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Solar Energy Technology in Development Cooperation

- Needs and market development for solar energy
- Financing for solar energy in developing countries
- Photovoltaics in development cooperation – moving from off-grid rural applications to large scale deployment
- Solar thermal: drying, air heating, process heat
- Solar thermal: heating and cooling, domestic hot water
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NEED: Network of Excellence in Renewable Energy Technologies for Development

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This paper presents the 'Network of Excellence in Renewable Energy Technologies for Development' (NEED), which was initiated by a project consortium of five partner institutions from Botswana, Germany, Namibia and Zambia. The collaboration is intended to initially function as a research network between the five partner institutions, but is subsequently required to evolve into a more expansive development network for the target region and the whole of Southern Africa.

Renewable Energy Resources in the Target Region

In all countries of the target region, lack of access to sufficient and sustainable energy supply affects most of the population, especially in rural areas. Considering that the target region comprises the countries with the highest potential in solar energy worldwide with an average solar radiation between 4.5-6.5 kWh/m²/d (in comparison: Germany 0.8-1 kWh/m²/d), it seems remarkable that only 30 % of the Southern African population have access to electricity (SOLARGIS, 2011). 90 % of the population still rely on traditional fuels for cooking, heating and hot water supply, which poses serious threats to health, economy and environment (Ketlogetswe et al., 2009).

Despite the excellent solar conditions in Botswana, solar energy currently contributes less than 1% to the primary energy supply of the country (Ketlogetswe et al., 2009). The total installed electrical capacity in 2011 was 132 MW, mainly based on coal power plants. 88 % of the electricity used was imported from foreign power providers, 66 % thereof sourced from ESKOM (South Africa). This overdependence on imports is a threat to energy security in Botswana, especially as ESKOM is currently failing to meet its own demands. Therefore, the use of own local energy resources is essential for Botswana. The country has, in addition to the high solar energy potential, resources from coal (about 200 billion t.) as well as dung and fuel wood. The only power utility in the country, the Botswana Power Cooperation (BPC), is currently expanding its coal-fired generation capacity despite several strategies and plans by the Government of Botswana to foster renewable energy technologies (RETs) and encourage greater private sector investment. For example, the National Development Plan aims at an increase of renewable energy usage to 15 % by 2015 and 25 % by 2030. (REEGLE, 2014a)

In 2013, Botswana started a tendering procedure for two new 300 MW coal-fired power plants. Yet, there are also plans for solar power plants, e.g. a 100 MW plant in Jwaneng, and the electrification of rural areas with solar home systems through BPC Lesedi (GERMANY TRADE&INVEST, 2014). However, the large scale implementation of RETs is still not effectuated.

Namibia faces severe constraints in terms of electric energy security and energy access. Up to 60 % of electricity has to be imported from regional power pool member states, while electrification rates are around 30 % only (Ndhlukula, 2010). Domestically, Namibia is supplied by a state owned company, called NamPower, covering all its electric energy needs. The country has a generation capacity of 415 MW, produced from four power plants: Ruacana Hydropower with 240-300 MW (depending on the water level), Van Eck coal-fired plant with 120 MW as well as Paratus (17 MW) and Anixas (22.5 MW) diesel power stations. RETs are currently mainly used for off-grid electrification and domestic water heating, while a few bigger RE projects are scattered in isolation all over the country. Namibia is the most arid country south of the Sahara and has an excellent solar energy potential especially in selected locations of the southern parts of the country (von Oertzen, 2012). Biomass, the bulk of

which is in the form of invader bushes, is another resource that can provide substantial and sustainable energy. Wind energy data suggest the suitability for the establishment of wind farms with installed capacities of up to 50 MW along the sea coast (von Oertzen, 2009). Lüderitz and Walvis Bay (western coast of Namibia) have potential for wind power with an average wind speed around 7 m/s (REEGLE, 2014b). However, national wind resource data sets are not readily available. This inhibits the optimisation, positioning and design of wind farms in Namibia. Just like in most SADC countries, Namibia's geothermal resource potential remains largely underutilised. In general, investments in off-grid electrification in Namibia have been small, and few real and sustainable successes can be shown (von Oertzen, 2009).
At present, electricity for industrial and household use in Zambia is supplied by local hydroelectric power plants (99 %) and imported crude oil. In contrast to Botswana and Namibia, Zambia was self-sufficient for a long time in all its energy sources with the exception of petroleum which has been wholly imported. Yet, Zambia's total demand currently exceeds internal generation as a result of the thriving mining sector. In 2008, 450 MW were unavailable from the country's generating infrastructure, leading to a peak-period deficit of 280 MW. Load-management has been practiced since, in order to maintain the balance of supply and demand (REEGLE, 2012). Zambia Electricity Supply Corporation Limited (ZESCO) is the state-owned power company that manages the three major hydro projects that are connected to the grid: Kariba North (690 MW), Kafue Gorge (990 MW) and Victoria Falls (108 MW). Although the hydroelectric potential is estimated to be up to 6,000 MW, the existing capacity is only about 1,750 MW (REEGLE, 2012). The current power situation is far from adequate as only about 28 % of the household population have access to electricity, while the rest subsists on fuel wood (SADC, 2010). The government of Zambia has recognised this situation and has applied measures that will lead to the development of renewable energy forms, as captured in the Sixth National Development Plan of 2011-2014 (MCTI, 2013). Plans undertaken on operational level are, for example, the development of university Master's degree programmes in environmental and renewable energy engineering, development of a set of standards for photovoltaic installations and a project to develop and build a model energy-efficient school using sustainable materials. Currently, further hydro energy projects (up to 800 MW) are

