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Energy with Development: 50 years' Experience of Community-driven Rural Electrification and Future Challenges for COOPEGUANACASTE in Costa Rica

Rolando Madriz-Vargas[1,2], *Anna Bruce*[1], *Muriel Watt*[1] *and Yuri Alvarado Rojas*[3]
[1]*School of Photovoltaics and Renewable Energy Engineering*
University of New South Wales, Sydney NSW 2052, Australia
[2]*Solar Energy Laboratory, Department of Physics*
Universidad Nacional, Heredia 86-3000, Costa Rica
[3]*Distribution Management, Santa Cruz Headquarters*
COOPEGUANACASTE, Guanacaste 11-5150 Costa Rica
E-mail: r.madrizvargas@student.unsw.edu.au

Abstract

Community-based rural electrification initiatives have the potential to overcome some of the barriers to providing modern energy services in off-grid areas in developing countries, especially those barriers relating to social integration of renewable energy technologies, end-user education and local maintenance capabilities. However, experience to date with rural community energy projects has been mixed, and it is not clear which implementation models or community capabilities are required to deliver a sustainable and successful community-driven energy venture (Madriz-Vargas, *et al.*, 2015). A case study of the rural electric cooperative of Guanacaste R.L. (Coopeguanacaste) located in Costa Rica is presented. A capabilities framework is used to examine the Coopeguanacaste experience, current and future challenges, and the main factors influencing the success of the initiative. The aim of this case study is to contribute to the body of knowledge on capabilities needed, lessons learnt and future opportunities for community-based solutions for off-grid rural electrification, especially in developing regions such as Latin America and the Caribbean, sub-Saharan Africa and the Asia-Pacific.

1. Introduction

Rural electrification via a cooperative (coop) model has the potential to enable socio-economic development in isolated communities of developing countries, and overcome some of the problems associated with other rural electrification implementation models. Coops initiatives in India, Nepal, Bangladesh, Kenya, Burkina Faso, Peru and Costa Rica are some examples of how positive have been rural electrification initiatives following this model (Yadoo and Cruickshank, 2010, Yadoo, 2012, ILO, 2014). For instance, Costa Rica presents today one of the highest electrification rates in the Latin American region (OLADE, 2013, WB, 2016), with the rural electric coop movement playing a vital role in this achievement.

However, rural electrification using a community-based model is not an easy task. Central barriers around these ventures relates to the lack of local technical, managerial and organizational capabilities (Madriz-Vargas, *et al.*, 2015), and there is a gap in the literature regarding adequate information on successful cases (Bhattacharyya and Palit, 2014). Therefore, we explore the rural electric cooperative of Guanacaste R.L. (Coopeguanacaste). This coop has been a major actor in rural electrification in Costa Rica, with more than 50 years of experience in providing livelihood improvement to rural communities in the Nicoya Peninsula, Guanacaste. Coopeguanacaste has recently received national and international awards recognizing successful business practices and high customer satisfaction levels. Thus, it is a model worth analysing in order to understand the success factors, and potentially replicating them in other community energy projects in developing countries.

First, we provide some background to the case study in **Section 2**. We then explore some key aspects around the Coopeguanacaste experience, using a capabilities-based framework in **Section 3** to assess the challenges and success factors across the following areas: community governance, capacity building and engagement, ownership structures, technical design, operation, maintenance and management, and follow up measures for system and project sustainability. Finally, discussion of preliminary findings and a conclusion are presented in **Section 4**.

2. Background and history of Coopeguanacaste

Coopeguanacaste was created in early 1965 by 229 members with financial support from the *Alliance for Progress* program. This program was established by U.S. President John F. Kennedy in 1961 and implemented in Costa Rica together with advisors from the U.S. government. At that time, national electricity access was nearly 50% and further efforts were required to increase the level of energy provision in remote areas of the country. Consequently, concession areas were designated by the Costa Rican Government to four new rural electric coops (Coopeguanacaste, Coopesantos, Coopelesca and Coopealfaroruiz) between 1965 and 1972. This was the birth of the rural electric cooperative movement in Costa Rica, extending the national grid and distributing electricity for off-grid settlements and agricultural businesses. This model has been highlighted as a successful and effective solution for rural electrification in Costa Rica (Barnes, 2011). Available data over a 66 years period shows how access to the grid was extended across the nation from 14% of households in 1949 to 99.3% in 2015. In particular, Coopeguanacaste manage a concession area of 3915 km^2 (7.7% of national territory) with an electricity access of 99.7% covering semi-urban and rural zones (ICE, 2015, INEC, 2016), see **Figures 1** and **2.**

