



SMART VILLAGES
New thinking for off-grid communities worldwide



Energy access in Nicaragua: the nexus between financial mechanisms and energy policies



Workshop Report 35

April 2017

MATAGALPA, NICARAGUA

Key words:
Nicaragua, Energy access, Renewable
energy, Finance, Policy

Smart Villages

We aim to provide policymakers, donors, and development agencies concerned with rural energy access with new insights on the real barriers to energy access in villages in developing countries—technological, financial and political—and how they can be overcome. We have chosen to focus on remote off-grid villages, where local solutions (home- or institution-based systems and mini-grids) are both more realistic and cheaper than national grid extension. Our concern is to ensure that energy access results in development and the creation of “smart villages” in which many of the benefits of life in modern societies are available to rural communities.

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The University of Central America (UCA)

The Central American University (UCA) is the first private university created in Central America. It was founded in Nicaragua by the Society of Jesus on July 23, 1960, as a non-profit, autonomous, public service and Christian inspiration institution. The UCA is part of the Association of Universities Entrusted to the Society of Jesus in Latin America (AUSJAL), made up of 31 universities in 14 countries of the region and integrated into the network of institutions of higher education of the Jesuits in Europe, Asia and U.S.

Academy of Sciences of Nicaragua (ACN)

The Nicaraguan Academy of Sciences (NAS) is a non-profit organization whose principal purpose is to promote and distribute information related to Science, Research and Science Education, which are fundamental elements for sustainable human development.

The NAS was preceded by the Nicaraguan Association for Science, also known as the Society for Science, which met for the first time in December of 2005 and was officially created during its VI General Membership Meeting held in July of 2006. The Association held a series of seminars entitled “Science and Society”, with speakers from the Nicaraguan science community as well as foreign scientists. The Association also established ties with other institutions such as the Nicaraguan Council on Science and Technology (CONICYT) and, on the international level, with the Inter-American Network of Academies of Science (IANAS), InterCiencia and the Caribbean Scientific Community (CCC). The journal Science, one of the most prestigious journals in the world, published a commentary announcing the creation of the Nicaraguan Association for Science and the interest in creating the Academy of Sciences in the future.

Publishing

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The Smart Villages Initiative is being funded by the Cambridge Malaysian Education and Development Trust (CMEDT) and the Malaysian Commonwealth Studies Centre (MCSC) and through a grant from the Templeton World Charity Foundation (TWCF). The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Cambridge Malaysian Education and Development Trust or the Templeton World Charity Foundation.

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SUMMARY

Over the past decade, Nicaragua has made great efforts to improve the electricity coverage rate of the country. By 2013, it was estimated that 76.2% of the population was connected to the grid, yet Nicaragua has one of the lowest electrification rates in Latin America, with only 54% of the rural population having access to electricity. Being ranked 124 out of 188 countries in the Human Development Index 2015¹, Nicaragua has the highest average retail price per electricity unit in Central America (partly due to its strong dependence on imported fossil fuels) and the electricity infrastructure faces major stability challenges.

According to the *Annual Report of Electrification Rate in Nicaragua*, the Caribbean side—the autonomous regions of North Atlantic (RAAN) and South Atlantic (RAAS), Jinotega, and Rio San Juan departments, which comprise 60% of the total area of Nicaragua—have an electrification rate of only 43.2%. These are also the areas with the greatest poverty and lowest economic and social development in the country. The last Nicaraguan census of 2005 recorded a low population density in those four departments. However, the area was poorly covered by the census due to accessibility problems. This limited the knowledge available on the electricity needs of the Caribbean side of Nicaragua, consequently delaying even further the development of electrification programmes for those areas.

In this context, the Smart Villages Initiative, jointly with the Academy of Sciences of Nicaragua (ACN) and the University of Central America (UCA), organised a national workshop in Matagalpa. The purpose of the workshop was to explore the major challenges to, and opportunities for, achieving electricity access for rural

and isolated communities to support productive processes and tourism, and to determine how financial mechanisms and energy policies can be improved to enable electricity access for all Nicaraguans. The event started with a field trip to the mountains of northern Nicaragua to visit the hydroelectric plant El Bote, one of the few successful micro-grid projects in the country. The following day the forum took place at Selva Negra Eco-lodge Resort in Matagalpa, bringing together 34 Nicaraguan experts on energy access projects, microfinancing, and energy policy and regulation.

In the workshop discussions, it was noted that although the Nicaraguan government is meeting grid extension targets it is doing so at the expense of the quality of the service and with very high prices for consumers. The fund for the Development of the National Electric Industry (FODIEN) has been investing mainly in electricity network extension projects to improve the living conditions of the rural population. A large number of people are now benefitting from access to the grid, yet some of them are struggling to afford the expensive tariffs, and many simply cannot afford the electricity. In addition, the transmission and distribution systems have frequent outages in these regions largely due to inadequate maintenance of and investment in distribution lines. Some projects, such as the El Bote project, have shown that local renewable energy sources in combination with the grid are a viable solution to provide cleaner energy at an affordable price for rural communities. However, support from the government is still necessary to balance the feed-in tariffs in order to make the models economically sustainable.

It was recognised that there is a significant lack of accuracy in the calculations of electrification rates and characterisation of the Caribbean side to inform the design of effective energy programmes for the country. The only surveys that have taken

¹ "Human Development Report 2016: Human Development For Everyone", United Nations Development Programme (2016). Available at: http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

place on the Caribbean side of Nicaragua are the 2005 census, which is out of date, and a survey of 1,000 houses undertaken in the *2014 Living Standards Measurement Survey*². This lack of information means that the communities who benefit from energy access initiatives tend to be those close to the distribution centres, and those located in places that make it economically feasible to extend the grid, which are neither the poorest nor the least developed communities. The priorities of the rural electrification programmes are not entirely clear; specifically, whether they aim to tackle poverty and development or just increase electrification rates.

Isolated, remote villages are unlikely to have access to the grid due to their greater distance from existing networks; hence local renewable energy technologies are the best options for the provision of stable electricity sources. But, despite its potential, the solar energy market has not been properly developed in Nicaragua. Though there is a demand for solar home systems, most rural households are unable to pay for them, which is the main barrier for their adoption. The lack of investors in Nicaragua slows down the distribution of solar panels and even large international organisations have difficulties in penetrating the market.

In contrast, micro-hydroelectric plants are a preferable technology in a mountainous country such as Nicaragua. Biogas has also become more and more prevalent in rural productive processes. Initially, biogas had a slow penetration in local markets due to lack of awareness of its potential and poor technical knowledge. Slowly, producers have recognised its advantages for powering irrigation and milking systems, for providing hot water for fresh cheese producers, and for supporting other productive uses. One thousand

biogas systems have been installed without any type of governmental incentive.

Participants commented also on the importance of including women in decision-making, since they are crucial users of energy and technological innovations. The consideration of human talent and gender equality increases the impacts of energy access interventions, providing more coherence to projects and maximising their potential, contributing to women's economic empowerment, and improving the project's sustainability. Simple measures such as recommendations on best practices for the installation and use of equipment, and the deployment of compatible technologies that maximise the efficiency of systems, can make a great impact. Capacity building of all actors concerned, including the community and project technical staff, is essential. Increasing the number of distribution centres and local technicians across the country, establishing productive enterprises for the use of electricity, as well as the creation of alliances between suppliers, technical supporters and microfinancing, were unanimously recommended by the participants to foster the renewable energy market and develop sustainable long-term projects.

The financing of renewable energy projects remains a challenge for Nicaraguans. The remote and dispersed nature of off-grid populations increases the costs of sales, distribution and after-sales support. Renewable energy systems are considered a high-risk investment, resulting in interest rates of up to 22%. To reduce interest rates, it is necessary to unify stakeholders and establish more communication between technology suppliers, microfinance institutions (MFIs) and policy-makers in order to develop financial innovations that benefit them all. Revolving credits, Green Credits, Results Based Financing (RBF) and Pay-as-you-go are financial practices that have shown feasibility in Nicaragua and should be adapted and encouraged further. Renewable energy projects tend to experience lack of funds

² *Encuesta Nacional de Hogares sobre Medición de Nivel de Vida (2014)*. Instituto Nacional de Información de Desarrollo (INIDE), Nicaragua. Available at: <http://www.inide.gob.ni/Emnv/emnv2014.html>

for design and post-implementation stages, which are critical for their sustainability.

