Progress Report

Project: **RPTC project INT 12R05**
Minimum Electricity Access (Min-E Access)
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Background

More than one billion people worldwide lack access to electricity. Most of them live in rural isolated communities and usually represent the poorest segment of the population. The extension of national electricity grids to cover these isolated rural areas however, is not economically viable in most countries. Yet recent technological advancements in renewable energy systems, especially solar PV, have made available a reliable, durable, and affordable stand-alone (off-grid) alternative.

The UN Department of Economic and Social Affairs (DESA) is leading a partnership initiative called "Minimum Electricity Access (**Min-E Access)**", which is designed to address the issue of energy poverty in rural isolated communities. Preceded by a preliminary phase in 2011, the partnership was started in 2012, following Rio+20 and in support of the Secretary General's SE4All initiative. This report provides a summary of the progress made until July 2015 and outlines the vision until 2030.

Objectives

The objective of this initiative is to provide rural isolated communities with a minimum access to electricity. ***Min-E Access*** provides a platform to promote access to affordable, reliable, and sustainable off-grid renewable energy systems in rural areas, in order to allow for a minimum access to electricity to cover at least three basic services: (1) lighting, (2) radio reception, and (3) cell phone charging. Most of the financial support required for this partnership will be directed towards two major modules that will ensure the sustainability of the initiative: one is **capacity building**, the other one is **entrepreneurship development**, and both are focused on the local level**.** It is recognized that this effort represents just the first step (but perhaps the fastest) towards adequate levels of universal electricity access worldwide.

This initiative is unique, as it can provide a fast vehicle of "empowerment" for people in disadvantaged isolated communities with the minimum energy necessary to improve education, accelerate the transfer of knowledge, facilitate communication, and promote entrepreneurship. Moreover, it acknowledges the Nexus approach to sustainable development in order to integrate energy provision with education, health, clean water access, sanitation, and food security. Furthermore, many people in Africa and other developing regions now own cell phones even in areas without access to electricity. These cell phones have allowed a record number of new small businesses to form there. The availability of "wireless electricity" (off-grid) could promote a revolution similar to the one started with these "wireless phones".

The overall strategy resulting from the preliminary phase of Min-E Access recognizes that the success of this partnership initiative will depend on the continuous availability of renewable energy experts living and remaining in the rural communities. One of the key aspects of the proposed overall strategy is the empowerment of local schools as the basis for further expansion of electricity access in rural communities. Schools represent centres where local community members can be trained, where equipment can be stored securely, and where the overall concept of minimum electricity access through renewable energy technologies can be demonstrated. Furthermore, schools provide the most promising sites where the nexus between energy and other development aspects can be demonstrated. In particular, by powering rural isolated schools immediate synergies can be realized with respect to education, water, health, gender, food security, and poverty eradication.

Justification

This effort represents an important contribution to the major initiative of the Secretary-General on Sustainable Energy for All (SE4All) and a concrete effort by DESA and its partners as part of "2012 the International Year of Sustainable Energy for All" and "2014-2024 the Decade of Sustainable Energy for All" (A/RES/67/215). It also constitutes an important part of the UN-Energy priority work on energy access and serves as a vital contribution to the achievement of the Post-2015 Development Agenda, including but not limited to Sustainable Development Goal (SDG) 7: "Ensure access to affordable, reliable, sustainable and modern energy for all", especially target 7.1: "By 2030, ensure universal access to affordable, reliable and modern energy services." The partnership initiative was presented at Rio+20 in June 2012 as an example of an effective action by DESA and its partners in pursuing universal energy access. The partnership further responds to the outcome of the Rio+20 Declaration "The World We Want", specifically paragraph #125: "the critical role that energy plays in the development process, as access to sustainable modern energy services contributes to poverty eradication, saves lives, improves health and helps provide for basic human needs"; and also paragraph #126: "we emphasize the need to address the challenge of access to sustainable modern energy services for all, in particular for the poor, who are unable to afford these services even when they are available."