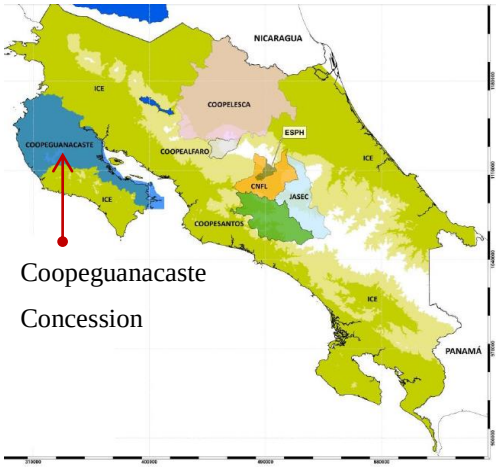


Figure 1. Concession areas by distribution companies in Costa Rica
Source: ICE (2015)

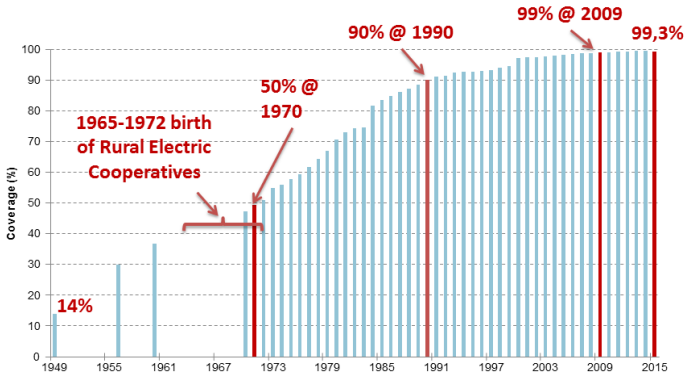


Figure 2. Electricity coverage in Costa Rica from 1949 to 2015
Source: based on ICE (2015) and Zuñiga (2009)

By 2015, Coopeguanacaste reported over 70,000 members and around 400 direct jobs to locals. There was electricity provision to nearly 100,000 people in a variety of socio-economic contexts and a peak demand, for instance, of 88MW experienced in Dec 31st at 6:45pm (Rangel, 2015). The main economic activities in the area requiring continuous and reliable energy supply are: a) ecotourism, with high air conditioning demand (hotels and private residential developments); b) agro-industry, with intense water pumping processes (e.g. sugar-cane, water melon and rice); and c) residential consumption (nearly 28,000 households).

However, electricity distribution is not the only business. Coopeguanacaste has also provided complementary commercial businesses; such as: a) selling household and energy efficient appliances at low prices and low interest rates for members (in 10 regional offices, a hardware store and a virtual shop); b) power generation, including two mini hydro plants of 17.5 MW each, c) wholesaling air time for prepaid mobile phones, d) cash sales in electric materials and components; and more recently, f) offering high speed internet and digital TV, which required an investment of US$10 million for 202km of lines to serve 5,444 households (Coopeguanacaste, 2015).

Further, 50 years of rural electrification efforts in the Nicoya Peninsula have been recognised nationally and internationally. The Ministry of Energy and Environment of Costa Rica in 2000 (for the PV social program), the Chamber of Industries of Costa Rica in 2015 (for social and environmental responsibility practices), as well as the Commission of Regional Energy Integration for Latin America and the Caribbean in 2015 (for the high residential customer satisfaction levels) are some of its recent achievements.

3. Assessment framework

Drawing from the community renewable energy literature, a capability-based framework, described in detail in Madriz-Vargas (forthcoming), is used in this section to evaluate challenges and success factors across six main capability areas that have been identified as important in this type of projects. These are: 1- community governance; 2- capacity building and engagement; 3- ownership structures; 4- technical design; 5- operation, maintenance and management; and 6- follow up measures for system and project sustainability.

3.1. Community governance

Two community governance organizations arose through this rural electrification initiative. First, a rural electric cooperative was formed. This model was proposed by *Alliance for Progress* advisors, as it was found successful for rural electrification in the U.S. since early 1900 (NRECA, 2016). Thus, an initial provision of US$3000 was granted (loan over 30 years, 1% interest rate and 10 years' period of grace) to replicate this model in Guanacaste. Consequently, on January 10th 1965 a group of 229 local leaders from the neighbouring communities of Santa Cruz and Carrillo took advantage of this opportunity and united efforts for tackling the energy access issue in the region (Arias and Hernandez, 2014). The main goals were to democratically govern local infrastructure, natural and financial resources. For this purpose, an administration board for decision making and conflict resolution was appointed. Today Coopeguanacaste has become one of the biggest cooperatives in the country and social investments are treated as a priority. For example, social programs within and outside its concession area received an allocation of 6% of total yearly revenues from non-regulated businesses, reaching over US$2 million in 2015 (Coopeguanacaste, 2015).