Maintaining low debt rates has always been a challenge for MFIs but better outcomes are achieved when payment policies are adapted to the clients' income characteristics. For example, dynamic businesses such as tortilla sellers improve their repayment rates with weekly payment schemes. Conversely, farmers or agricultural enterprises generate seasonal incomes, thus seasonal payments suit their profile better. Revolving credits give flexibility to MFIs since they allow them to improve their control of borrowing and, with proper training, revolving credits empower users to manage their own finances. In addition, it is sometimes necessary to determine the movement patterns of users, for example whether they periodically travel to the neighbouring town for other motives, to enable payment methods and increase flexibility for those living in remote places.

At the community level, access to financing can be facilitated through the creation of cooperatives, which increase bargaining power, reduce direct risks to individuals, and improve the value-for-money of the investment. Strategic partners (NGOs or development agencies) can help cooperatives to create long-term financial plans

that adjust to their own reality. They can also act as backup entities to make cooperatives more trustworthy and to reduce the investment risk. Corporate social responsibility should also be considered as a financing option for renewable technologies.

From the government perspective, it was agreed that exclusive dependence in ENEL for small-scale electrification projects is impeding the continuous development of isolated and rural areas of Nicaragua. Providing electricity to remote areas is costly, so the government needs to reconsider its strategy to attain service provision for that population. The cross-subsidy model implemented by the Electrical Social Compensation Fund (FOSE) in Peru, for example, promotes profitable renewable energy through the participation of private investment in off-grid rural villages, and it is considered a promising model for Nicaragua as well. Measures suggested in the workshop to support electricity access and development in the rural sector included the establishment of smart subsidies and the lowering of the annual fees levied by the National Commission for Microfinances (Comisión Nacional de Microfinanzas; CONAMI), as well as the update of national statistics to inform design solutions on the real needs.

INTRODUCTION

Continuing with the Latin American series of workshops, the Smart Villages Initiative, the Academy of Sciences of Nicaragua (ACN), and the University of Central America (UCA) organised a national workshop in Nicaragua in April 2017. The workshop was held in the Matagalpa Department and brought together 34 experts from academia, the private sector, NGOs, and international organisations that have worked extensively on improving people's wellbeing in rural Nicaragua.

The workshop aimed to explore the energy access challenges of Nicaragua and the role of financial mechanisms and energy policies in fostering distributed electricity generation in rural and

isolated communities of the country. It started with a visit to the ATDER-BL organisation and its hydroelectric plant at El Bote, which has been serving around 5,200 people in the surrounding area for over a decade. The forum continued in the Selva Negra Eco-Lodge with a day of interesting presentations and fruitful discussions. This report summarises the two-day event, where enthusiastic professionals expressed their opinion on the issues faced by Nicaragua in improving energy access in rural areas. It records the suggestions made by workshop participants on how challenges can be overcome, providing valuable information for the Smart Villages Initiative and other entities concerned with the issues of rural energy access.



Over 35 experts in off-grid energy gathered in Matagalpa for the one-day workshop.

FIELD TRIP

Early in the morning participants set out on the journey towards the Association of Rural Development Workers Benjamin Linder (ATDER-BL), a local non-profit organisation that has been working on rural development projects for over 20 years. The Association was created to continue the work that Benjamin Linder started in 1985, and since then several drinking water systems, small-scale hydroelectric plants, and transmission lines for rural electrification have been built.

The first stop of the visit was the Association's main office and the mechanical shop located in the village of El Cuá in the Jinotega Department. The project engineer, Felix E. Rosales, welcomed and guided the group on the tour. He explained that ATDER-BL has designed and manufactured several hydroelectric systems of up to 5 kW. Every turbine is designed according to the height and flow of the water. The greater the fall and the stronger the flow of the stream, the more power is generated. Stream characteristics vary around the region and the systems are designed accordingly. The most common system manufactured is the double-jet Pelton turbine, since the Jinotega Department is fairly mountainous and Pelton turbines are ideal for high falls. However, they also manufacture Turgo and crossflow systems for short falls and low-flow streams respectively, in order to maximise the efficiency of the plants. Figure 2 shows a pico-hydro turbine manufactured in the mechanical shop that serves up to 70 homes and enables households to use refrigerators, irons, TVs, etc.

After the offices and the workshop, the group headed to the hydroelectric plant at El Bote (Figure 2), a plant with two turbines of 450 kW each that serves around 5,000 homes in the local area. ATDER-BL designed and implemented the system and now manages the electricity services for the community. The plant supplies houses and

shops as well as several coffee makers in the region; this permits an efficient use of the electricity generated, since the coffee makers use the energy during the day while in the evenings the main load consumption is switched to the households.

The tariff is set according to the type, size and number of appliances used by the household. If power consumption exceeds a certain load level the price increases and a tariff for businesses is used. For example, if a house has a small fridge the tariff is the same as for any other house, but if the monthly electricity use is greater than 50 kW then it is presumed to be a business and the tariff increases.

The distribution companies extended the grid to the El Bote community, but the service fails constantly and tariffs are too high for the locals' income. Therefore, the aim of the El Bote hydroelectric is to complement the grid supply and to provide a good-quality service at an affordable price. The system has two turbines, one connected to the grid and an autonomous one; when more electricity is generated than is required by the local community, the connected turbine diverts the electricity not required to the grid and Disnorte, the national distribution company serving Jinotega, buys the electricity exported from the El Bote plant. On the other hand, if the hydroelectric plant cannot generate enough power to meet local demand, ATDER-BL can also buy electricity from Disnorte, although at a significantly higher price than the feed-in tariff.

This is one of the major challenges for the El Bote power plant and the factor that most jeopardises the economic sustainability of the project, since the community has grown to the point where both turbines are unable to supply the existing demand. This has forced ATDER-BL to buy more electricity from the grid than the amount allowed under the

reduced tariff, so now a new renewable power system is required to cope with the demand. Regardless of the issues of selling electricity to

the grid, the autonomous turbine has allowed the villagers to benefit from a constant electricity supply for the last 10 years.



Professor Jorge Huete-Pérez, Founding President of the Nicaraguan Academy of Science and Vice-Rector General, University of Central America, encourages the audience to engage in discussion about Nicaragua and off-grid energy access.

SESSION 1

Roberta Mutschler Opening Remarks

In her opening remarks, Roberta welcomed participants to the workshop. She explained that the Smart Villages Initiative is concerned with how energy access and technology can promote development in off-grid villages in developing regions of Africa, Asia and Latin America, and in the case of this workshop, in Nicaragua. She indicated that the aim of the workshop was to explore with attending Nicaraguan experts the day-to-day challenges they face in terms of technology, financing, and politics, and to identify how energy access to support rural sector development in Nicaragua can be accelerated.

Dr. Jorge Huete Opening Remarks

Jorge Huete kindly chaired the workshop during the first part of the day. He opened the forum by extending his gratitude to all participants for being there to share their experiences, perspectives, and opinions with the rest of the audience.

He invited participants to get involved with Nicaraguan society and to investigate together more effective policies in order to achieve improved wellbeing for all sectors of Nicaragua's population. He observed that the Centro American University has played a crucial role in relevant discussions to date, and considered that transparency and training are the key values for any institution. He concluded by expressing his pleasure at co-organising the forum with the Sciences Academy of Nicaragua and the Smart Villages Initiative, and invited the participants to enjoy the day.

1. The Smart Villages Initiative

Dr. Claudia Canales, Smart Villages Initiative, UK

Introducing the Smart Villages Initiative, Claudia Canales presented key figures on the lack of access to sustainable energy sources globally: 1.1 billion

people do not have access to electricity, and three billion people still cook on dirty and inefficient stoves. Many of the 4.3 million people who consequently die prematurely each year from inhaling smoke from cooking are women and children. The Sustainable Development Goals include Goal 7 on energy access, but it is important to recognise that energy access is a key enabler of most of the other Sustainable Development Goals.

Claudia Canales went on to introduce the smart villages concept in which access to sustainable energy acts as a catalyst for development, enabling much improved provision of local services such as healthcare, education, clean water and sanitation, the opportunity for new productive enterprises, and to allow farmers to capture more value from the agricultural value chain. As nearly half of the world's population and 70% of the world's poor still live in rural communities, it is important to have an ambitious vision for their development analogous to the smart cities concept for urban communities. Technological developments are shifting the balance of opportunities between cities and villages.