Phases of the Min-E Access partnership initiative

DESA has been leading this global effort in collaboration with private and public organizations and international donors since 2011. The initiative includes four phases:

(1) A preliminary phase from 2011 to 2013, in which a systematic approach for technical cooperation and capacity development was designed, based on pilot tests in a number of countries. Drawing from the resulting experiences and consultations, two major modules for ensuring the sustainability of the initiative were designed: (1) capacity building and (2) entrepreneurship development. Moreover, several partners from the private and public sector were secured for the successful continuation of the initiative. Furthermore, a comprehensive assessment of the global situation with respect to rural electrification has been conducted, which defined barriers that need to be overcome and outlined actions that could accelerate the process.

(2) A first phase from 2013 until 2015, in which training courses were conducted in selected countries (including Liberia, Ethiopia, Uganda and Bolivia) with support of partners already working in the three major developing regions Africa, Asia, and Latin America. These activities were able to greatly benefit from the findings resulting from the preliminary phase research, especially the design of the two major modules (1) capacity building and (2) entrepreneurship development. During this phase more commitments and key partners have been secured in order to continue the initiative. In addition, DESA has been providing leading support in this global effort by promoting coherence and integration in the implementation process at the international level. The first phase was designed to allow implementation of a systematic approach and to provide a great number of people with a minimum access to electricity through December 2015, coinciding with the end of the Millennium Development Goals (MDGs) timeframe. To date, 3 pilot schools in isolated rural communities in Bolivia have been electrified and 20 Training Tool Kits have been developed, assembled, and purchased. About half of these have already been distributed to designated trainers in Africa and the remainder will be put to use in Latin America and Asia later this year.

(3) A second phase from 2015 through 2024, in which the implementation process will be expanded in different communities of developing countries in Asia, Africa and Latin America. The objective is to scale-up the effort worldwide. DESA's work will support the recent resolution by the GA on "2014-2024 the Decade of Sustainable Energy for All" and in particular SDG 7 as well as target 7.1 to "[b]y 2030, ensure universal access to affordable, reliable and modern energy services" of the Post-2015 Development Agenda.

(4) A final phase from 2024 through 2030, in which DESA and other organizations will continue to scale-up international cooperation on rural electrification, in order to achieve full and universal access to electricity worldwide by 2030, which is the main goal of the initiative of the Secretary-General on Sustainable Energy for All.

Preliminary Phase 2011-2013

Three consultancies have been completed, which supported the design of the systematic approach for capacity building, entrepreneurship development, and technical cooperation in the specific area of rural electrification. A total of 38 organizations from different regions of the world are now partners or have indicated their interest in becoming partners of the Min-E Access initiative. This includes governments, academic and research institutions, NGOs, and public and private organizations. Table 1 provides a list of the current and future partners of Min-E Access. Quantitative commitments[1] have been made by different partners for direct training programmes in several countries in Africa and Latin America. The implementation of these commitments started in 2012 and will continue through 2030 in selected countries.

[1] Note: The Min-E Access partnership is currently in the process of updating its commitment database in light of the recent and projected imminent addition of several important new partners and a more general shift of its focus and strategy.

Table 1: List of partners of the Min-E Access initiative as of July 2015

Adama Science & Technology University (Ethiopia)
Adolescence Education Programme (India)
Asantys Systems (Germany)
ASTURS - Inti Wasi (Peru)
Beta engineering (U.S)
Clean Energy Development Bank (Nepal)
Cultivando Agua Boa (Brazil / Paraguay)
Dalarna University (Sweden)
Electriciens Sans Frontieres (France)
Empower Generation (U.S.)
Energética (Bolivia)
Environmental Camps for Conservation Awareness (Nepal)
Fosera (Germany)
GIZ Ethiopia
GIZ Germany
Government of Bolivia - Direccion General de Energias Alternativas / Vice Ministerio de Electricidad y Energias Alternativas
Horn of Africa (Africa)
Institute for Decentralized Electrification, Entrepreneurship and Education (Germany)
Instituto Tecnológico de Energías Renovables (ITER) Tenerife (Spain)
Itaipu Binacional / Federal Government of Brazil
Itaipu Binacional / Government of Paraguay
Menschen für menschen (Germany)
National University of Engineering (Peru)
Orb Energy (India)
Palma Interface (India)
Phaesun (Germany)
Phocos (Germany)
Plan (U.S.)
RangDe.Org (India)
Reiner Lemoine Institut (Germany)
Rural Education and Development (READ) Global (U.S.)
SESCA: Société d'Energie Solaire du Cameroun
Solar Age Namibia
Solar Energy Research Institute of Singapore (SERIS)
Solar23 (Germany)
Solux (U.S.)
University of Applied Sciences, Ulm (Germany)
University of California, Berkeley (U.S.)

