanker participated in session 2 – “PV Market Development Trends: The Expected Rise of New Business Models”. Thomas Meier presented the results of his research about Innovative Business Models and Financing Mechanisms. Anjali Shanker presented macro-economic trends and their impact on business models.</p>	<ul style="list-style-type: none"> <li>· Business Models and Financing Mechanisms</li> </ul>	<ul style="list-style-type: none"> <li>· Private Sector</li> <li>· Universities</li> <li>· Individual researchers</li> <li>· PVPS members from all tasks</li> </ul>
------	---	--	---

The above table of dissemination events is not exhaustive. Besides the official Task 9 dissemination events, Alex Arter and Anjali Shanker (Operating Agent Task 9, France) have also shared their experience during the REPIC Workshop in Bern, on Sept. 24, 2013. Other group members such as Peter Ahm (Denmark) and Jean Christian Marcel (France) participated in various meetings and conferences where they presented the results of Task 9 to policy makers and representatives from the PV industry.

## 2 SWISS CONTRIBUTION TO THE TASK 9 WORK PLAN IN THE REPORTING PERIOD

### 2.1 Objectives according the Contract with REPIC

According to the contract with REPIC, the current working phase is covering a 12 month period from August 1, 2013 to July 31, 2014. Due to some delays in project implementation and to have the possibility to participate in important meetings, a cost-neutral extension was granted until December 31, 2014.

This project was carried out in accordance with Objective 2 of the REPIC platform, i.e. 'Networks, Information and Communication'.

The specific objectives and deliverables have been defined in the project proposal "**Swiss Contribution to IEA PVPS Task 9 Program, Photovoltaic, Services for Developing Countries (PVSDC)**" from June 17, 2013. The work was performed in accordance with the work plan formulated in that proposal with major contributions to two Subtasks:

- **Subtask 5B 'Innovative Business Models and Financing Mechanisms'**  
Switzerland took over the leadership of that Subtask in 2013 with the objective to identify and analyze innovative business models and financing mechanisms for PV deployment in developing regions. The final result should be an official IEA-PVPS publication.
- **Subtask 6 Deployment and Outreach**  
Switzerland has been a main contributing country in Subtask 6 focusing on establishing partnerships in Asia. The objective was to organize joint events with these partners as platforms to disseminate the results produced in the other Subtasks.

The above mentioned proposal was prepared for a two-years period from July 2013 to June 2015. As mentioned earlier, the contract provided by REPIC covered only a one-year period. Naturally, the shorter time frame limited the scope of results that could be achieved.

The next two sections provide details about the work progress and results achieved in the two Subtasks with Swiss contribution.

## 2.2 Subtask 5B - Innovative Business Models and Financing Mechanisms

In 2013, Switzerland has taken over the lead of Subtask 5B 'Innovative Business Models and Financing Mechanisms'. Subtask 5B was originally led by the Netherlands, but their contribution was withdrawn in 2012. Subtask 5B does not aim to develop new business models on its own but to systematically collect and analyze information about existing business models. The objective of Subtask 5B has been defined as:

### **SUBTASK 5B: Innovative business models and financing mechanisms**

The objective is to evaluate and disseminate information on new and innovative business models as economically sustainable alternatives for PV deployment in developing countries.

### Activity 5.1 General Analysis Framework

The first activity conducted was the preparation of a general framework for the gathering, analysis and synthesis of information from cases studies of business models. A literature research was conducted with the purpose of identifying existing tools for that purpose. The analysis framework selected was the Business Model Canvas as it was recently developed at EPFL Lausanne by Alexander Osterwalder and Yves Pigneur.<sup>1</sup> Figure 1 shows the Business Model Canvas. The tool resembles a painter's canvas – preformatted with nine blocks – which can be used to draw new or existing business models. It is a hands-on tool that fosters understanding, discussion, creativity, and analysis.