planned. Besides the high potential for solar energy applications, also the biomass potential of Zambia should not be neglected. As 42 million hectares of the total 70 million hectares are considered as suitable for cultivation, biomass resources are estimated to be able to contribute up to 500 MW to electricity production (Walimwipi, 2012). Wind resources are considered rather low (IRENA, 2013). With respect to geothermal energy resources, historical surveys identified over 80 hot and mineralized springs, but no current potential is known (Walimwipi, 2012).

Focussing on the target countries, especially in the vast and low densely populated countries, the extension of the grid to un-electrified areas is extremely difficult and cost intensive, hence there is a need to strongly take RET into account (Rena, 2012). Yet, even though in all three countries the potential for renewable energies has been recognised for several decades and ambitious political goals and activities to foster the implementation of RETs exist, several factors still undermine the widespread development and economic use of RET. One of the main reasons for the slow adaption of RETs is the lack of knowledge and the inadequate work force. Local entrepreneurship, an established maintenance culture and consumer education are missing and have led to inappropriate installation and the failure of initially working devices and thus to loss of revenue and low uptake of the technology applications by consumers (Pushpendra, 2002). Another factor for malfunctioning systems is the lack of mandatory standards for locally produced as well as for imported technological equipment. Certain standards in the field of RET that exist in the different countries are in addition inconsistent and often not compatible across national borders and thus an obstacle for the wider use of RETs in the region (Chavaphi, n.d.).

It can be summarized that despite strong government ambitions to increase the use of renewable energy resources, no real coordination of RET related activities including training, research, equipment supply and maintenance exists. This status can be partly explained by a lack of awareness and understanding amongst managers, users, government agencies, politicians and decision makers in general.

The NEED Project

To address these obstacles for the wider implementation of RET in Southern Africa, the NEED project was developed by five partners: Botswana International University

of Science and Technology (BIUST), Okavango Research Institute (ORI), Polytechnic of Namibia (PoN), Technische Hochschule Ingolstadt (THI) and the University of Zambia (UNZA). The NEED project will set up and institutionalise a 'Network of Excellence' inter-linking RET initiatives, institutions and experts. During the project implementation period, the network will be active in three so-called 'fields of activity'. Those are 1) to formulate research policies, 2) to harmonise and develop RET industry standards and 3) to enhance practical RET education ('dual studies'). Moreover, the project aims to demonstrate, based on model regions, technical options of renewable energies for typical local environments. For this purpose, the wetlands in Botswana and a dryland area in Namibia were selected. Experiences from the model regions can subsequently be incorporated into the formulated (research) policies on a national scale. Based on the project findings, a plan will be rolled-out to transfer the lessons learned to the whole Southern African region. Each local member of the project consortium is responsible for one activity. THI, as project coordinator, offers support in terms of technical and management capacities, takes care of the network and ensures knowledge transfer among the project partners and local activities. The activities related to research policies (coordinated by UNZA) are intended to accelerate research in RET appropriate to endogenous energy resources. To harmonise and develop RET industry standards (coordinated by BIUST) will help to reduce costs associated with installation and maintenance of RE installations and consequently engender large-scale economic development. The development of 'dual study' programmes (coordinated by PoN) will make a step forward in terms of practical higher education and contribute to an increase of technical capacities and experienced professional workforce in the field of RET. The two model regions, the Okavango Delta (wetlands; coordinated by ORI) and the drylands community at Gobabeb (coordinated by PoN), are expected to benefit from the above three fields of activity and produce roadmaps for regional transition towards sustainable energy production and consumption especially for rural areas. The NEED project started its activities in March 2014 and will run for 36 months. The project is part of the African, Caribbean and Pacific states (ACP) Science and Technology Programme, an ACP-EU cooperation programme in the field of science and technology and funded by the European Union.

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