

DGS Publications



REEPRO

REEPRO

Rural
Renewable
Electrification

Promotion of the
Efficient Use of
Renewable Energies in
Developing Countries

Reepro Project Leader



Deutsche Gesellschaft für Sonnenenergie e.V.

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Intelligent Energy  Europe

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DGS – German Solar Energy Society

The DGS - **D**eutsche **G**esellschaft für **S**onnenenergie e.V. (German Solar Energy Society) is the largest and leading scientific and technical organisation for solar based renewable energy such as solar energy and biomass in Germany. The DGS has a network of 36 local and 5 regional offices throughout Germany with over 3,000 individual and corporate members.

The DGS has a strong base in education, standardisation and conception of regional energy concepts. As the national section of the International Solar Energy Society (ISES) the organisation is active in international cooperation for education and standardisation of renewable energy installations. The DGS is strongly committed to education. The DGS developed multilingual bio-energy, solar thermal and photovoltaic guidebooks (English, Spanish, Portuguese, German, Italian). The DGS coordinates eight German DGS Solar-Schools, which offer training courses on photovoltaic, solar thermal and biomass energy. Since 1996 hundreds of engineers, architects, craftsmen and interested citizens have been taking part in the SolarSchool courses in Germany. Today the successful training concept is also being transferred to third countries. In 2004 one SolarSchool was opened in Taiwan, in 2007 in Macedonia and in 2009 one school per country in Ethiopia, Laos and Cambodia.



Hands-on training in the SolarSchools Weimar and Phnom Penh

The REEPRO Project

The “REEPRO - Promotion of the Efficient Use of Renewable Energy in Developing Countries” project was motivated by the fact that poor households in developing countries often lack access to basic energy services. The REEPRO approach is the provision of energy services to those currently unserved or underserved with higher quality energy services on the basis of an introduction of renewable energy and energy efficiency. Therefore, the REEPRO team developed an extensive training and information campaign, which was implemented in the REEPRO target countries Laos and Cambodia. These training courses target politicians, engineers, technicians and community stakeholders to overcome barriers for renewable energy sources (RES) utilisation, which are characterised by lack of technological knowledge and awareness of RES financing options and models.

Training for children, including text books, slides, videos, handouts, hands-on training material and teaching descriptions, were developed for biomass energy, solar energy and renewable energy economics management. Training kits were developed for three levels:

Level 1 – Renewable energy experts

Trainers and disseminators (scientists, engineers, architects etc. with a higher education degree as well as government representatives)

Level 2 – Technicians

Those with basic understanding of engineering subjects

Level 3 – Community stakeholders

Those often with a very basic education level.

Trainers of each level were trained and training courses for each level performed from January 2008 to December 2009.

Background

Out-dated diesel generators are the main source of electricity in rural areas in developing countries. They are used to run battery charging stations, village grids or single applications such as for rice mills. Those systems are inefficient and expensive since they:

- use inefficient generators,
- are the source of environmental damages and
- are fuelled with expensive diesel with instable prices and rising costs e.g. 0.90 US\$ in 2007 to 1.2 US\$ in 2008 in Cambodia.

Car batteries are another common source of electricity. Batteries are charged at central battery charging stations, yet again mainly operated with diesel generators. The charging of one 120 Ah battery costs e.g. in Cambodia 0.50 US\$. The charging stations are situated at central locations in the villages or districts inducing additional costs for the transportation of the batteries from home to the charging station and vice versa. Hence, the average cost ranges between 0.50 to 1.50 USD per charging.



Fossil-fuel-based electricity generation in rural areas in Laos and Cambodia
One possibility to overcome the energy deficits in the rural areas of developing countries is the local use of renewable energy sources (RES). The use of locally available RES such as the sun and biomass can bring a multitude of benefits for the region. These include: independence from grid connection and imported fossil fuels, generation of new jobs in the energy sector, availability of clean energy, improvement of the quality of life and consequently a reduction of rural migration.