As more organizations and donors join the partnership and more resources are made available, the programme will be extended to more countries that have significant shares of rural isolated populations without electricity access. Partners will provide capacity building, technology transfer, and entrepreneurial skill development. The partnership activities will continue to include capacity development and technical cooperation, especially for the maintenance and installation of the systems, and will also look at the issue of up-scaling.

The results of the preliminary phase of Min-E Access pointed towards the need to promote coherence, coordination, and information dissemination at the global and national levels, with respect to technological and entrepreneurial capacity building strategies. Therefore, DESA has also been leading a comprehensive effort to survey and map activities being conducted at the national level by international organizations on rural energy access.[2]

[2] See Division for Sustainable Development (UNDESA) 2014: A Survey of International Activities in Rural Energy Access and Electrification, May 2014.

In addition, an Expert Group Meeting was conducted in August 2013 at the UN Headquarters in New York City on the barriers and challenges for rural energy access, followed by a Global Conference on "Rural Energy Access: A Nexus Approach to Sustainable Development and Poverty Eradication" in Ethiopia, December 4-6, 2013. The conference provided an open platform for knowledge sharing and the exchange of best practices in sustainable rural electrification. With participation from governments, international and regional organizations and associations, financial institutions, NGOs and civil society, and the private sector, it brought together more than 250 participants, representing about 40 different countries. It provided a platform for a total of 27 organizations to present and exchange their practices and to display their technologies and equipment. Some of the key highlights and lessons learnt from the conference were the importance of the Nexus approach to sustainable development and the centrality of energy systems within this framework as a synergistic investment in not only electricity access, but also in education, clean water access, health, food security, gender equality, entrepreneurship development, poverty eradication, and environmental protection.

Accomplishments and outputs of the preliminary phase

The preliminary phase resulted in the design of the two major modules that ensure the sustainability of this initiative: (1) a capacity building module and (2) an entrepreneurship development module, both to be implemented at the local level**.** The work so far demonstrates a practical, effective, and sustainable approach for providing minimum electricity access in rural areas in selected countries and has resulted in the definition of a business model for implementation in major developing regions.

The capacity building module includes the following:

- A package with detailed technical information and didactic material about the most appropriate, affordable, reliable, durable, stand-alone (off-grid) renewable energy systems to be used in poor isolated rural areas.

- An outline for the training programme to be followed, including lectures and hands-on training for the operation and maintenance of the selected energy systems and their practical application in rural areas.

- A package for basic education, as a preliminary course or requirement, for potential candidates in need of a minimum background before embarking in the technical training on the renewable energy systems. It is recognized that there are isolated rural communities in which potential trainees might not have the basic knowledge in areas such as energy, electricity, mathematics, or natural resources.

- A strategy to be able to secure the long-term development of regional experts that could serve as the "trainers of trainers." It is recognized that the success of this partnership initiative will depend on the continuous availability of renewable energy experts living and remaining in the rural communities. The strategy stresses the empowerment of local schools as the basis for further expansion of electricity access in rural communities.

- A "Training Tool Kit" specifically designed for trainers, which includes the minimum technical equipment on solar energy (Pico-PV) necessary to demonstrate and simulate the overall energy system and its use in rural areas. The Tool Kits have been developed and assembled through partners of the initiative and 20 of them have been purchased to date. Half of these Training Tool Kits have already been deployed for training courses in Africa and more will continue to be distributed through Latin America and Asia until the end of 2015. Each Training Tool Kit includes the following components:

    - *A solar PV module 5,2V, 380 mA*
    - *A Diode module*
    - *A LED module*
    - *A Scandle 200 LED-Lamp*
    - *A Deep Discharge Protection mechanism*
    - *A Series Regulator*
    - *A Lighting module*
    - *A Capacitor module*
    - *A cable set*
    - *A box for transport*

The entrepreneurship development module includes the following:

- An overall business model for the effective and practical transfer of technology and equipment from the manufacturers to the final users in the rural communities and for securing the basic working capital necessary for the initial entrepreneurial activities. The model aims to maximize the use of technical parts and/or equipment that might be produced and sourced locally, such as batteries, cases, wiring, piping, etc.