The Smart Villages Initiative aims to identify the barriers to village-level energy access for development and how those barriers can be overcome, communicating new insights and recommendations to policy makers, development bodies and stakeholders more generally. Through a series of engagement programmes in six regions (East and West Africa, South and Southeast Asia, South America, Central America, the Caribbean and Mexico) frontline workers in energy access for development are being brought together to discuss the issues.

The project aims to identify the framework conditions necessary for the implementation of local energy solutions in rural communities, and to maximise the leverage of public sector funding in attracting private investment. A key premise

is that an integrated approach should be taken at a community level, and an important concern is to establish how the rate of progress through the levels of energy access and development can be substantially increased.

2. Impact investing in solar

Mackenzie Welch, Global Partnerships Investment Research Associate

Global Partnerships supports small enterprises that are creating businesses for the common wealth. Their mission is to expand opportunities for people living in poverty through energy access and business development. Mackenzie Welch explained that, to date, the organisation has invested US\$225 million in impact projects and allied with 101 partners in Latin America and East Africa. Through funding raised from donors and investors, Global Partnerships invests in social enterprises, including microfinance institutions (MFIs) and cooperatives to reach families living in poverty. The focus is to invest in essential products and services in the area of health services, economic resilience, and green energy for impoverished families.

The Solar Investment Initiative of the organisation aims to improve the economic position and quality of life of resource-poor households. The target is people living with less than \$3.10 a day; therefore, the strategy is to invest in mission-driven players throughout the value chain of solar products, such as solar lights, solar lights with charging, and small solar home systems (SHS). These players are carefully selected in order to offer good quality products/services at an affordable price for the families. The sustainability of the services is managed through the pay-as-you-go model, where clients make regular payments over a period of time to cover the capital and operational costs of the equipment rather than having to pay the full cost of the equipment upfront.

The lessons learned from their investments include:

Working with large manufacturers and distributors of solar panels and cookstoves promotes the sustainability of the project over time, since these organisations have a stronger value chain, provide more opportunities for branching out and reduce the economic risk of Global Partnerships.

The pay-as-you-go model is a socially and financially appealing one, because it gives access to electricity for lower income families and has a strong financing structure that gives flexibility with variable incomes, as well as reducing portfolio and lending risks.

The demand is high when clients have access to solar products. A market study performed by Global Partnerships showed that in Nicaragua there is a strong desire for Solar Home Systems (SHS) but that the ability to pay for them is the main hurdle for families who want to adopt the technology. Also, it was shown that higher levels of adoption are achieved when the systems are portable and “plug and play”.

The organisation has had to face some challenges as well. From the investment perspective, in Africa and Asia the solar panel market has developed considerably faster than in Latin America. Investors in Latin America are not interested in solar enterprises, hence the number of solar companies is fewer and technology access is reduced. Small companies that are trying to grow in the Americas are facing financing difficulties due to the lack of investors. For example, large organisations such as USAID, DunFunder and Alphamundi have an important presence in Africa and Asia but are nearly absent in Latin America. Conversely, MFIs are working hard on increasing investment in solar systems but they still have to limit their customers due to risks of becoming over indebted—a problem that affects both Africa and Latin America. China’s generic low-quality copycats are another factor spoiling the market, though this is much more common in Africa than Central America.

Global Partnerships is very interested in building “energy ladders” to increase rural incomes. They look forward to reducing solar panels costs in order to increase the opportunities for the wider use of SHS as a household product and larger systems for productivity. Currently, the potential of solar panels has not been exploited as it should, so they anticipate the expansion of productive systems in rural areas through use of solar energy.

3. Access and use of renewable energy in rural areas: Biogas technology

Carlos Bueso, SNV Sector Leader Energy Central America

For SNV, smart development means changing the underlying systems that keep poverty in place through giving people the tools to guide their own development. This work involves consolidating the connection between different ideas, experiences and people, and learning from what has worked and has not, in order to achieve scalability. SNV works to eradicate poverty in 39 countries around the globe, including across Central America. The focus is on agriculture, energy, and water, since these are three sectors that are believed to have the greatest positive impact on the lives of people living in poverty. SNV started 52 years ago in the Netherlands by sending young Dutch professionals to help to build capacity in the developing world. Nowadays, they have over 1,200 professionals around the world and 85% of their staff members are from the country where they live and work, giving an in-depth understanding of local needs and contexts.

Although SNV is working on several projects, Carlos Bueso focused on biogas technology and its effective use in the agricultural sector of Nicaragua. In 2010 SNV, Hivos, the Bilateral Investment Fund, and NDF undertook a feasibility study on the use of biomass as the principal source of energy for households. The term study considered access to energy, use of energy, gender and equality in the energy sector, energy for health,

the increased demand, increases in the prices of energy, and CO₂ emissions. Subsequently, in 2012, SNV established the Development Programme of the Biogas Market in Nicaragua (PBN) that aims to increase access to, and use of, non-conventional renewable energy in rural areas of Nicaragua. The objective is to activate the biogas market and the goals are to install 3,000 biogas systems to produce electricity, to increase the gross agricultural margin of 2,000 producers by 20%, and to reduce carbon emissions by 378,000 tonnes. The biogas technology was chosen to create value from biological waste with the generation of electricity, and the production of fertiliser as a by-product of the process.

The great challenge with biogas is creating enabling market conditions rather than implementing the technology itself. In the past, several organisations with poor knowledge of the technology and the local market attempted to introduce biogas systems into Nicaragua. Many projects that were implemented with unproven technologies failed, damaging the reputation of biogas in the country. Therefore, the first step included the identification of barriers through demographic studies in order to awaken people’s interest and demand for the technology. Efforts were concentrated on demonstrations of the system’s practicability, participation in fairs, sending special invitations to producers, etc., in order to create a marketing strategy where the users would communicate the benefits of biogas plants to potential new clients. Supportive regulations and policies are essential to creating an effective biogas market and SNV has been working with the Nicaraguan government on the creation of a policy framework for biogas that is expected to be approved at the end of 2017.

SNV had developed a multi-stakeholder model for market development that has had great success all over the world, especially in Africa. However, that model turned out to be too expensive in the Nicaraguan context and it took three years to create the ecosystem of the market. The ecosystem consists

of the local offer (micro-entrepreneurs, product and component supplier companies, suppliers of finance, and technical training), the local demand (promotion tools, local organisations, and dairy companies), institutional coordination, and business extension. Initially, the programme was focused only on reducing the use of firewood in cooking, but this new model made them realise that the demand for electricity was wider, and uses such as irrigation systems, milking systems, and hot water were considered as well.

To date, 1,000 systems have been implemented paid for entirely by the users. Green credits, Result-based Financing (RBF) and Pay-as-you-go are promising financing mechanisms that could improve access to clean energy.

4. Green and inclusive energy: Hivos approach

Dr. Myriam Blanco, HIVOS; Consultant and coordinator of the OSC and SE4All projects

Myriam Blanco introduced Hivos as an organisation that fights for renewable energy to support the production of food and achievement of social equality in Latin America. The long-term vision is to create socioeconomic systems with 100% green energy and inclusivity, which includes the generation of development opportunities for women and men, and contributes to increasing resilience to climate change.

Although in Nicaragua electricity coverage has increased greatly, development in the country has not achieved the same levels. Energy access issues go beyond grid extension and include off-grid solutions, quality and quantity, generation and transmission, cooking, and transport. In Nicaragua there are still many households that have access to the grid but cannot afford the tariffs.

To achieve gender and social inclusion, it is important to avoid differences within society. Women are particularly affected by the lack of energy

access. They are exposed to health risks (such as respiratory problems and burns) and safety risks due to the lack of illumination. Likewise, they have less time for income-generation activities, education, citizenship participation, and leisure. Hivos believes, therefore, that women are key transformational agents in the adoption of renewable energy. Women need to step up in society through public policies that support equality and through being involved in decision-making and productive processes.

Opportunities are found in the development of new energy policies for cleaner cooking technologies and the sustainable use of firewood. Women can be integrated in renewable energy value chains, for example through access to information, internship programmes, and by being supported to study engineering degrees with energy specialisations. Technological innovations can reduce their workload at home and help to empower them.

Hivos has changed; it is now an organisation focusing on social innovation instead of micro-financing. It supports entrepreneurial ideas with programmes such as the Sumba Iconic Island programme in Indonesia, which seeks to promote the development of a poor and isolated island with 100% renewable energy. Hivos also participates in programmes of market development for biogas technology and distribution of certified clean cookstoves in Nicaragua, in the Women-Childhood-Health-Energy campaign led by Nicaragua's Incidence, Gender and Energy Network (Red de Incidencia, Género y Energía de Nicaragua: RIGA), and financed by Sustainable Energy Access Fund for Poverty Reduction in Central America (FOCAEP).