The main obstacle for the sustainable implementation of renewable energy in developing countries is the limited knowledge and awareness of all stakeholders, who range from engineers to villagers. Not only the rural population, but also technicians, engineers, and experts are unaware of the existing funding programmes and of the potential of RES, and all lack economic understanding. They only see that the first investment in renewable energy (RE) technologies is often higher than in conventional, fossil energy technologies.

Renewable Energy The solution for efficient rural electricity supply

Comparing the investment plus the operation costs to get a real feasibility picture is rarely considered. Another problem is the incorrect installation and the lack of maintenance for applied RE technologies. Solar home systems (SHS) are often completely or partly shaded, dirty or installed facing the wrong direction. Small-scale biogas plants are often operated ineffectively and are sometimes even out of order. Installers and users are not aware of the correct installation, operation and in particular maintenance.



Left, dirty module of a SHS; right, shaded module of a solar water pumping station, 12pm

There is no knowledge of the negative influences of shading, dust and of the incorrect installation on the efficiency of photovoltaic (PV) modules.

Solar systems can suffer a great deal of power reduction if shaded. For example, a solar system with only 10% of its module area cov-

ered by shading from leaves or other obstructions will suffer a power loss of up to 90%.

The REEPRO Training Approach

The REEPRO training is structured according to the snowball-effect. To disseminate the knowledge, local renewable energy experts are initially trained as Level 1 trainers (train the trainer approach). Afterwards, Level 1 trainers train the Level 2 technicians. Then the Level 2 technicians and the Level 1 trainers train the Level 3 community stakeholders. The REEPRO project team along with the Level 1 and 2 training participants jointly developed the REEPRO training material, which was tested in the REEPRO pilot communities in Laos and Cambodia. The Level 2 and 3 training courses were only offered in the REEPRO pilot communities and were accompanied by the development of electrification master plans for the respective communities and for the implementation of pilot applications.

The REEPRO training approach can be transferred to other Lao and Cambodian communities but also to other developing countries world-wide.

Training material

The REEPRO team developed training kits for each level, based on the existing DGS photovoltaic, solar thermal and bio-energy guide-books along with training material from the Asian partners and demand surveys performed in the first REEPRO project year. The different local framework conditions, such as educational competence, available and appropriate technologies, economic situation, available biomass, etc., were considered during the preparation of local training kits. The Level 1 local training kits were developed in English and afterwards translated into Lao and Khmer; this procedure ensured transparency of the detailed content of the local versions' training kits.

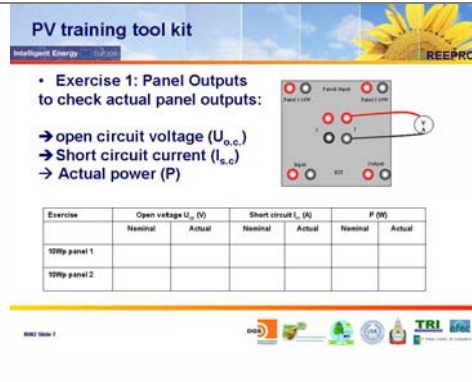
Levels 2 and 3 of the training kits were developed in Lao and Khmer with only the final version being translated into English. All first versions of the training kits were further developed based on the experience during its application. The final versions of the training kits were prepared in the last semester of the project. Additionally, all versions of all three levels were published on a CD.