Second, on June 26th 1989 the national consortium of rural electric cooperatives of Costa Rica (CONELECTRICAS) was created by the four rural electric cooperatives, with a more profit-driven agenda. This group focus on: a) developing renewable energy power plants to reduce dependence on incumbent generators in the wholesale market, and b) representing end-users' collective interests to decision makers in the Costa Rican electricity market, see **Figure 6**. The size of the consortium also made feasible a portfolio of investments in the power generation market, which reduced the technical and financial risks of participation in this new venture. Today CONELECTRICAS have more than 25 years of experience in mini hydro electricity generation, and Coopeguanacaste is a big player in this organization with participation by equity of 33%.

3.2. Community capacity building and engagement

At Coopeguanacaste, building the capabilities to own and operate a rural electricity coop started almost from zero and used many approaches. Creating and maintaining skills in some key areas such as accounting, finance, management, and operation and maintenance (O&M), has been assisted by other actors committed to rural development in Costa Rica. For instance, during the first decade of operation the Nacional Bank of Costa Rica (BNCR) supported Coopeguanacaste with financial advice and training. The coop was then able to manage its own loan for the next 30 years after the period of grace of 10 years given by the actors involved in the *Alliance for Progress* program.

Managerial skills were supported initially by U.S. advisors working together with local leaders. However, the coop quickly took responsibility, hired trained personnel and built the organizational capabilities required. As a result, after around 1 year the coop the initiative was being managed by locals.

Technical know-how for the design and construction of electric lines, installation of transformers, protections and other safety measures were transferred from the Costa Rican Institute of Electricity (ICE). The ICE is the system operator and transmission service provider in Costa Rica. It took almost 3 years to build the first distribution lines delivering electricity locally, and around 5 years before Coopeguanacaste operated with some independence from ICE. However, to ensure continuous technical advice and training, one representative from the ICE has remained part of the coop's board from the outset.

Additional training has been provided to Coopeguanacaste by the Center for Studies and Cooperative Training (CENECOOP) and the INCAE Business School on topics such as: marketing, customer service, and strategic planning. Recently, the National Institute for Learning (INA) has provided also technical and non-technical courses for new linesmen. For instance, a 250 hour course covers electricity basics, safe construction of single-phase and three-phase lines and cleaning of isolators (up to 34.5kV) with water at high pressure.

In the area of power generation, capacity building started in the early 90s with CONELECTRICAS. Coopeguanacaste have built capacity for developing its own mini hydro power plants: Canalete (17,5MW), operating since 2008 and Bijagua (17,5MW) since mid-2016; both located in the northern part of Costa Rica.

Another key organization supporting Coopeguanacaste is the Coweta-Fayette Electric Membership Corporation (EMC), an electricity utility based in Georgia, USA, which has acted in recent years as a mentor to Coopeguanacaste, providing advice on key areas, namely: smart grids, new technologies and knowledge exchange at a practical level, e.g. there is a 2-week internship program between linesmen from both organizations.

In addition, consultation and engagement with local communities has occurred usually through Rural Development Associations (RDAs), which are formal civil organizations with legal capacity as well as government institutions, e.g. the Ministry of Education and municipalities. This engagement has become more active in the last 5 years as a result of the new generation projects, and the inclusion of new commercial businesses mentioned in **Section 2**. Local engagement activities are strategically selected by the Education and Social Wellbeing Committee at Coopeguanacaste.

3.3. Ownership structures

There are 3 different ownership structures in Coopeguanacaste. These are: a) coop assets, b) mini hydro power plants, and c) the PV social program.

Firstly, all assets from the electrical infrastructure and distribution network, telecomm technologies and admin facilities belong to coop members. Legally, a member is anyone in the concession area that owns an energy meter; therefore all end-users are also the owners of

these assets. Thus, energy consumers have a say regarding new investments and network upgrading. To facilitate this, delegate elections are run every 3 years. One delegate represents 100 members from his or her home community. Delegates must meet once a year, and among many tasks, should elect new board members in charge of assets management.

Secondly, for mini-hydro plants, a Build, Lease and Transfer (BLT) model is used where, due to the lack of expertise, a third company designs, builds and operates the plant on leased private land, for a period of 15 years. Thus, operation and management activities are undertaken by non-members of the coop. In the meantime, Coopeguanacaste is gradually achieving the expected financial returns and developing the technical know-how needed before taking on responsibility to operate the power plants. This legal arrangement allows Coopeguanacaste to remain as the owner of land, civil and electromechanical infrastructure, and the revenues.