5. Data on energy access in Nicaragua

Ing. Lâl Marandin, PELICAN S.A. Principal

Lal Marandin presented some observations on the energy access data of Nicaragua. The western side of Nicaragua has experienced a good pace

of development but on the eastern (Caribbean) side there is still plenty of work to do. In the rural areas of Nicaragua that are connected to the grid, energy consumption per household is declining due to outages, and lack of maintenance of the distribution system is one of the major economic challenges facing remote places. In addition, limited information and data are available on the isolated regions of Nicaragua.

The Inter-American Bank programme PNER (National Program for Sustainable Electrification and Renewable Energy) has been one of the most successful programmes in the country. PNER invested in large projects of grid extensions and grid reinforcement, but regrettably little effort was dedicated to the isolated populations. Ten years ago there were important initiatives to promote the implementation of solar projects, mini-hydroelectric plants (using the hydroelectric plant of El Bote as a role model), and hybrid micro-grid systems. However, with the exception of El Bote and a few other projects, these did not succeed over time.

The official electricity access figure is close to six million people, which corresponds to an electricity coverage of 85%, but a problem with these figures is that a significant proportion of the population of Nicaragua was not adequately covered by the 2005 census. In addition, the 85% grid coverage rate does not mean the grid is reaching the people but more likely that the people are migrating towards the grid.

The electricity coverage figure is calculated using three official datasets: Planer (Rural Electrification Plan), the 2005 census, and EMNV 2014 (2014 Living Standards Measurement Survey). The Planer study aimed to project an electrification strategy from 2014 to 2024 based on historical data from 2012 and 2013. The sample covered 3,284 off-grid communities, resulting in a total of 220,000 homes being surveyed. The Pacific side of Nicaragua was extensively reported but access difficulties impeded data collection on

the Caribbean side, therefore projections had to be made for that zone assuming a similar demographic profile to the Pacific side.

The census gives the government crucial data for planning, development, and improvement of residents' quality of life. In Nicaragua, the last census was performed in 2005; consequently, current governmental research (INIDE³ statistics and projections) is using data which is more than 10 years old. The EMNV 2014 surveyed 7,570 households in four regions: Managua (41.6%), Pacific (22.4%), Central (21.9%), and Costa Caribe (14%). The information gathered is valuable but dispersed, and again the sample distribution was based on the cartographic update performed in 2004 for the 2005 census. Therefore these three datasets have relevant information for national projections of rural electrification, but only by combining the three of them can more reliable data be obtained.

Electrification budgets are generally lower than needed; hence the most cost-effective solutions are always favoured. Currently in the country the most important factors for decision-making for the electrification of off-grid communities are demographic density and their distance from Managua (most service industries and economic activities are located in Managua, so costs generally increase with distance from the capital). The distribution of energy in Nicaragua is carried out by Unión Fenosa, ENEL, Zelaya Luz S.A., the utility that got the concession for the national grid (and hold the monopoly of distribution and retail supply) covering the Western, Central, and Northern zones of the country. This results in grid extensions being the preferred option, followed by micro-grids and lastly household-level solutions. However, this leads to the dilemma of which is the population segment that should be served first: the poorest communities or those who are easier and cheaper to serve?

³ INIDE: Instituto Nacional de Información de Desarrollo (National Development Information Institute)

Designing and implementing an electrification strategy for a whole country is difficult, but only by identifying the principal flaws of past strategies can new ones be improved. From the Nicaraguan experience, accurate and updated data are essential for projections and the creation of a national electrification strategy.

Lal Marandin and his team studied different scenarios for universal energy access in Nicaragua. The first approach prioritises the distance to Managua, since it is the main distribution centre of the country and therefore the implementation costs are significantly reduced. A second option is prioritising the poorest communities, commencing the electrification process on the Caribbean side. The third option is to prioritise the most cost-effective investments according to population density and distance from the grid.

The ESMAP Multi-Tier Framework for Energy Access states that above Tier 3 (a minimum of 1 kWh per day), a household is considered to have electricity access. A modular photovoltaic system providing a Tier 3 level of supply costs on average US\$1,000, thus electrifying the 220,000 homes of the Planer survey, for example, would require a total investment of US\$220 million, which is not economically feasible for Nicaragua. Therefore, Lal Marandin and his team proposed a three-phase strategy to achieve electricity access in Nicaragua. They estimated a budget of US\$60 million for the first phase which would cover the restoration of the distribution lines on the Pacific side of the country, providing around 26,000 households with access to the grid. The second phase is projected to cost US\$50 million and would give electricity access to 20,000 more households. The third phase, and the most challenging and expensive, is the incorporation of the poor and isolated communities of Rio San Juan and RAAS⁴, which are fewer in number but have greater need of development. This phase is

⁴ RAAS: Region Autónoma del Atlántico Sur (Autonomous Region of South Atlantic)

expected to cost US\$35 million, reaching around 17,000 households.

In this electrification strategy, the RAAN⁵ Department was not included due to the lack of data, but it was roughly estimated that an extra US\$80 million investment would be needed for the provision of electricity access to RAAN. To support this investment, though, new players must join the energy sector of Nicaragua and work together with the government through cross-subsidies as in the case of FOSE (Electrical Social Compensation Fund) in Peru, where consumers who use less than 100 kWh per month have a discount financed by those who consume more.

6. Science academies working together to promote science and technology for development, prosperity, and equity in the Americas

Dr. Katherine Vammen, University of Central America (UCA), Dean of Sciences and Technology Faculty

Katherine Vammen started her presentation by announcing the publication of the *Guide for the Sustainable Energy Future for the Americas*⁶, by the Inter-American Network of Academies of Sciences (IANAS). The guide focuses on how science and technology can contribute to a sustainable energy future for the continent, with five key areas of research: energy efficiency, energy for unserved populations, renewable energy, bio-energy, and capacity building. In addition, the guide contains a chapter entitled Women, Energy and Water, which centres on the importance of women's ability to access and control energy and water resources, and on the role of effective environmental management for sustainable social and economic development.

⁵ RRAN: Region Autónoma del Atlántico Norte (Autonomous Region of North Atlantic)

⁶ *Guide for the Sustainable Energy Future for the Americas* (2016). IANAS—the Inter-American Network of Academies of Sciences. Available at: <http://www.interacademies.net/Publications/30439.aspx>

These resources are intimately interconnected. Demand for water is increasing for both energy generation—a 56% rise in demand is expected in Latin America and the Caribbean (LAC) by 2030—and for food production, with agriculture claiming 70% of the water used. And energy is in turn required for the distribution of clean water and for sanitation.

For these reasons it is critical to discuss the use of these resources in an integrated way, especially since the pressures on water, food, and energy are likely to increase even more due to predicted global population growth and the effects of climate change. Addressing current and future challenges will require comprehensive and coordinated interventions between all relevant actors. This represents a global challenge, and not just one relevant to LAC. Access to adequate energy and water services by underserved populations is also crucial for poverty alleviation, and central to attaining multiple SDGs.

Examples illustrating the need for water in conventional energy generation include extraction from tar sands, traditional production of oil and gas, fracking, mining, and nuclear power. And water is of course a key requirement for the production of biofuels. Contamination of water sources is a serious risk in all of these activities. While water is also required for the generation of renewable power, the demands are far lower, especially for solar and wind power, and the impact on water quality is also reduced. Geothermal energy has a potential which is independent of climate change and which has not been properly exploited to date.

The level of energy required for water access is dependent on the water source (with deeper water sources requiring more energy for access than superficial reserves) and on whether the water requires treatment (e.g. desalination) prior to use.

Gender issues are intimately linked to both water and energy in LAC: overall, women dispropor-

tionally lack access to these resources. Collecting water and biomass for cooking still claims a large proportion of the time women in rural areas spend on domestic chores. In Central America alone, 20 million people rely on the use of biomass for cooking using open fires or rudimentary cookstoves. Lack of access to clean energy sources for cooking also has devastating health consequences due to indoor air pollution, which mainly affects women and children. Gender is a crosscutting issue in the energy-water nexus. Women can, and should, also play a decisive role in the production and use of energy, empowering households and communities as they take charge of roles traditionally set aside for men.