Media and material for the different levels

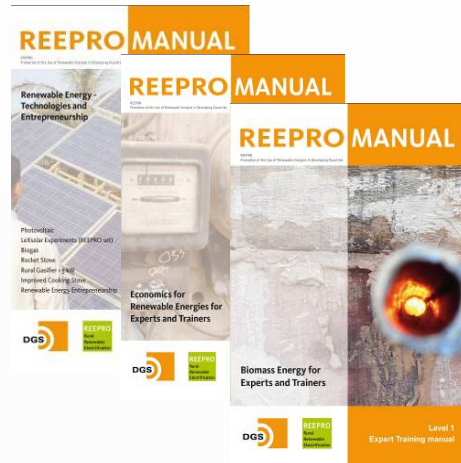
The training kits for the different levels contain different material as presented below:

Media	Material
Level 1 Experts and disseminators	
<ul style="list-style-type: none"> • Lecturers • Workshops • Project work • Practical work & excursions 	<ul style="list-style-type: none"> • Scientific textbooks • Slides with explanatory text for the trainers • Handouts • Videos, practical training equipment • Excel calculation tools for planning and dimensioning RE projects
Level 2 Technicians	
<ul style="list-style-type: none"> • Practical work • Lecturers • Excursions 	<ul style="list-style-type: none"> • Technical textbook/manuals with experiences/handouts • Videos • Practical training equipment
Level 3 Community stakeholders	
<ul style="list-style-type: none"> • Stakeholder workshops • Coaching • Meetings • Consulting 	<ul style="list-style-type: none"> • Handouts • Posters • Videos, etc.

The training kits are assembled in such a way so that energy experts or REEPRO Level 1 training participants can use the material to perform training by themselves. For example, all slides are accompanied by an explanatory text, which helps the new lecturers to present the content of the slides during training courses.

Slide of the practical work module	Explanatory text for this slide																											
 <p>PV training tool kit</p> <p>Intelligent Energy Europe REEPRO</p> <ul style="list-style-type: none"> Exercise 1: Panel Outputs to check actual panel outputs: → open circuit voltage ($U_{o.c.}$) → Short circuit current ($I_{s.c.}$) → Actual power (P) <table border="1"> <thead> <tr> <th rowspan="2">Exercise</th> <th colspan="2">Open voltage $U_{o.c.}$ (V)</th> <th colspan="2">Short circuit $I_{s.c.}$ (A)</th> <th colspan="2">P (W)</th> </tr> <tr> <th>Nominal</th> <th>Actual</th> <th>Nominal</th> <th>Actual</th> <th>Nominal</th> <th>Actual</th> </tr> </thead> <tbody> <tr> <td>100Wp panel 1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>100Wp panel 2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Exercise	Open voltage $U_{o.c.}$ (V)		Short circuit $I_{s.c.}$ (A)		P (W)		Nominal	Actual	Nominal	Actual	Nominal	Actual	100Wp panel 1							100Wp panel 2							<p>In this exercise, the trainees are to measure actual open-circuit voltage (V) and short-circuit current (A) of each single module (1 and 2), then to calculate the actual power, and to compare these measured figures with the nominal figures on the label of the module.</p>
Exercise		Open voltage $U_{o.c.}$ (V)		Short circuit $I_{s.c.}$ (A)		P (W)																						
	Nominal	Actual	Nominal	Actual	Nominal	Actual																						
100Wp panel 1																												
100Wp panel 2																												

REEPRO Manuals (scientific and technical text books)



Several books for the different levels were developed during the REEPRO project. The final REEPRO training kit set consists of 3 books in English, Lao and Khmer. The Level 1 training kit contains one solar energy, one biomass energy and one economics for renewable energy book.

Each of the three books presents the REEPRO project with technical or economical basics and scientific chapters on the respective themes, solar energy, biomass energy and economics.

For Level 2 the different subjects are assembled in one manual covering the subjects photovoltaic, biogas, gasification (rockets stoves and small-scale gasifiers), improved cooking stoves and renewable energy entrepreneurship.

You can order the REEPRO training manuals using the order form under <http://www.reepro.info/2454.0.html> or by e-mail reepro@dgs.de. We can provide you the books free of charge but are required to collect a service fee of about 25 EUR.