- The business model specifies the most appropriate distribution channels for the equipment, as well as the facilities necessary for storage and maintenance of the equipment at the local level. It acknowledges local schools as not only a viable location to store equipment securely, but also to provide a natural platform for demonstration and the perhaps best training ground in disseminating knowledge about the new technologies within the community.

- A business educational package with basic training tools in managerial areas such as accounting, marketing, and financing. The package also includes specific approaches for building long-term partnerships with local and regional suppliers of equipment and parts.

The activities and modules specified above have been developed and implemented as pilot projects by experts, partners, and consultants of DESA, who possess advanced knowledge on renewable energy equipment specifically designed for isolated areas, and have ample experience in working in rural communities. The preliminary workshops and related activities have taken place in Ethiopia, Liberia, Uganda, and Bolivia, with support from partners of the Min-E Access initiative.

The implementation of the activities in the preliminary phase has allowed the initiation of training courses in pre-selected rural communities, where teams of qualified candidates are being identified and partners are able to test the proposed training packages, training tool kits, and entrepreneurship strategies. The training implementation process has been proposed to be focused on the local rural schools, with students and teachers from the local communities.

First Phase 2013-2015

One of the key aspects of the proposed overall strategy is to empower local schools as the basis for further expansion of electricity access in rural communities. By powering rural isolated schools, immediate synergies can be realized with respect to education, water, health, gender equality, food security, and poverty eradication. Therefore, the pilot implementation of the overall strategy has been initiated first in two, then in three schools located in rural isolated communities in Bolivia.

In 2012, only 73% of Bolivia's rural population had access to electricity, while 99% of the urban population did. In Latin America and the Caribbean in general, the corresponding average figures for electricity access are 87% (rural) and 99% (urban). Min-E Access has formed a public-private partnership in Bolivia, including the Municipal Government of Morochata and the NGO Energética, who have volunteered to provide the equipment and experts for the pilot powering of two rural schools and a corresponding training workshop for local technicians and installers. The equipment includes solar photo-voltaic (PV) systems for electricity, solar water heaters, clean cooking stoves, and greenhouse facilities, in order to improve energy access, water availability, hygienic conditions, health, and food security. DESA has lead the overall effort by providing: (1) guidance in the implementation of the overall strategy, (2) support for the installation of the equipment, (3) support for the technical and entrepreneurial capacity training of local community members, and (4) support for follow-up activities related to maintenance and monitoring. DESA has further provided support in the form of professional fees for the expert consultant Energética working in the selected rural areas in Cochabamba, Bolivia.

After the initial contact with local technicians from various municipalities had been established through two comprehensive local workshops, the selection of pilot areas and projects for the electrification of rural schools was proposed and carried out. The most pronounced interest came from the Municipal Government of Morochata, with representatives of which a number of site visits at different schools was organized. Two schools in the communities of Sauce Rancho and Pucarani were eventually selected and after successful installations there, the budget permitted the addition of a third school in Humamarca to the programme. All three schools already possessed a 150 Wp solar PV system, which had been donated as part of the government literacy promotion program "Yo si puedo", but in each case had fallen into disrepair and ceased to function.

Accomplishments and outputs of the first phase

From November 20 until November 21, 2014, Energética conducted the first of two training workshops in the city of Cochabamba. The goal of the workshops was to present the overall strategy of Min-E Access, reinforce knowledge about renewable energy technologies (especially solar PV) as a viable off-grid alternative in rural areas, highlight the opportunities for the productive activities they open up, and demonstrate the technological evolution towards new Pico-PV systems and their particular benefits. The second workshop was originally planned to take place shortly after the first one, but due to heavy rainfalls and resulting road blockages could not be carried out until late April the following year. Both workshops together attracted a total number of 44 participants, including local technicians from 12 different municipalities, technical installers, and regional representatives. The workshops were very well received by the participants, with over 96% of them being satisfied or content with their implementation.