#### Presentation at 29<sup>th</sup> Expert Meeting in Paris

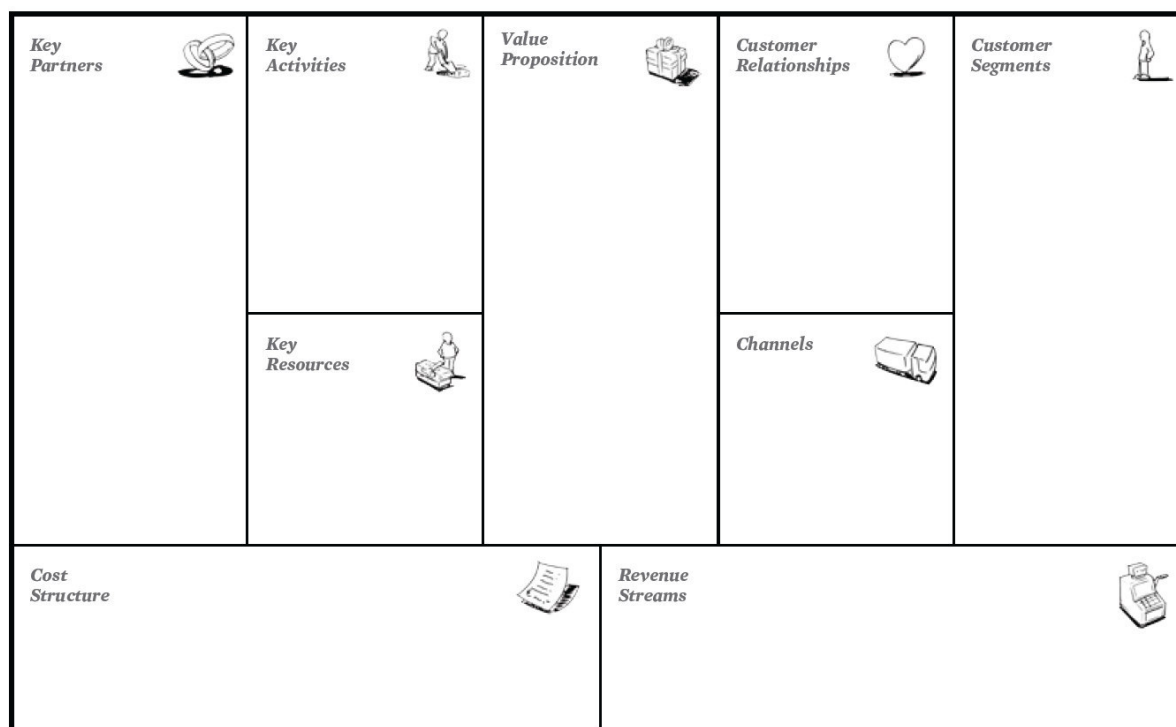
Thomas Meier participated at the Task 9 Expert Meeting in Paris on Sept. 26/27, 2013. The planned Swiss contribution to Task 9 in the period 2013 to 2015 was presented and the proposed business model canvas explained.

Participants in the meeting were delighted about the presentation and approved the business model canvas approach. It was expected that the proposed activities will create synergies with the other subtasks, particularly subtask 5A. Considering these expectations, it was therefore decided that Subtask 5B should initially focus in business models suitable for the urban environment in emerging countries.

Peter Ahm, Denmark, obtained the presentation with the purpose of presenting it at the Task 1 Meeting in Korea im Dez. 2013.

---

<sup>1</sup> Osterwalder A., Pigneur Y, Clark T. (2010): Business Model Generation : a handbook for visionaries, game changers, and challengers. Hoboken : Wiley.

**Figure 1 The Business Model Canvas** (Source: Osterwalder et. al, 2010:44)


### Activity 5.2 Repository of Case Studies

After the analysis framework had been defined, the next step was to collect information about existing business models. However, obtaining case studies from PVPS members proved more difficult than anticipated. The reason for this situation lies in the fact that the different Tasks of the PVPS program are very strong in technical research and the analysis and assessment of data at the macro level. The members of Task 9, in addition, have broad experience in dealing with national governments and the practical implementation of development programs and projects. Dealing with specific business models, however, means to deal with the micro-level of individual companies, which is new territory for many members. In the course of the work it was found that there is a lot of interest in this subject within PVPS and Task 9. However, due to their previous orientation, only a couple of members were in a position to contribute information on specific case studies on concrete business models.