Posters, booklets and videos



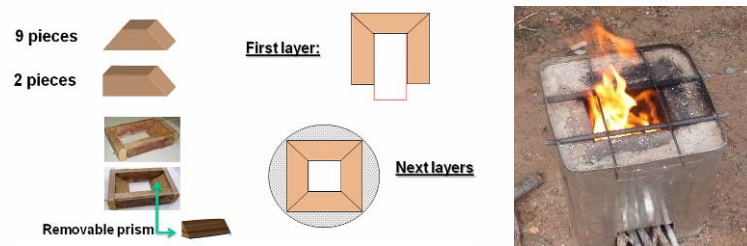
For the Level 3 training courses posters, booklets and videos were developed for the subjects rural bio digesters (biogas), solar home systems and rocket stoves. The material can be downloaded from the REEPRO website: <http://www.reepro.info/2454.0.html>.

Practical training equipment

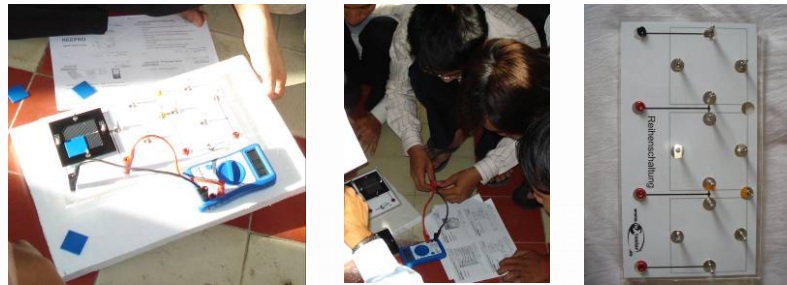
Two different kinds of showcases were developed and implemented within the REEPRO project. Community showcases – static installations in the pilot and project communities and training showcases – installations and training equipment for practical training.

Community showcases (demonstration plants) using different technologies like biomass and wood gasification, biomass stoves and SHS were planned and installed as a part of the REEPRO project. The REEPRO team and the REEPRO Level 1 and 2 trainers supported the pilot communities in developing renewable energy concepts to meet their needs. Twelve communities in Laos and Cambodia were supported to encourage existing or install new renewable energy plants (community showcases). For more information please see: www.reepro.info/2400.0.html.

Nine **training showcases** covering the subjects biogas, rocket stoves, solar thermal energy and photovoltaic were developed during the REEPRO project and used during the performed training courses.



Training showcase - Practical training equipment rocket stove



Training showcase - LeXsolar-Photovoltaic experiment kit (REEPRO Set)

Data sheets on the different developed showcases can be found under: <http://www.reepro.info/2454.0.html>. The REEPRO manual provides the necessary background information to rebuild the showcases and perform exercises.

Training Programme

For Level 1 two one-week courses were developed, one on biomass and one on solar energy. Each course contains 20 units á 90 minutes, thus 30 hours. The biomass course contains 9 and the solar course 8 subjects. Both courses include: an introduction to the subject, basics, power transmission and storage, economics, project work (case study) and excursion/practical work. The subjects photovoltaic and solar thermal energy are only taught in the solar and biogas course; biofuel and gasification are only taught in the biomass course.

The Level 2 courses, which last between 2 to 4 days, 8 to 16 units á 90 minutes, are offered on the following subjects:

- Technical and economic aspects of renewable energy
- Photovoltaic
- Biomass gasification and
- Biogas

The Level 3 training courses last from 1 day to 2 weeks and offer the same subjects as the Level 2 courses.

REEPRO Solar Schools

The REEPRO renewable energy training programme and material is the basis for the operation of renewable energy training centres in Laos and Cambodia. In November 2009 two DGS SolarSchools (renewable energy training centres) were opened, one in Laos at the National University of Laos and one in Cambodia at the COMPED training centre. Those DGS SolarSchools will continue with the REEPRO training programme. Additionally, the REEPRO courses and material can be used to perform training courses world-wide.

The SolarSchools offer courses for all 3 REEPRO levels.

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