Thirdly, the PV program for remote off-grid households (112 families in 2015) uses a contract that gives low income families access to a PV system, providing they commit to protect the system from robbery and vandalism. A fixed installation fee is paid once and a monthly fixed rent fee is paid until the grid reaches their homes. The PV modules, regulator, battery and circuit components are owned, operated and maintained by the coop as a subsidised social service, see **Figure 3**.

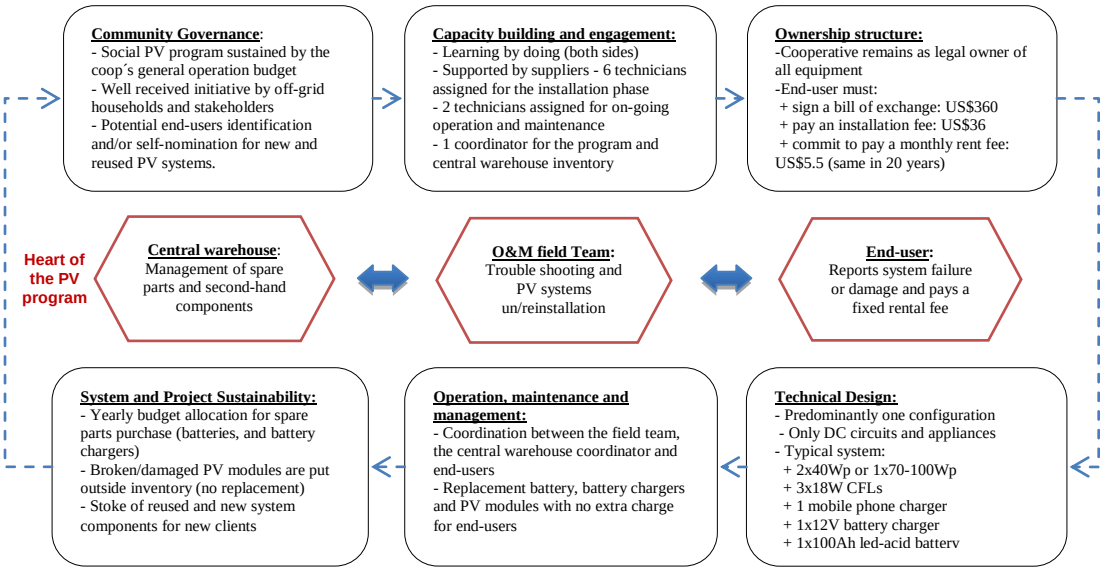


Figure 3. Description of the Social PV Program at Coopeguanacaste

3.4. Technical design

Three areas are briefly described: a) the distribution network, b) the mini hydro power plants, and c) the PV social program.

As mentioned in ***section 3.2*** technical capabilities for the distribution network design, construction and operation were initially supported by national institutions such as the ICE, INA, and recently CONELECTRICAS. Today Coopeguanacaste has all the skills required to operate the network supplying 73,325 end-users using 3,731 km of lines, 43,736 posts, 11,204 transformers, 19,725 street lamps and 80 MVA of substation capacity (Rangel, 2015).

However, in the generation side a third party was in charge of civil and electro-mechanic designs, construction and performing O&M on behalf of Coopeguanacaste for the first 15 years. The first project at Canalete (17.5MW) in 2008 was successful for all parties. For instance, this plant was built in only 1.5 years and the investment recovered in 6 years; in

both cases, a shorter time than estimated. These positive outcomes encouraged Coopeguanacaste to develop a second power plant, similar to its predecessor (17.5MW) located at Bijagua. These plants were developed outside the concession area in the Province of Alajuela. The Bijagua plant was commissioned in mid-2016 with an investment by installed capacity of US$3800/kW. The energy is being sold to the ICE using a transmission line of 34.5 kV and it is anticipated to produce 66 GWh/year with incomes forecasted in around US$7 million a year (Coopeguanacaste, 2015). Again, no technical designs were developed by Coopeguanacaste, and despite operational and financial successes, there is still high dependency on third parties in the generation business.

The PV system design for the off-grid remote household PV program was assisted by international consultants in the mid-90s and has been run the same way till today. Hence, the same system configuration, size and costs have been used since its outset and Coopeguanacaste has not developed design capabilities in this area. These systems have proven to be a financial burden for Coopeguanacaste, and according to interviews, this program is seen by managers as a secondary activity rather than a profitable commercial opportunity, see **Figure 3**.