To overcome the information gap, Thomas Meier researched the internet for innovative business models and financing mechanisms. The challenge was that there is a lot of information about approaches to PV deployment in rural areas of emerging regions, but less about the urban environment. For this reason, the original focus on urban areas was loosened to some extent by also looking at case studies from rural areas as well as industrialized countries. However, this relaxation did not detract from the quality of work. Rather, it was found in the course of the work that the categories of system size and grid integration status are more relevant than the division between rural and urban areas. The following twelve cases were identified and researched in more detail:

1. SELCO – India – Solar lighting for vulnerable, poor and remote populations through joint liability groups, restructuring crop loans, and solar light agents.
2. **Chloride Exide – Kenya – Achieving PV Sales by using an Existing Distribution Network.**
3. **Grundfos Lifelink – Denmark – Innovative PV water supply system in off-grid areas.**
4. Sundaya – Indonesia – Modular Pico PV Systems.
5. Grameen Shakti – Bangladesh – 700 Technical Centres Sell, Install and Maintain Small PV systems.
6. **SunEdison – India – Medium-scale PV Investments as a Hedge Against Raising Electricity Tariffs.**
7. Mera Gao Power – India – Microgrids as a business opportunity for rural entrepreneurs.
8. **AZURI Technologies – United Kindom – Pay-As-You-Go Model to Make PV Affordable for Low Income Households in Africa.**
9. Greenleads – Kenya – Green electricity services with low risk for clients.
10. **Gham Power – Nepal – Urban Hybrid PV Microgrids as an Answer to Load-Shedding.**
11. OneRoof Energy – United States – PV leases as part of new roofing or re-roofing projects.
12. **MOSAIC – United States – Crowdfunding model to solar energy installations.**

Comments and explanations for selecting the case studies:

Based on the initial literature research, the six business models, printed in bold, were selected for further analysis. The selection of these six business models was not made with the intention that they are the only recommended models, nor that they are exclusive for all available models. The selection was made primarily on the basis of the following criteria:

- The models had to be innovative and market-oriented (not solely oriented on the market for donor financing).
- They were suitable to cope with frequently encountered energy supply and access issues in developing regions.
- They had to contain interesting mechanisms that can be transferred as elements into other business models (and other renewable energies).
- They may have an invigorating effect on start-up energy companies and provide them with approaches to design their own business models. (It is not intended that entrepreneurs adopt the models one to one.)
- They enable companies to develop a reasonably large market allowing them to generate profits.

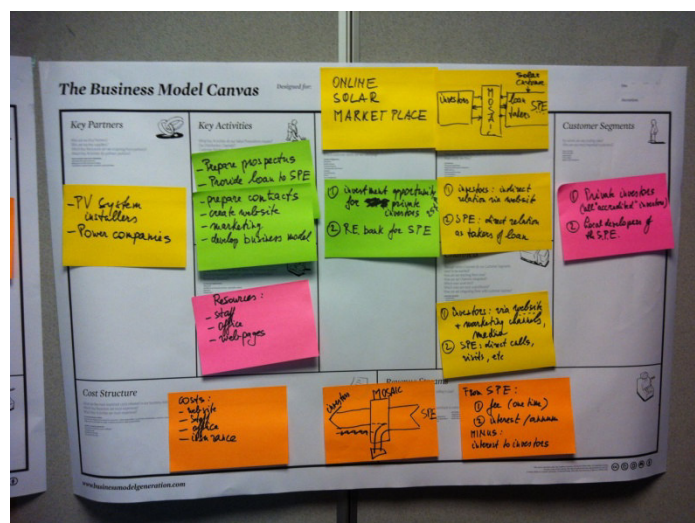
In this sense, the selected models represent a range of options that may be considered by entrepreneurs and assist them in designing their own business models. Business models

should never be taken as fixed constructs. They are subject to constant change. They are always reflecting the current political and socio-economic setting, as well as market trends and need to keep pace with change. Keeping this in mind, the selected models show how individual entrepreneurs have responded to the actual conditions in their environment at the time of analysis and how they designed their business models accordingly.

The number of business models examined was essentially limited by the time available. It would have been possible to identify and analyze a range of additional models, if resources had been available. Other more technical factors which limited the selection of the business models was the reachability of company managers and their willingness to give interviews. The publicly available literature is never sufficient for a good description and analysis of cases studies. A clear picture of a business model and the current state of a company can only be obtained when directly talking to an entrepreneur. Four business models (of the original list of twelve) had to be dropped for reasons of non-reachability of managers. Two more models were not included because of doubts regarding their replicability by other parties. For the remaining six business models, detailed questionnaires were developed and telephone interviews conducted. The interviews were transcribed and subsequently compiled into individual case studies together with the information from the literature review.

