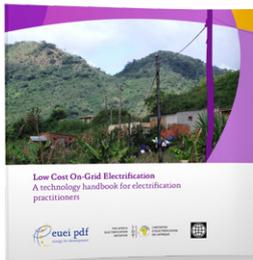


Low Cost Grid Electrification Technologies – A Handbook for Electrification Practitioners

Background

Rural areas in Sub-Saharan Africa suffer the lowest electrification rates in the world with as much as 85% of the rural population living without access to electricity. According to the IEA's Africa Energy Outlook 2014, this proportion is estimated to increase, as the rate of population growth outpaces the rate of electrification. Despite significant efforts made during the past decades, the effectiveness of investments in electrification has been hampered by applying practices suitable for dense-populated urban areas and often associated with high costs rather low cost electrification options applicable for different scenarios given in the rural areas.



The EUEI PDF in cooperation with the Africa Electrification Initiative (AEI) has therefore initiated a project aiming at identifying and disseminating innovative, low-cost electrification approaches for rural areas. The handbook “Low Cost Grid Electrification Technologies”

is intended to assist rural electrification practitioners in sub-Saharan Africa to adopt more appropriate technologies applicable to the loading conditions in rural areas.

Objectives

The overall goal of this handbook is to promote cost-effective rural electrification schemes through the application of appropriate grid electrification technologies, resulting in increased electricity access rates in rural areas.

The specific objectives towards this goal are to:

- ▶ Raise awareness of appropriate low-cost grid-based electrification technologies
- ▶ Build capacity on implementing these technologies in sub-Saharan Africa

Activity	Low Cost Grid Electrification Technologies
Project Partner	Africa Electrification Initiative World Bank
Project Manager	Niklas Hayek
Term	October 2012 – March 2015

Low cost electrification technologies (examples)

Single Wire Earth Return (SWER): SWER systems have been successfully used in many countries, particularly where the load densities are considerably low. It offers the lowest cost technology for rural electrification with grid extension when the loads are at a minimum. SWER is best applied when the load density is sufficiently small and expected load growth rates are not high enough to need an upgrade of the system in a few years.

Shield Wire Systems (SWS): These systems are characterised by the use of the shield wire of transmission lines to transport medium voltage power along the transmission route. A single shield wire can provide a single phase medium voltage system and two shield wires can be used to obtain a three phase system using the earth return as the third phase. SWS offer an ideal solution to reach remote areas where access through a transmission line is readily available.

Single phase reticulation: In this technique, the backbone line is designed to carry the overall load using three phase technology while single phase laterals serve each dispersed load area. This allows the cost of the laterals to be reduced from the three phase option and also allows further reduction by use of conductors of a minimal cross sectional area. Single phase laterals are most suitable for application when the load density does not allow the lower cost distribution options described above.

Low cost transmission expansion: For many unserved rural areas in Sub-Saharan Africa, it is technically not possible to provide the needed supply by extending medium voltage networks, due to the large distances involved. Often it would not be cost-effective to extend the transmission system and build grid substations using traditional standards. The handbook however describes various low cost options to enable grid extensions to reach such locations at the required technical standards and at acceptable cost.



The Handbook

The handbook reviews number of appropriate low-cost **electrification approaches**, tested in several countries as cost-effective solutions for providing electricity supply to low-load density rural areas. Technologies addressed in the handbook include Single Phase Reticulation, Single Wire Earth Return System (SWER), Shield Wire Systems (SWS) and the associated cost-effective design of the transmission expansion.

The handbook also covers the important issue of maximising service connections in completed rural electrification schemes: as Household connections often take a long time to materialise due to high service charge, the requirement to pay upfront or to logistical difficulties faced by rural consumers.

Finally, as the systematic distribution network planning is a key success factor of any electrification programme, the

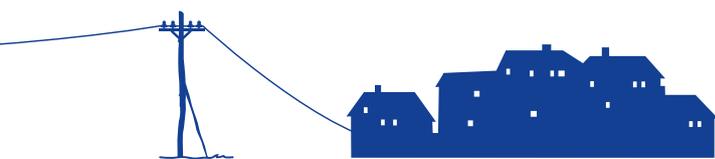
Handbook provides basic guidance on the planning process related to the choice of technology, selection of areas to be electrified and the progressive development of the power network.

Results

The handbook was developed in association with two practitioner workshops in Arusha, Tanzania in September 2013 and Cotonou, Benin in April 2014, attended by more than 100 participants. Several activities related to low cost grid electrification technologies were initiated by the Africa Electrification Initiative following the practitioner workshops and handbook development, including an activity to address low cost electrification technologies in Zambian grid expansion programme, as well as the development of a manual covering planning, design, installation and maintenance of Shield Wire System lines.

Low Cost Rural Electrification – Success Stories

- ▶ **USA:** In the 1930s, the US embarked on a targeted program to increase electricity coverage to rural farmsteads and townships using low cost technologies in both network design and construction techniques.
- ▶ **New Zealand and Australia:** About the same time in New Zealand the innovative Single Wire Earth Return (SWER) technology was invented to serve the far flung low density areas in the countryside. This technology was thereafter used extensively in Australia.
- ▶ **The Philippines:** A major effort was made commencing in the 1970s to provide rural access by a system of rural electric cooperatives following the single phase reticulation model developed in the US.
- ▶ **Bangladesh:** A similar program (to the Philippines) was developed in commencing in the 1980s. The rural cooperatives are well known for their high connection rates, efficiency of operation with low losses and good collections.
- ▶ **Tunisia:** When the country embarked on a massive rural electrification program in the 1970s, a major change was made from the existing three-wire three-phase MV network to a four wire system to enable single phase extensions.
- ▶ **South Africa:** ESCOM launched its program of “electricity for all” using similar low cost technologies in the 1990s.
- ▶ **Ghana:** The innovative Shield Wire System (SWS) was developed in the 1980s to provide electricity at lower costs to far-flung communities close to transmission lines.



Pictures: EUEI PDF, GIZ

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For more information,
please contact:

EU Energy Initiative
Partnership Dialogue Facility
(EUEI PDF)

c/o Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH
P.O. Box 5180
65726 Eschborn, Germany

T +49 (0) 61 96-79 63 12
E info@euei-pdf.org
I www.euei-pdf.org

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euei
EUROPEAN UNION ENERGY INITIATIVE