The success of these workshops not only built capacity among local technicians, commercial installers, and regional project officers, but also built the necessary foundation for the identification and selection of pilot schools in rural areas and the implementation of their (re-)electrification. It had become clear that the training of local renewable energy specialists who would remain located in the area will be vital for the sustainability of these projects. In order to ensure that the installed systems would not fall into disrepair again, this "training of trainers" component has been stressed by Min-E Access. Additionally, a legally binding written commitment from the mayor of Morochata further ensures that the systems will be adequately maintained. Initially, Energética will conduct periodic control and maintenance visits together with municipal technicians, who will then gradually take over these duties. Other pilot experiences in Africa have shown that there is also a growing technological potential for remote monitoring systems. However, the most important monitoring facilitators remain (1) the training received by local renewable energy experts, such as school teachers and local technicians, through workshops, installations, and monitoring visits, and (2) the simplicity of installation and maintenance of Pico-PV systems. Table 2 summarizes the 3 pilot school installations.

In addition to the reactivation of the existing 150 Wp solar PV system already in place at the schools, so-called Pico-PV systems were installed. By utilizing highly efficient appliances such as LED lamps and modern Lithium-based battery technology, these inexpensive and easy to install (plug-and-play) systems can provide for (1) lightning, (2) radio reception, (3) mobile phone charging, or even (4) small TVs. A sample installation of two LED lamps, a radio, a small TV or portable DVD player, and one cell phone today can consume as little as one third of the energy needed for similar but outdated appliances. Therefore solar panels as small as 10-20Wp can already provide a rural isolated household with the minimum electricity access necessary to improve education and communication, while opening up new potential income streams from entrepreneurial activities such as mobile phone charging. The systems are modular and scalable, which makes possible the addition of more appliances like small fridges or even inexpensive and highly energy efficient simple PCs such as the Raspberry Pi. Furthermore, the use of microelectronic control units greatly improves the portability and ease of installation and maintenance of these novel Pico-PV systems, by making them both compact and plug-and-play.

Table 2: Min-E Access rural school electrification in Bolivia as of July 2015

Community	**# teachers /students**	**Systems installed**	**List of components**
Humamarca	8/92	150W Solar PV system *(reactivated)*	150Wp panel *(in place)* 20A charge controller 150Ah battery 3W LED lamp (x3) 350W 12/220 invertor Cables and accessories
		Pico-PV systems (x3) *(installed by teachers)*	10-20Wp panel 4-7Ah battery (LiFePO4) 3W LED lamp (180 lumen) (x3) Charge adapters
		Efficient cook stove	
Sauce Rancho	3/45	150W Solar PV system *(reactivated)*	150Wp panel *(in place)* 20A charge controller 150Ah battery 3W LED lamp (x3) 350W 12/220 invertor Cables and accessories
		Pico-PV systems (x2) *(installed by teachers)*	10-20Wp panel 4-7Ah battery (LiFePO4) 3W LED lamp (180 lumen) (x3) Charge adapters
		Efficient cook stove	
Pucarani	2/27	150W Solar PV system *(reactivated)*	150Wp panel *(in place)* 20A charge controller 150Ah battery 3W LED lamp (x3) 350W 12/220 invertor Cables and accessories
		Pico-PV system *(installed by teachers)*	10-20Wp panel 4-7Ah battery (LiFePO4) 3W LED lamp (180 lumen) (x3) Charge adapters
		Solar thermal system	Solar collector (ca. 2x2m) (x2) 200l Stainless steel tank Support structure Key set and accessories
		Efficient cook stove	

In all three schools efficient and clean new cooking stoves were installed, which reduce wood consumption by 30% and eliminate toxic indoor air pollution. Every year more than 4 million deaths occur because of indoor air pollution (more than from outdoor air pollution), which mostly originates from inefficient biomass and coal stoves. In addition to removing these health threats, clean and efficient cooking stoves also help to reduce the time that has to be spent to collect firewood and to cook. This freed up time can then be used for more productive purposes, like education and entrepreneurial activities. Since in most rural communities tasks like cooking and collecting firewood are traditionally done by women and girls, these simple technologies can thereby directly improve not only health, education, and entrepreneurial opportunities, but also gender equality.