### Working Session Business Model Canvas

During the 30<sup>th</sup> Task 9 Expert Meeting in Lyon on 1/2. April, 2014, Thomas Meier conducted a working session base on the Business Model Canvas Methods. All participants were given a printout of the repository of case studies. After a brief introduction on the subject, the members were divided into four groups. Each group had to choose a business model and then map this model in the Business Model Canvas. For this purpose pre-printed formats of A1-size were distributed. After 45 minutes, the groups came together again and presented and explained the business model they worked on.



The participants appreciated the business model canvas method and the business models selected and thanked Thomas Meier for the effort made. It was found that these business



models should also be presented in other committees that are more rooted in the technical or regulatory fields. Anjali Shanker said: "That would be science fiction for them".

The colorful results of the canvas should not be regarded as results to be published anywhere. Much more important is the process and the discussions that come up when working with the canvas. It becomes clear quite quickly which Business Models are already well-elaborated and which still need to be further developed. In particular, it became also clear that there are a multitude of detailed questions to be answered in order to develop a business model, and that this requires a fairly large amount of work. In some cases where PV investment opportunities are offered, the process of defining the business model and fine-tuning it to the requirements of the regulators can easily take two years until approval is given.

#### Presentation at joint Task 1 and Task 9 meeting in Kyoto, Japan, Nov. 2014.

Thomas Meier presented the case studies and business model canvas methodology during the joint Task 1 and Task 9 meeting in Kyoto, Japan on Nov. 22, 2014. The objective was to inform Task 1 members about our activities and to identify possible joint operations for the future. The feedback from Task 1 members was positive. People found the methodology and case studies very interesting. However, since Task 1 used to work more on the macro level of PV development in the past they seemed to have difficulties to imagine dealing with more down-to-earth approaches in the future. It was agreed that Task 9 would continue working on the micro level with concrete business models and share the working results in the future with Task 1 during joint meetings approx. once a year.

### **Activity 5.3 Publication: Innovative Business Models and Financing Mechanisms**

Initially it was planned to write a comprehensive publication about innovative business models and financing mechanisms based on a variety of case studies. The publication should furthermore include recommendations for decision makers and entrepreneurs regarding the design of support programs and the shaping of concrete business models.

Since it was not possible to mobilize the required resources for a comprehensive publication, the Task 9 experts decided during their meeting in Utrecht in Sept. 2014 to prepare a less comprehensive publication based on the existing repository of case studies. In addition to the purely descriptive case studies, the publication should describe the Business Model Canvas method which was used to prepare the case studies. Furthermore, it should provide an approach to categorize the different business models.

Thomas Meier has written this publication in the course of October 2014. The peer reviewing process within Task 9 and PVPS was completed at the end of 2014. The official publication is expected to take place in early 2015 under the title: "Innovative Business Models and Financing Mechanisms for PV Deployment in Emerging Regions."

## 2.3 Subtask 6 – Deployment and Outreach

### Activity 6.1 Coordination with Megaphones and Dissemination of Results

#### Coordination with Megaphones:

Alex Arter had intensive discussion with ACE and GIZ Jakarta about a continuation of the cooperation ACE-Task 9 and the harmonization of the work programs of Task 9 and GIZ Jakarta. GIZ Jakarta runs a project focusing on technical standards for mini grids. They are interested to narrow down their focus on PV hybrid mini grids in the future and would like to cooperate with Task 9 in this field. The ongoing discussions about joint activities focus on workshops and publications with a regional focus on South and South-East Asia.

As a result of the Key note speech in Myanmar on the occasion of the GIZ-ACE-Task 9 conference and the follow-up event in Bangkok, organized by Switzerland on behalf of Task 9 in 2013, Alex Arter was invited as a guest speaker for the EEP annual conference, with the effect that Task 9 has gained the reputation of a reliable partner in South-East Asia. The participation in particular raised the interest of two countries in PVPS and Task 9 – (1) Thailand and (2) Finland:

(1) A new cooperation opportunity emerged in Thailand where the Government strongly supports the increase of PV power in the country's energy mix. Thailand, represented by the Department of Alternative Energy Development and Efficiency (DEDE), has officially become a member of the IEA-PVPS program in March 2014. After the EEP conference, Alex Arter and Peter Ahm (Danish Task 9 representative) have entered talks with DEDE to identify cooperation possibilities with Task 9. Three coordination meetings were held in Bangkok regarding this matter.