7. BlueEnergy: interventions, challenges, and opportunities Jean-Baptiste Boudot, BlueEnergy Development Unit Manager and Managua Link

BlueEnergy is an NGO focusing largely on coastal communities in Nicaragua, one of the countries most affected by climate change in the continent. Services provided by BlueEnergy include access to clean energy sources, clean water access and sanitation, and waste treatment. In addition, the organisation works with communities to develop plans for adaptation to climate change, to help identify likely risks, and to ensure community preparedness. Strengthening capacity at the community level is a core objective of all interventions, which are community oriented: technology and practice are integrated in meeting local needs and aspirations, and solutions are localised to maximise impact.

In terms of approach, Jean-Baptiste Boudot explained that BlueEnergy does not provide technology for free, and beneficiaries are expected to participate in the project either financially or by contributing labour. Projects aim to benefit all members of a community, in particular the most vulnerable groups. Three key challenges were identified: attaining the financial sustainability of

projects; the ability to carry out adequate impact evaluation of projects; and crosscutting issues needed for the success of all interventions.

Key for success is the financial sustainability of projects. In 2016 BlueEnergy derived 66% of its funds from revenue generated by projects; 10% from its Global Leadership Program; and 24% from individual donations. Challenges encountered include the need to finance the project design and other supporting activities not part of the project itself, high project costs (especially related to travel and distribution to remote and dispersed areas), and high financial risks. The reduction in the level of funds made available through international cooperation aggravates the problem. New models are needed to convince funders of the viability of projects in order to increase access to project funds.

In terms of assessing the impact of projects, challenges include difficulties in carrying out comprehensive monitoring and assessment activities, especially since not all communities respond the same way to a given intervention. Difficulties in formulating integrated policies and identifying all the existing opportunities and synergies are also a problem.

Crosscutting issues are considered critical for success and provide coherence to interventions. They include human talent and gender equality, central at both the community and global levels. The empowerment of communities, increasing local capacity, and valuing diversity are key goals of BlueEnergy. Traditional practices can sometimes offer the best solutions for increasing the resilience of communities and mitigating the effects of climate change, and communities are assisted to revalue these. Working with the community also helps identify opportunities and challenges to overcome, and to be better prepared. Essential for effective interventions are an integrated approach to interventions, and promoting local solutions with the active participation of the community.

8. Solar energy: not just a temporary solution

Morgan Babbs, Colibrí CEO

Morgan Babbs highlighted the fact that, although many households already have access to solar energy, these are often inadequate because they were deployed as sub-standard temporary solutions. Many projects have suffered from inconsistent presence of actors (such as NGOs with temporary presence in a community), lack of effective planning, follow-up, and service provision, and inconsistent financing schemes. While micro-financing institutions may provide a solution to enable the access of resource-poor households to energy technologies, they often lack the technical know-how to subsequently provide support to users and improve the sustainability of the intervention.

Colibrí was set up in Matagalpa, Nicaragua, to address these challenges. The company installs and finances solar energy solutions, and aims to contribute to the transition to clean energy and increase the revenue of households. The solution offered is an innovative pay-as-you-go set-up, “Colibrí fácil pago” (Colibrí easy payment) to access solar solutions. The installation of a solar system marks the start of a long-term relationship with clients, who commit to making monthly payments for a year in several “easy payment” locations manned by a team of agents. After a year, the equipment belongs to the users. After-sales support is included in the service, and energy provision is stopped if users fail to make their payments. Colibrí guarantees minimum technology standards to ensure the systems continue working after the first year. While the current focus is on rural areas, solar solutions are also appropriate for urban areas where the quality of grid connection is often very poor, and the price of energy high.

The success of the approach is reflected in the fact that 96% of users have signed up to the service despite the fact that they not had access to

an unrelated financial service (e.g. a loan from a bank, micro-finance organisation or NGO).

Challenges include the lack of options for users to make in-cash payments, especially among people with a low level of financial resources; the remote and dispersed nature of off-grid populations which increases the costs of sales, distribution, and after-sales support; the lack of financial innovation in Nicaragua; and the difficulty to access working capital for solar energy enterprises.

9. Small-scale renewable energy

Jaime Muñoz, Fenix Association
(Asofenix) Director

Asofenix is a Managua-based NGO that has been active in the country since 2002. It works in collaboration with other partners and associations. Jaime Muñoz explained that, over the years, work carried out by the organisation has increasingly focused on two key areas: solar energy for the provision of clean drinking water for households, and energy for irrigating crops. Solar technology is accessible to low-resource users, is a well-known option, and maintenance is relatively easy, which makes it a suitable energy solution. Improved cookstoves is another area of work, addressing health issues related to indoor pollution and excess exposure to heat, especially for women and children. Sustainable agricultural production is the fourth area of intervention (through irrigation, home vegetable plots, and improved agronomic practices). The first component of a project is always to engage with community members, and a key objective is also increasing local capacity.

The installation of solar systems to provide clean drinking water started in 2014, and since then 15 systems have been installed, benefitting 2,460 people. Each system requires an investment of approximately US\$60,000. The projects are complemented with other initiatives, such as increasing the capacity for water storage, distribution and sanitation; distributing improved cookstoves; promoting reforestation; and the installation of latrines. Asofenix has also installed a micro-hydro plant of 174 kW of installed capacity, with the active participation of the community. These interventions have been complemented by helping communities to acquire the tools needed to protect water bodies, and to use the energy generated in productive enterprises, for example through the installation of coffee de-pulping machines. To date 260 families have directly benefitted. The drop in water levels, however, has led to a decrease in the generation capacity of these systems.

Another project has focused on the provision of credits for the installation of small solar home systems, and reinvestment of funds from the activity has allowed the project to grow from one benefitted community to seven or eight, and from 25 families to 227. The demand was high for 50-watt systems, since the costs of these corresponds to a level at which most community members are comfortable to take a one-year loan. However, increasing the length of payback time encourages users to take higher loans for slightly bigger systems. Community members were also trained in installing and maintaining the solar panels, and as a consequence the project is still successful.

In conclusion, the key for the sustainability of energy projects depends on establishing productive uses of energy. Therefore, all Asofenix interventions include this as a key component.

DISCUSSION SESSION I

Asked to identify the key challenges faced by Colibrí, Morgan Babbs indicated that the main problem in terms of beneficiaries is that many clients are based in locations that require three hours of travel to reach the company's main office, and they cannot be expected to make the journey just to make a small payment. A key challenge is therefore to determine the pattern of movement of users, who have to periodically travel to town for other reasons, and balance this with the number of payment agents needed to make the system financially viable. Financial products such as pay-as-you-go systems and electronic wallets would greatly increase the ease and comfort of transactions for users, which is critical for the success of operations. Financial institutions have recognised these as the way forward; however, this awareness has not been matched by mechanisms to provide finance to SMEs starting a business, which is a big obstacle especially at the start of trading.

When asked to comment on the contribution of solar energy to households connected to the grid, Morgan Babbs referred to the fact that Nicaragua has one of the highest prices for electricity of the region, especially after exceeding a low level of consumption (150kwatt/hours/month). Incorporating solar energy to the mix can help grid-connected households significantly save on the energy costs.

Carlos Bueso from Smart Development Works was asked to expand on a comment in his presentation on the high loan rates of micro-credits as an obstacle for access to finance for resource-poor users for the installation of biogas reactors. He responded that the comment reflects a situation encountered on the ground. Often farmers initially reject loans from banks, micro-finance institutions and even the FISE (el Fondo de Inclusión Social Energético—the Social Energy Inclusion Fund) because they are reluctant to commit to

the high interest rates and the financial risk that these represent to them. Innovative financial solutions are needed to ensure that these funds reach the intended beneficiaries. For example, funds could be provided to farmers' cooperatives and farming associations to reduce the direct risk to individuals, and at the same time strategies could be established to decrease the risk of taking a loan through the generation of increased revenue. Another common problem is a mismatch between the financial service offered and the means and needs of the intended users, even in the case of green funds made available through the FISE. Examples include setting the minimum loan level at US\$5,000 when the required investment is only US\$600, which effectively becomes a financial barrier. Another problem is that financial institutions sometimes require many months to determine whether an applicant qualifies for a loan, when users cannot afford to lose this time.