Today a number of different types and technologies for efficient, clean cooking stoves are widely available. Some rely on biomass like wood or charcoal that is traditionally used by the indigenous population in rural areas, but burn it more efficiently and without releasing toxic pollutants indoors. Others make use of non-solid fuel types such as bio-ethanol, which in some cases can be locally produced from native plant species and thereby unlock even further entrepreneurial opportunities for the community. Today there is even simple solar cooking technology available which eliminates reliance on any kind of fuel whatsoever, using parabolic mirrors to harness the sun's energy. In any case, local circumstances and the availability of natural resources, as well as cultural attitudes in terms of the acceptability of new technologies, need to be carefully considered when deciding among various technological alternatives.

In Pucarani, the school has additionally been equipped with a solar thermal system, which can be used to heat the available but freezing cold ground water in order to make it usable for washing and cleaning purposes. The system thereby unlocks immediate health and sanitation benefits for students and teachers, as well as the community as a whole. Further potential can be seen in the construction of Greenhouses, which in cases where unfavorable soil quality and weather patterns otherwise prohibit the cultivation of a variety of vegetables can contribute to food security and improved nutrition.

In December 2014, DESA released a report on the interrelationships between electricity and education,[3] prepared by an expert consultant and under the supervision of Dr. Ivan Vera. In assessing the global state of schools without access to electricity, the report concludes that collectively 188 million children in Sub-Saharan Africa, South Asia, and Latin America attend schools which lack access to any type of electricity. The situation is especially grim in Sub-Saharan Africa, where roughly 90% of children go to primary schools without electricity access. The report puts forward four key recommendations to overcome existing barriers and challenges for school electrification programmes: (1) leverage innovative financing streams, such as public-private partnerships, (2) ensure technical reliability through standards and certification, (3) bundle school electrification programmes with the provision of household access and clean cooking options, (4) couple school electrification programmes with community training and capacity building.

Future Plans

Min-E Access has recently secured the support from the Brazilian government as a new partner of the initiative. Brazil is in the process of starting to provide support in Guatemala, the Dominican Republic, and Bolivia, following a rural Nexus approach. The country is particularly interested in supporting Bolivia and has already offered to fund at least two workshops there. In light of this new and sizable support we believe it would be sensible to tap into RPTC funds in order to continue and further grow this programme.

[3] See Division for Sustainable Development (UNDESA) 2014: Electricity and education: The benefits, barriers, and recommendations for achieving the electrification of primary and secondary schools, December 2014.

The general strategy flowing from what has been outlined in great detail above, is to concentrate the efforts on schools in isolated rural areas of one single country first, in order to demonstrate the viability of a successful and effective pilot initiative, which is to be replicated and scaled elsewhere. In this context, we have launched a new public-private partnership to further support universal energy access in rural communities. "Twin-Schools: Open Source Solar PV Technology for Rural Electrification and Education" is a two-pronged project with both technical and social goals and components. Inexpensive, high quality solar PV products and training systems for the promotion of rural electrification will be developed, designed to be assembled by classes in participating developed country schools and to be offered through the partnership to their developing country "Twin Schools". Likewise, a team of teacher and student technicians in the developing country will be trained to set up, modify and repair the solar PV systems. Furthermore, educational programs will be prepared to give instruction in subjects related to sustainable development and to promote a two-way educational exchange between universities and secondary schools in developed and developing countries.

In Bolivia today there are more than 4,000 schools without access to electricity. Both the Brazilian federal government and the government of Paraguay have already signaled their willingness to lend support to our activities in Bolivia through Itaipu Binacional. The potential to expand this South-South cooperation to the Tapajós Amazon valley, where 4,000 out of 5,000 isolated communities lack access to electricity, is currently being discussed. Further contributions can and will be secured from our partners in Europe. The Institute for Decentralized Electrification, Entrepreneurship and Education (Germany) for example has already conducted capacity building activities in Ethiopia and Liberia within the Min-E Access partnership and will put more of the Training Tool Kits it helped develop to use in Bangladesh later this year. The RPTC funds would therefore be used most wisely for further capacity development activities within the Min-E Access framework and in support of the closely related Twin-Schools initiative.