3.5. Operation, Maintenance and Management

In Coopeguanacaste the Distribution Management (DM) is in charge of the administration of technical and non-technical O&M activities. On one hand, the DM aims to comply with national regulations and international standards, on the other, to reach high availability of the network. The main O&M tasks managed by the DM are, but not limited to:

- Strategic planning and accountability for new rural electrification investments
- Design, budgeting and construction of new electric overhead lines
- Maintenance of underground electric lines, e.g. for private residential and hotels
- 24/7 troubleshooting service and testing of new technologies, e.g. digital meters
- Installation/uninstallation of PV systems and component replacements
- Energy audits for large consumers, e.g. hotels, agro-industry and hospitals.
- Cutting trees and clearing of weeds for electric line and wildlife protection
- Energy meter readings for payment collection
- Connection, disconnection and reconnection of end-users, e.g. after non-payment
- Coordination of training for technicians and engineers, e.g. with the ICE, INA, etc.
- Facilitating: 1) coop democratic election processes; 2) socio-cultural activities with community leaders and civil organizations; and 3) engagement events for end-users.

The DM at Coopeguanacaste deals with the operation of all but 219 of the 3915 km2, which are operated together with the ICE. There is 1 coop employee per 9,36km2 or to serve 185 members. Technicians responsible for fixing network failures represent around 25% of total workers. Network operation is an intense task, for instance, only in 2015 the network required attention for 6865 faults (Rangel, 2015).

Energy sales follow the reselling principle, whereby tariffs seen by end users are defined by the ARESEP. Tariffs include cost recovery for energy purchased from the system operator, new investments in, operation of the distribution network, as well as a national variable cost of fuels; among other factors. Monthly sales, peak loads and average consumption for Coopeguanacaste are presented in **Figure 4** and **Figure 5.**

Additionally, the operation of electricity distribution networks is overseen by the Regulatory Authority of Public Services (ARESEP). The ARESEP enforces compliance with: a) operational service indicators, see **Table 1** and **Figure 4**; b) tariffs, see **Figure 5**; and c) technical and non-technical regulations, see **Figure 6**.

Table 1. Operational monthly network indicators at Coopeguanacaste during 2015

Values	Average interruptions		Faults		Average Availability	Quality Index	New End-users
Unit	Frequency (N°)	Time Out (Hrs)	Frequency (N°)	Time Out (Minutes)	Service (%)	E Losses (%)	Connections (N°)
Max.	3.56^{6}	2.22^{1}	726^{1}	97363^{1}	$99.9\%^{12}$	$9.19\%^{10}$	295^{2}
Min.	0.99^{12}	0.59^{12}	473^{2}	52748^{2}	$99.7\%^{1}$	$6.87\%^{1}$	83^{8}
Total	24.06	14.86	6865	834841	-	-	1914
Ave	2.01	1.24	572.08	69570	99.8%	8.07%	-

Note: Superscripts x^{n} represents the month of the year when the value was reported