Also on the matter of financial tools, Makenzie Welch was asked to define how Global Partnerships identifies potential partners for investment. Global Partnerships invests in 14 different partners, the majority micro-finances, and has identified pay-as-you-go for access to solar energy as the best solution to reach the poorest families and also offering the best repayment conditions. The problem for many interesting small organisations that would qualify in terms of activities undertaken is that the minimum loan provided is US\$300,000 (and usually payments are around US\$500,000). This is often much more than small companies require and are able to take on. For this reason, Global Partnerships highly values organisations that work with small companies to help them grow and attain the level of trading needed to qualify for their investment. The interest rate of loans to users also remains a problem; however, micro-finance often represents the only opportunity for people who do not qualify for bank loans to access credit.

In terms of approaches to improving the sustainability of projects, it was agreed that a key factor is the development of productive use enterprises that generate revenue in the community (such as agricultural value addition, hairdressing, or setting up a small cinema).

10. Sunisolar: The usual energy within reach

Douglas González Martínez, Sunisolar Operations Manager

Douglas Gonzalez presented on the company Sunisolar and showed interesting case studies of renewable energy systems in rural Nicaragua. Sunisolar was established in 1999 with the aim of creating a profitable renewable energy company in Nicaragua. The enterprise sells products and implements projects based on photovoltaic solar thermal and wind systems, and on energy efficiency. Only a few wind energy projects have been implemented in Nicaragua due to a lack of wind energy resources. The preferred system depends on the sector it serves. The housing sector requests mainly photovoltaic systems; tourism requests photovoltaic and solar thermal systems, and energy efficiency measures, which are perceived as an added value by the tourists; the livestock and agricultural sector needs solar water pumps for irrigation; hospitals and health centres need solar thermal systems; and the commerce and industry sectors prefer photovoltaic systems and energy efficiency measures.

The company has participated in several solar projects in isolated areas of rural Nicaragua. In 2005 the national project PERZA (Off-grid Rural Electrification Project) was implemented in Nicaragua and Sunisolar was one of the suppliers of photovoltaic panels. They installed systems ranging from 50 kW to 500 kW on farms at a total cost of US\$400,000. With this project, and advertising support from international agencies on solar systems, the company increased its participation in the energy market and obtained

financial support from the government. In 2009 Sunisolar also worked with the Ministry of Education on the installation of 924 small (100 W) systems to provide electricity for rural schools, with the purpose of supporting the education of the illiterate rural community.

Currently, the company is implementing photovoltaic systems connected to the grid, such as the UCN (Central Nicaragua University) project. Hybrid systems are deployed in rural areas using PV panels connected to diesel generators as back-up power. Lately, hybrid systems have been the preferred option, with over 100 15 kW systems installed in 68 isolated communities mainly for the telecommunication sector. Similarly, in RAAN the EURO-SOLAR project benefitted 42 communities with PV systems for Internet connectivity and refrigeration systems for health centres. The total capacity installed was 47 kW in the Siuna, Rosita, Bonanza, Prinzapolka, Puerto Cabezas and Waspan regions. The Santiago Hospital in Jinotepe installed 50 m² of solar thermal systems to heat up 3,000 litres to 70°C for the provision of hot water for male, female, paediatrics, and maternity wards.

PV irrigation pump systems are in great demand for rural productive enterprises. In the Chontales Department, for example, 28 drip irrigation systems with solar powered pumps were installed for the production of corn, passionfruit, papaya, tomato, and other vegetables. A less demanding but interesting technology is the solar thermal system for the production of fresh cheese. Sunisolar has installed five of these systems to obtain hot water for making cheese and washing utensils, significantly reducing the production costs.

Douglas Gonzalez also commented on the challenges in his business. He emphasised the need for technical knowledge and more distribution sites across the rural sector of the country. More effort should be dedicated to educating local technicians in those off-grid areas that are a long way

from Managua, and to promote financial models such as pay-as-you-go to increase the market development in wider areas.

11. IEEE Smart Villages: Empowerment of off-grid communities

Ing. Mario Aleman, IEEE Nicaragua President

Mario Aleman presented on the Smart Village programme of the Institute of Electrical and Electronics Engineers (IEEE). IEEE is one of the world's largest professional associations, with over 420,000 members in 38 societies in more than 190 countries. They work in the compilation of standards for electricity access in order to promote good practices among engineers. IEEE is active in 10 global regions; technical sub-units of one or more IEEE Sections are organised as Power Energy Society (PES) Chapters, of which there are about 230. PES members share technical interests and geographical proximity. The Smart Village programme aims to empower off-grid communities with education and the creation of sustainable, affordable, and locally owned entrepreneurial energy businesses through energy access. The idea is to bring electricity to the villages and to promote education in communities with replicable and scalable self-sustaining business models. The goal is to offer US\$2 million per year to educate at least one million people per country.

IEEE works with volunteer engineers who visit social enterprises to encourage entrepreneurs to use more efficient and cleaner electrical systems. The volunteer engineers help entrepreneurs choose innovative systems, and provide training and ongoing support to start-ups. They work with NGO partners and entrepreneurs to build or develop their micro-utility businesses with the promise of reinvesting profits in community empowerment through economic development and learning. Once the businesses have succeeded, the case studies and knowledge gained are shared with the rest of the IEEE community.

The IEEE Smart Village programme operates with modular PV charging stations that are portable and easy to install. The first model, SunBlazer II, was created in 2011 after the Haiti earthquake. The 1.5 kW base station includes 80 to 100 rechargeable battery packs for modest lighting with an auxiliary outlet for both AC and DC powered devices. Under a business plan this system pays for itself within two to three years.

The programme funds open community-based education through a unique partnership with Regis University and the Posner Centre for International Developments in Denver, Colorado. This educative plan offers two courses. The *Development Practice Degree Certificate* prepares practitioners with a holistic approach to community development and humanitarian engineering. The *Community Entrepreneurship Vocational Training* provides on-site entrepreneurs with sufficient wide-ranging knowledge to deploy, maintain, and franchise an IEEE Smart Village seed-funded micro-utility. It targets local labour and entrepreneurs, and national IEEE volunteer ambassadors help them to identify opportunities and develop best practices. In parallel, the ambassadors measure the impact of the activity and assess the NGO and its ability to work with the community. IEEE ambassadors have encountered ineffective situations, such as oversized diesel generators or women processing food manually instead of using the electricity available. Their job is therefore to correct these situations, showing villagers more efficient ways to perform their productive processes.

Mario Aleman asked workshop participants to submit proposals to participate in the IEEE Global Humanitarian Technology Conference 2017, focusing on innovation, deployment, and adaptation of Technology for Humanitarian Goals and Sustainable Development. He ended his presentation by highlighting the importance of creating strategic alliances and identifying the income-generating activities of villages.

12. Achievements and challenges of bringing clean energy to Nicaraguan micro-entrepreneurs

Verónica Herrera, Mi Crédito Chief Executive Officer

Veronica Herrera presented Mi Credito and the Solar Panel Programme that aimed to provide energy and improve quality of life through health and productive activities. The programme resulted in collateral benefits, such as the enhancement of children's school grades and new micro-businesses providing mobile phone charging services.

In 2004, the Canadian organisation MEDA (Menonite Economic Development Associates) established Mi Credito to provide, and improve the level of, financial services, and to target the underserved rural market in Nicaragua. Mi Credito's solar panel loans benefitted over 1,300 families across 220 communities in Nicaragua, allocating US\$170,143 to assets and US\$536,017 to credits. In total 1,478 energy systems were installed to replace the local use of candles and kerosene lamps. In the interest of supporting the local market, Mi Credito prioritised the financing of Nicaraguan green energy suppliers. To date, the programme has financed 1,231 photovoltaic illumination systems, 211 solar thermal systems, and 36 portable lanterns.

In partnership with Global Partnerships, Mi Credito set out to increase their annual energy portfolio by 10% by the end of 2017. Global Partnerships is committed to supporting projects with technical assistance throughout their entire lifetime. They support the relationship with Mi Credito's chosen local green energy suppliers, TecnoSol and NicaSolar, training Mi Credito's loan officials, and educating clients on energy options and access to financing. The alliance with Global Partnerships has been key to improving the microfinance prospects since training and education of local workers in energy matters has always been a challenge for Mi Credito.

Managing guarantee policies and reducing interest rates are two further challenges that Mi Credito has had to face working in Nicaragua. In order to adapt to the rural market, the organisation had to change their financing policies and apply flexible payment options allowing clients to make loan payments in line with the agricultural season. They also supported solar system entrepreneurs to set the correct prices of products at a level that enables them to pay the interest rates of loans and make profits at the same time.