The rapid growth of Thailand's PV sector means that the country sooner than later will face the technical problems related to high penetration of PV in distribution grids. Similar issues will emerge in many other south and south-east Asian countries over the coming years. It was therefore proposed to conduct a regional workshop of integration of PV in public grids in emerging markets in Asia. Such a workshop could take place in the second semester of 2014 or first semester of 2015 with Bangkok as a possible venue and DEDE as a co-organizer. A concept for such an event is going to be developed. Switzerland would have the lead within Task 9.

(2) Finland has expressed interest to re-join IEA-PVPS and Task 9 which is also the merit of Alex Arter and Peter Ahm who promoted IEA-PVPS and Task 9 during several meetings with the Finnish representative of the EEP program for the Mekong region. Finland expressed its appreciation of the IEA-PVPS program, in particular due to the chance for a worldwide exchange with colleagues in solar PV. They are expecting to benefit from lessons learnt and by joining forces with other participating countries.

#### Dissemination of results:

As mentioned above, Alex Arter has participated as guest speaker in the 4th EEP Mekong Annual Regional Forum “Solar Power – An Abundant Energy Resource in the Mekong Region” on October 24, 2013 in Siem Reap, Kingdom of Cambodia. The forum was attended

by around 150 participants mainly from the Mekong Region. The Forum was organised by EEP together with its partner in Cambodia, the Ministry of Industry, Mines and Energy.

During the one-day event, seventeen presentations were given by senior government officials from Lao PDR, Cambodia, Myanmar, Thailand and Vietnam (highlighting their countries' solar energy outlook) and international experts. The presentation by Alex Arter was titled 'Advances in making solar energy affordable' and addressed the activities of Task 9, the Swiss contribution, the business model canvas approach, and selected innovative business models.

Thomas Meier was invited to speak at the 6<sup>th</sup> World Conference on Photovoltaic Energy Conversion (WCPEC-6) on November 25, 2014 in Kyoto Japan. The IEA PVPS program conducted a joint workshop titled “Challenges and Promises to Large Scale PV Development”. The workshop was structured into 5 sessions during which around 20 presentations were made by members of different PVPS Tasks. Thomas Meier participated in session 2 – “PV Market Development Trends: The Expected Rise of New Business Models”. He presented the results of his research about Innovative Business Models and Financing Mechanisms.

### 3 OUTLOOK

In 2013, about 99% of the globally installed PV capacity of 135 GW were grid-connected systems. Off-grid systems which once dominated a small market, now account for 1% at most. Nearly 1.3 billion people did not have access to electricity in 2011, mostly in sub-Saharan Africa and remote regions in Asia. Given the current speed of development and available financing, the IEA (2012) projects that close to 1 billion people will still be without electricity in 2030. IEA further expects that several hundred million people will continue to live in sparsely populated rural areas where off-grid solar PV systems would likely be the most suitable solution for basic electrification.

Task 9 was the first initiative within an implementing agreement of the IEA which concentrated on energy related issues in non-OECD countries. This step-motherly existence has ever been problem for the Task to raise sufficient funds for its useful work. The importance of developing countries was too small to gain much interest by the member countries. However, this situation is due to change dramatically over the next 30 years. It is forecasted that to limit the global mean temperature increase to 2°C in the long run, 83% of the required emission reductions by 2050 will have to be achieved outside the OECD in emerging regions.

The above two key aspects underline the importance and relevance of Task 9. The current member countries of Task 9 have therefore decided to continue their work under a new workplan from 2015 to 2019.

Given the speed of developments taking place, the new Task 9 will have to shift focus from doing its own independent research to transforming and adjusting the mass of experience and knowledge available within PVPS and present it to non-member countries. Task 9 is the only Task within PVPS that has the required background and network to act as the interface between IEA member countries and non-member countries.