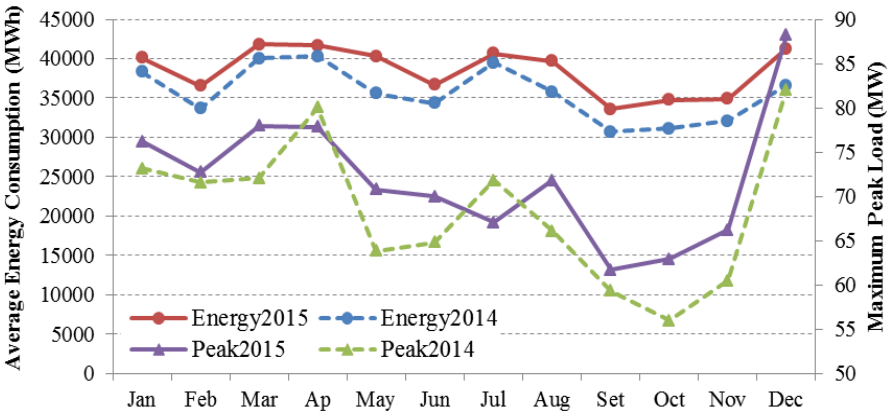


Figure 4. Average energy sales and peak loads in 2014 and 2015

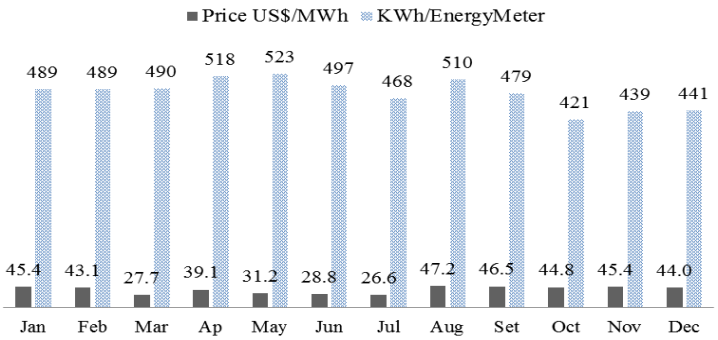


Figure 5. Average price of energy and consumption per energy meter in 2015

The general management reports long-term stability in labour relations. An exception occurred in 1982 when a labour strike of 45 days resulted from a financial crisis in the cooperative due to high exchange rate variation (Costa Rican Colons vs US$), which caused employees (around 50 people) to fear losing their jobs. Nevertheless, the union negotiated new working conditions with a new management board appointed by the national government. Consequently, after 1.5 years the cooperative recovered financially. Now the cooperative employs over 400 workers from neighbouring communities across the distribution, generation and telecomm businesses.

3.6. System and Project Sustainability

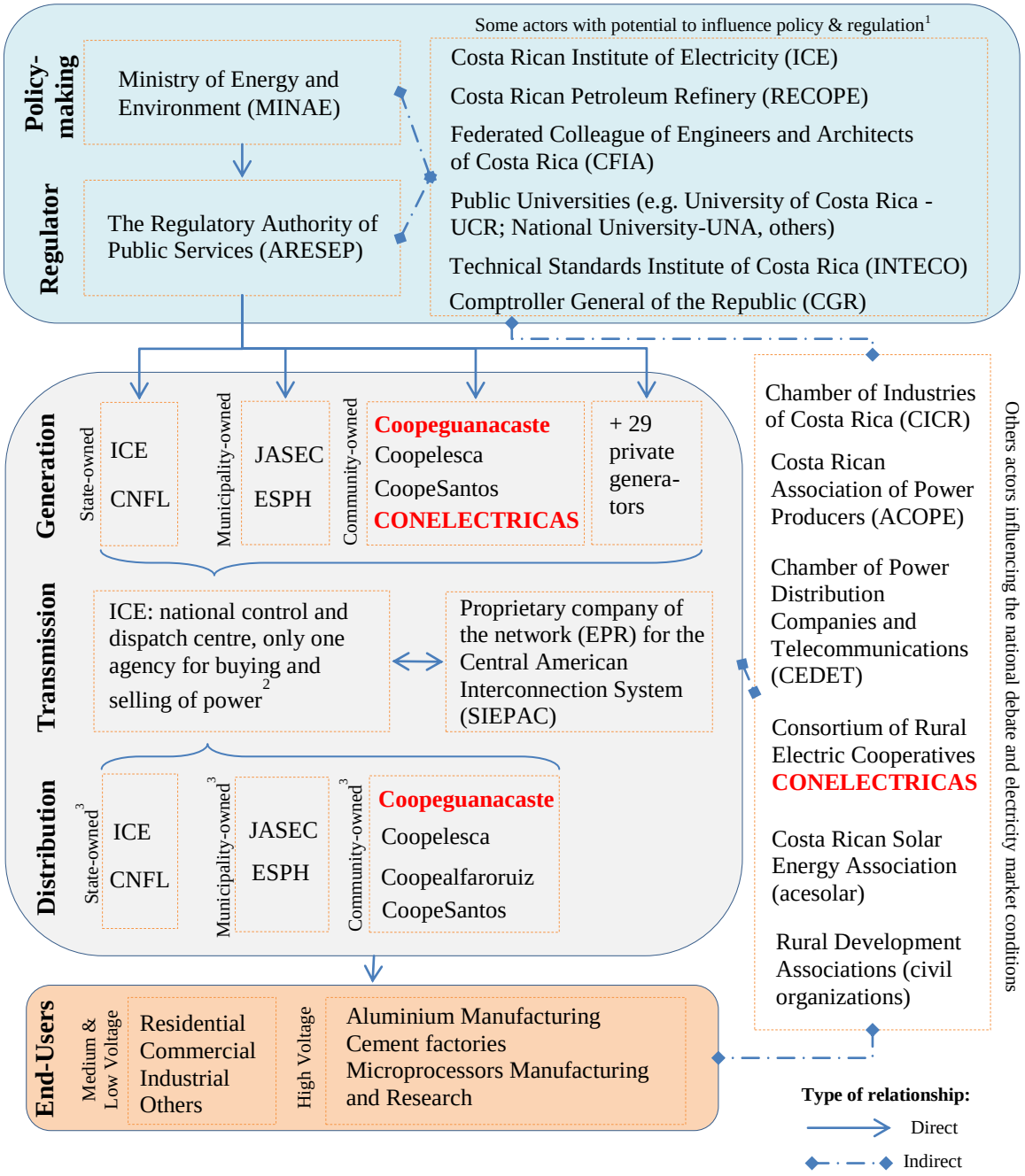
The social PV program uses a range of strategies for keeping it sustainable as a social service; including putting aside budgets for O&M and recycling used components. These measures have been effective for nearly 20 years; see **Figure 3** for more details.