Veronica Herrera highlighted the difficulty of reducing interest rates. Differences in interest rates between large loans and micro-loans are dramatic. Interest rates depend on five factors: the risk of the investment, the funding source, transaction costs, regulations, and the infrastructure and administration costs. It is commonly known that higher risks mean higher interest rates. The ability of rural entrepreneurs and individuals to pay for credits is subject to high uncertainty. On top of that, transaction costs can be up to 20% of the value of the loan because the loans are small (e.g. US\$100-500) and lending the money requires a close relationship between the client and the loan officer. In order to create this customer-official liaison, staff must travel to remote places to offer their products, which takes time and is costly. In terms of regulation barriers, all microfinance organisations affiliated to CONAMI (National Commission of Microfinance) are regulated and have to pay the same governmental annual fee, no matter what their size. This impacts negatively on microfinances and hence their clients are affected as well.

Fortunately, there are methods to reduce interest rates, but these require the will and alignment of all stakeholders in the sector. Twenty years ago the annual interest rates were close to 70%; nowadays they have dropped to 22%, thanks to more efficient microfinance mechanisms and strategies. The sustainability of long-term interest rates is crucial in this market and the best way to achieve it is throughout policy reforms, incentiv-

ising saving capacity, reducing energy technology costs and, most importantly, working together to reduce the interest rates available to rural energy access solutions.

13. The FUNDENUSE Institution

Denis Aleman, FUNDENUSE General Manager

FUNDENUSE is a microfinance institution that started operating in 2012 to cover the north of Nicaragua. With around 27,000 clients, of whom 58% are women and 51% live in rural areas, the organisation manages a portfolio of US\$21 million distributed funds and has 20 branch offices.

Denis Aleman explained that, in 2013, the organisation began the *Green Energy Access initiative* in partnership with Red Katalysis, IDEAS, and OI-KOCREDIT. In this initiative, Fundenuse focused on finding social and environmental metrics, rather than financial metrics, to measure results. Collaborating with other organisations helped them to strengthen their loan processes, adapt to customers' demands for new energy technologies, and increase the number of beneficiaries.

Green energy loans start from US\$30 and go up to 10 times the GDP per capita, providing individual and group credits as well as revolving credits. Revolving credits permit the major inclusion of women and more participation of system suppliers, since the systems act as guarantee. Women were trained to work as "energy distributors", through which they learned how to make use of the revolving credit line to generate an income selling solar energy products. Currently, women are widely trading small solar products across energy-deficient areas of cities and in off-grid communities.

Fundenuse designed different forms of payment depending on income source. For example, women selling tortillas opt for weekly payments since the business is more dynamic; conversely, agricultural producers can apply to make annual pay-

ments due to the harvesting seasons. To finance larger technologies such as solar refrigeration, clean cookstoves or solar TVs, clients can choose to take a financial lease, where they have the option to buy the asset at any point.

In the last three years, 779 loans were made for solar products, the majority in the department El Jicaro (149), followed by Quilali (136) and Yali (125). The average loan is US\$80, which in financial terms is small; but those loans mean that over 4,000 people have benefitted from clean electricity. Fundenuse's vision follows a social and environmental approach, hence their interest in providing solutions that improve customers' wellbeing.

To quick-start the business model, Fundenuse had to adapt their credit policies to provide more flexibility in credit amounts. They also had to create alliances with suppliers and technical organisations to gain synergy and exploit the scalability potential of the solar energy market. In general, all MFIs should make an effort to balance their business economy approach with the social and environmental needs of Nicaraguans in order to improve clients' quality of life.

Denis Aleman highlighted several lessons learnt in their business. Financial services must be constantly adapted to clients' incomes and needs. For instance, Fundenuse started requesting guarantees but realised that guarantees were a barrier instead of a benefit for the business, and excluding them does not affect the business' profits. In microfinance, the rotation of credits is high: people are constantly borrowing money on a weekly or monthly basis, making personal loans way too complicated. Credit lines are better suited to the dynamics of controlling such borrowing. However, to understand these financial systems, clients need to undergo financial training that will help them to safely use the service and to empower themselves in the administration of their incomes. The lack of partnership opportunities between MFIs, suppliers and technical supporters across

the country is a difficulty for Fundenuse. The distances to some places increase operational costs so not all branch offices offer the benefit of training services.

14. Renewable energy access from the National University of Engineering Suyen Cordoba, National University of Engineering (UNI); Director of the Alternate Energy Sources Direction (DFAE)

Suyen Cordoba and her team work principally in energy access projects across Nicaragua, in collaboration with other universities, to comprehensively address the renewable energy challenges. They have the vice presidency of the Renewable Energy Association of Nicaragua and have a

partnership with RIGE⁷ (Energy and Gender Incidence Network) to contribute on gender equality and women's inclusion in energy projects.

The Alternate Energy Sources Direction (DFAE) started in 1998 as an energy access programme and evolved to become the academic organisation it is today. DFAE provide training courses on solar cookstoves, renewable energy technologies, and energy efficiency. It also works with the Energy and Mines Ministry coordinating the national Renewable Energy Training Program (Programa de Capacitacion de Energias Renovables), which seeks to train the programme teachers to promote critical thinking on renewable energy and environmental technology matters. In parallel, DFAE works on water and sanitation projects, and on information and communication technologies.

⁷ Red de Incidencia en Género y Energía



Workshop participants took part in group discussion sessions at the end of the workshop.

DISCUSSION SESSION II

In the second discussion session, participants were invited to split into groups and respond to three questions. They then shared their main conclusions with other workshop participants.

The first question concerned the role of local electricity generation in enabling productive processes and tourism activities in villages. Participants commented that productive uses should be promoted but that more studies should be carried out on the needs of communities, so that customised systems that will serve the specific business or community requirements can be designed and installed. Access to clean electricity has direct social and environmental impacts, and it increases productivity hence it decreases operational costs. However, people have to be informed about the benefits and uses of electricity for productive processes. Fairs, advertising, and training campaigns play a crucial role in increasing awareness. Every system or product sold should include recommendations and education of the users on installation best practices and compatible technologies that maximise the equipment efficiency.

From the government perspective, minimum quality standards for renewable technologies, incentive measures, and tax reductions must be put in place to promote clean energy and avoid fake or poor-quality products entering the market. The dependence on only one governmental institution (ENEL) to design energy access programmes based on smaller-scale, local systems is considered an inefficient approach. The government should allow the participation of the private sector and diversify suppliers of electricity. Nicaragua should assess the viability of solutions “out of the box”, and learn from the experience of other Latin American countries that have implemented models with successful impact. The government should also secure the provision of a reliable service to clients and subsidise those suppliers that comply with their

duties. In this scenario, beneficiaries should be charged a social fee to hold them accountable as well. This model (the FOSE initiative) has been very successful in Peru and should be evaluated for Nicaragua.

Regarding tourism activities, there is little research on what the energy needs are to promote tourism in Nicaragua, as well as limited training on the potential benefits that renewable energy could provide to products and services. Those benefits must be identified in action to show evidence of the viability and functionality of renewables. In the tourism industry, the adoption of renewable energy helps to show a green and clean image, which can be capitalised on. Pilot projects are a good method to start with.

The second question explored how affordable finance could be made available to support the supply and use of electricity for productive enterprises and services. Participants agreed that the creation of cooperatives enables access to affordable financing in communities. Boosting communities to form groups of people to represent them improves their bargaining power and, although it is difficult to reduce interest rates due to the large number of intermediaries, consensus across a community improves the impact and profitability of the investment. Strategic partners can support cooperatives to create long-term financial plans adjusted to the realities of their situations, and can act as backup entities to make cooperatives more trustworthy, thus reducing the investment risk. Likewise, access to corporate social responsibility funds could improve financing prospects. In Nicaragua, corporates’ social investments rarely address energy access solutions, which give a new opportunity to consider.

Finally, the third question aimed to analyse synergies between energy access, income-generating activities, and basic social services (education, healthcare, and clean water and sanitation).

Regarding energy policies, participants criticised the lack of net metering policies and the fact that adopting solar energy technologies is 40% more expensive than conventional options. Integration of more appropriate policies created by multi-disciplinary groups is greatly needed. A policy-making institution that embraces experts from each sector—health, education, clean water and sanitation, and energy access—would bring the necessary diverse range of perspectives together to generate policies with greater impact. This applies also to energy access interventions

in communities, where multi-disciplinary groups can contribute to designing integral solutions that would maximise the uses of electricity. Measures such as stakeholder mapping, private-public alliances, and greater participation from universities in training courses were suggested to improve the impacts of energy access initiatives. Promoting renewable energy systems as backup technologies to give continuity to daily activities, rather than only as off-grid solutions, would accelerate their adoption.