However, the now high level of energy access within the concession area (99.7%) discourages efforts to maintain this program. Unfortunately, the operation of the current 112 PV solar home systems seems to depend on the life span of available components and no additional purchase of PV modules is foreseen in the coming years.

Therefore, areas of opportunity were also found for the PV social program at Coopeguanacaste. In general, some highly recommendable actions to improve the technical design capabilities and project planning for future PV programs may include:

- To access additional training for technicians and engineers on the current status of PV technology and components. Aspects such as: updated costs, technological options, techniques for sizing, modelling and configuration of PV systems, and performance monitoring and evaluation, should be included in the curriculum. This could be done on a yearly basis to enable technical capacity development.
- To coordinate, with international institutions, (e.g. a donor agency) and/or national institutions (e.g. a university) a social and techno-economic study identifying opportunities where the PV program could be run as a profitable commercial activity or as a social subsidised program. As a result, the investments for new programs could be reduced and the social service sustained.
- At a residential level, PV system upgrading to include AC circuits is also needed. Based on the interviews with end-users, future PV designs should consider a new load characteristic. Increasing from 3 bulb lights to 6; from 1 mobile phone charging point to 3; to include food refrigeration; and entertainment options (possibly a couple of TV screens and a radio); these loads should be included at a minimum.
- At a commercial level, detailed designs could be developed when a productive use of energy is sought. Access to micro financing can also be offered to end-users. Currently, coop members have the right to access credits for buying energy efficient electrical appliances (TVs, LED lamps, laundry machines, etc.). In the same way, financial resources could be made available to cover the initial capital for commercial systems. However, this implies that additional regulations and tariff settings are needed as, typically, new investment must be clearly understood and approved by the coop´s general assembly and managers before being implemented.
- Regarding system operation, current best practices should be followed. Having a dedicated field team for corrective O&M of the PV systems, as well as a central warehouse with new and second-hand spare parts are key elements to be included for new programs.
- Finally, to establish a decision-making process at a managerial level is vital. An evaluation of obstacles and benefits derived from the PV the program should at least be done every 1-3 years. This may allow financial, social and technical corrective measures be discussed, selected and prioritised. As a consequence, the long-term sustainability of the PV program can be continuously enhanced.

On the network side, Coopeguanacaste had renewed its concession for another 20 years. However, this does not guarantee long-term network operation. There is high political pressure to open up the electricity market in Costa Rica, see **Figure 6**. This may allow international private companies with more capital than Coopeguanacaste to sell energy in Costa Rica; or even result in loss of the concession area in favour of private interests.



Notes:

1. Other actors have been involved in particular tasks influencing local regulations, e.g. the Ministry of Economy, Industry and Commerce (MEIC) and the Fire brigade of Costa Rica during the implementation of the National Electric Code.
2. Acting as the market operator; also owns, operates and maintains the transmission lines. In addition, is the one actor in Costa Rica importing/exporting electricity thought the SIEPAC from and to neighbouring countries.
3. Acting as network operators and retailers at the same time.

Other relevant institutions in the generation and distribution sectors and rural electrification in Costa Rica are:
CNFL= Compañía Nacional de Fuerza y Luz S.A.; **ESPH**=Empresa de Servicios Públicos de Heredia, S.A.; **JASEC**= Junta Administrativa de Servicios Eléctricos de Cartago; **Coopelesca**= Cooperativa de Electrificación Rural de San Carlos R.L.; **Coopesantos**= Cooperativa de Electrificación Rural Los Santos R.L.; **Coopealfaroruiz**= Cooperativa de Electrificación Rural de Alfaro Ruiz R.L.

Figure 6. Coopeguanacaste presence in the Costa Rican Electricity Market
Source: Madriz-Vargas & Alvarado (2016), based on Zuñiga (2009)

Therefore, current strategies for network sustainability and survival of the coop are critical and include:

- Securing the stability and reliability of the network, to meet regulations and policies from the ARESEP and the ICE, and via implementing energy efficiency measures, e.g. swapping sodium-vapour lamps for LED, changing electrometrical energy meters for smart digital ones, and integration of storage technologies at a MW level in the near future.
- Enhancing engagement with the community by increasing the impact of social services, e.g. scholarships for high school students (US$27/Month), donations and credits to low-income families for medical equipment, medicines, etc.
- Increasing environmental investments for mitigating impact on the ecosystem, for instance, running a reforestation program of 25,000 trees in 5 years, and installing over 500 bridges and semi-isolated cable for wildlife protection from electric lines in areas with high sighting, e.g. of squirrels, monkeys, anteaters, etc.
- Being independent from the transmission company by increasing generation capacity. Today, mini hydro plants produce nearly one third of the total energy demand, hence the electricity purchased by Coopeguanacaste from the ICE is gradually being reduced. Further, there are new renewable energy projects currently under development seeking energy autonomy in Coopeguanacaste, including: 3 PV power plants (5.9MW+6.6MW+0.5MW), 2 wind farms (9MW+20MW) and a bioenergy gasification plant (9MW) using municipal wastes from surrounding communities.
- Diversification of complementary businesses is another critical element, seeking financial strength for supporting new investments and sustaining social and environmental programs, see more details in **Section 2**.

4. Discussion and conclusion

Electrification via rural electric cooperatives has proven to be a suitable long term solution in Costa Rica (ESMAP, 2005, Barnes, 2011). Rural electrification in the Nicoya Peninsula has had two main phases.

Firstly, with the creation of Coopeguanacaste, in which energy supply using municipal and privately owned diesel minigrids were replaced by grid extension in mid and late 1960s. The national grid was powered mainly by hydro plants, thus providing socio-environmental benefits to the Guanacaste region in both reducing energy costs and carbon emissions, as well as in enabling higher electrification rates.

Secondly, implementing PV stand-alone systems in mid 1990s as a social program allowed almost 100% energy access fostering social inclusion and enabling basic community services provision for families in poverty and isolation in Guanacaste.

Drawing from the community energy research field, we used six capability areas to present this case study. In summary, some of the aspects vital to the success of the Coopeguanacaste case are:

1. Community governance: 50 years of long lasting social structures support local organization and decision making. In addition, 25 years working together with other rural electric coops in Costa Rica have enabled a platform for additional revenue collection, knowledge transfer, and energy dispatch between cooperatives.
2. Capacity building and engagement: Training for capacity building and development has been assisted by international and national institutions from the outset. Community engagement has progressed from informative and consultative to an active interaction including new generations (children and youth), which has increased significantly the levels of engagement with locals and coop employees in recent years.

3. Ownership structures: Legal ownership of assets has remained within the community to date in the areas of distribution, generation and recently telecommunications.
4. Technical design: The distribution management has reached a high level of maturity in designing, budgeting and building electric lines. In contrast, there are opportunities to develop technical and operational capabilities in the renewable energy generation business, as these projects (mini hydro, PV, Wind and Bioenergy) have been designed and implemented by non-community members.
5. Operation, maintenance and management: Social stability, no military conflicts and a stable and growing economy in Costa Rica have enabled adequate conditions for operation over time. In the generation area, a Built-Lend-Transfer model was strategically adopted for the renewable energy power plants, allowing Coopeguanacaste to focus efforts on its core distribution business today, and has provided time to acquire new operational capabilities. However, this model represents a financial burden, as paying a third party to perform the O&M tasks impact negatively on the energy costs and delays operational capability building for Coopeguanacaste.
6. Measures for system and project sustainability: future operation of the social PV program was found to be at risk as today this service is considered by most managers as a financial burden for Coopeguanacaste. From the network side, Coopeguanacaste have active participation in the national electricity market debate, which provides visibility of potential political and market risks, and more significantly provides the opportunity to represent and defend community interests at a political level; see additional measures supporting long-term sustainability of the Social PV program and the distribution business in ***section 3.6***.

Preliminary findings indicate that Coopeguanacaste has several elements which support its sustainability over the next 20 years of concession. Social, financial, environmental and organizational dimensions are altogether perceived as strengths by managers and stakeholders. In contrast, there is evidence of a high level of dependency on outsiders regarding the technical know-how, in particular in the renewable energy generation business.

Further, the political dimension around the Costa Rican electricity market seems to be a critical risk for Coopeguanacaste. Market privatization and conflicting policies from the national regulator were highlighted as major threats during the interviews with coop leaders. This situation has posed significant concerns for the administration board and managers. Despite that, Coopeguanacaste aims to become the first smart grid in Costa Rica; and current high levels of customer satisfaction and engagement by employees and locals can offset external potential risks.

This study set out to understand the main aspects driving Coopeguanacaste's success as well as the challenges and future opportunities for rural electrification in the Nicoya Peninsula, Guanacaste province, Republic of Costa Rica. We hope that the framework used and case findings allow comparative analysis with other community-based energy initiatives in developing regions, including Latin America and the Caribbean, sub-Saharan Africa and the Asia-Pacific.

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