ANNEX 1: WORKSHOP PROGRAMME

Local Workshop

Energy access in Nicaragua: nexus between financial mechanisms and energy policies

Hotel Resort Selva Negra, Matagalpa, Nicaragua

27-28 April 2017

Agenda

Friday 28th April

08:30 Welcome and Event Initiation

Roberta Mutschler, Smart Villages

Dr. Jorge Huete, University of Central America (UCA)

08:40 The Smart Villages Initiative

Dr. Claudia Canales, Smart Villages

09:00 Impact investing in solar

Mackenzie Welch, Global Partnership Research Associate

09:20 Access and use of renewable energy in rural areas: Biogas technology

Carlos Bueso, SNV Sector Leader Energy Central America

09:40 Green and inclusive energy: Hivos Approach

Dr. Myriam Blanco, HIVOS Consultant and coordinator of the OSC and SE4All projects

10:00 Data and energy access in Nicaragua

Ing. Lâl Marandin; PELICAN S.A.; Principal

10:20 Coffee break

10:40 Guide towards a sustainable energy future for the Americas

Dr. Katherine Vammen, University of Central America (UCA), Dean of Sciences and Technology Faculty

11:00 BlueEnergy: Work, Challenges and Opportunities

Jean-Baptiste Boudot, BlueEnergy Development Unit Manager and Managua Link

11:20 Solar energy not only as a temporary solution

Morgan Babbs, Colibri Global, Chief Executive Officer

- 11:40 Small-scale renewable energy
Jaime Muñoz, Fenix Association (Asofenix) Director
- 12:00 Discussion session I
- 13:00 Lunch
- 14:00 Sunisolar: With the usual energy at your fingertips
Douglas González Martínez, Sunisolar Operations Manager
- 14:20 IEEE Smart Villages: Empowerment of off-grid communities
Ing. Mario Aleman, IEEE Nicaragua President
- 14:40 Achievements and challenges of bringing clean energy to Nicaraguan micro-entrepreneurs
Lic. Verónica Herrera, Mi Crédito Chief Executive Officer
- 15:00 The FUNDENUSE Institution
Denis Aleman, FUNDENUSE General Manager
- 15:20 Renewable energy access from the National University of Engineering
Suyen Córdoba, National University of Engineering (UNI): Director of the Alternate Energy Sources Direction (DFAE)
- 15:40 Discussion session II
- 16:20 Close of workshop

ANNEX 2: LIST OF PARTICIPANTS

Title	Name	Surname	Organisation	Position
Ing.	Mario	Aleman	IEEE Nicaragua	Presidente
Sr.	Denis Antonio	Aleman Casco	FUNDENUSE	Gerente General
Otro	Morgan	Babbs	Colibrí	CEO
Sr.	Hector	Baldivieso	Inter-American Development Bank	Energy Specialist
Ing.	Analy	Baltodano Martínez	Universidad Centroamericana	Encargada de Mediciones/ Investigadora
Sra.	Angela	Barreto	IEEE	Miembro
Dr.	Myriam	Blanco	Hivos	Consultora Coordinadora de Proyecto Fortalecimiento de la Participación de las OSC en la Iniciativa Energía Sostenible para Todos
Sr.	Jean-Baptiste	Boudot	BlueEnergy	Gerente Unidad de Desarrollo y Enlace Managua
Sr.	Carlos Alberto	Bueso Varela	SNV	Sector Leader Energy Central America
Dr.	Claudia	Canales	Smart Villages	Gerente de Proyectos
Srta.	Hellen Cristina	Castillo Rodríguez	Academia de Ciencias de Nicaragua	Asistente de comunicación
Ing.	Suyen Elena	Córdoba Chamorro	Universidad Nacional de Ingeniería-Dirección de Fuentes Alternas de Energía	Directora
Sr.	James	Downer	Colibrí	Co-Founder
Ing.	Francisco Javier	Espinoza Gomez	blueEnergy	Gerente Programa Energía Renovable
Ing.	Douglas	González Martínez	Sunisolar	Gerente de operaciones
Ing.	Ana María	Gutiérrez Aguirre	Asociación Roncalli- JuanXXIII	Responsable de Proyectos Integrales
Lic.	Veronica	Herrera	MiCrédito	Gerente General
Dr.	Jorge Alberto	Huete - Pérez	University of Central America (UCA)	Vice-Rector General
Sra.	Molly	Hurley-Drepret	Smart Villages	Narradora y Gerente de Políticas
Ing.	Lâl	Marandin	PELICAN, S.A.	Principal

Title	Name	Surname	Organisation	Position
Lic.	Julio César	Membreño Idiáquez	University of Central America (UCA)	Coordinador Carrera Diseño Gráfico
Lic.	Odaly María	Molina Altamirano	Niura	Community Liaison
Sr.	Jaime Enrique	Muñoz Hernandez	Asociación Fénix (Asofenix)	Director
Sra.	Roberta	Mutschler	Smart Villages	Research Associate
Ing.	Johana Lisseth	O'Connor Mendoza	Universidad Nacional de Ingeniería-Dirección de Fuentes Alternas de Energía	Especialista de Proyectos
Sr.	Manuel Antonio	Ortega Hegg	Academia de Ciencias de Nicaragua	Presidente de la Junta Directiva
Sr.	Octavio	Pereira	PELICAN S.A	Economista
Sr.	Alvaro Javier	Quezada Larios	FUNDENUSE	Gerente de Negocios
Lic.	Moisés	Rodríguez Cruz	Financiera FDL	Vice Gerente Regional de Negocios
Lic.	María Catalina	Solano Uribe	Academy of Sciences of Nicaragua (ACN)	Asistente ejecutiva Academia de Ciencias de Nicaragua
Sr.	José Luis	Solórzano	Universidad Centroamericana	Director del Centro de Gestión Empresarial
Sr.	Jesus	Tefel Amador	IEEE Seccion Nicaragua	SIGHT Chair & Young Professionals Chair
Dr.	Katherine	Vammen	Universidad Centroamericana	Decana de la Facultad de Ciencia Tecnología y Ambiente
Ing.	Alexis Arturo	Vega Aburto	Ministerio de Energia y Minas	Director de Programa
Srta.	Mackenzie	Welch	Global Partnerships	Investment Research Associate
Ing.	Claudio José	Wheelock Horvilleur	Estación Solar "Julio López de la Fuente, S.J."	Director



SMART VILLAGES

New thinking for off-grid communities worldwide

The Smart Villages initiative is being funded by the Cambridge Malaysian Education and Development Trust (CMEDT) and the Malaysian Commonwealth Studies Centre (MCSC) and through a grant from the Templeton World Charity Foundation (TWCF). The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Cambridge Malaysian Education and Development Trust or the Templeton World Charity Foundation.

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The University of Central America (UCA)



The Central American University (UCA) is the first private university created in Central America. It was founded in Nicaragua by the Society of Jesus on July 23, 1960, as a non-profit, autonomous, public service and Christian inspiration institution. The UCA is part of the Association of Universities Entrusted to the Society of Jesus in Latin America (AUSJAL), made up of 31 universities in 14 countries of the region and integrated into the network of institutions of higher education of the Jesuits in Europe, Asia and U.S.

Academy of Sciences of Nicaragua (ACN)



The Nicaraguan Academy of Sciences (NAS) is a non-profit organization whose principal purpose is to promote and distribute information related to Science, Research and Science Education, which are fundamental elements for sustainable human development.

The NAS was preceded by the Nicaraguan Association for Science, also known as the Society for Science, which met for the first time in December of 2005 and was officially created during its VI General Membership Meeting held in July of 2006. The Association held a series of seminars entitled "Science and Society", with speakers from the Nicaraguan science community as well as foreign scientists. The Association also established ties with other institutions such as the Nicaraguan Council on Science and Technology (CONICYT) and, on the international level, with the Inter-American Network of Academies of Science (IANAS), InterCienca and the Caribbean Scientific Community (CCC). The journal Science, one of the most prestigious journals in the world, published a commentary announcing the creation of the Nicaraguan Association for Science and the interest in creating the Academy of Sciences in the future.