Opportunities and Challenges for the Integration of Solar Energy in Latin American Communities

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***Abstract*—This memory provides the discussion around of solar energy applications to community scale in Latin American. The information provided was collected in the plenary session held at the IEEE Concapan (by the acronym in Spanish of IEEE Congreso de Centro América y Panamá), held in San José, Costa Rica, in November 2016.**

***Index Terms*—solar energy, community, Latin America, opportunities, challenges.**

I. Introduction

As demand for energy increases, many countries are seeking ways to meet this demand with clean, safe, resilient, and reliable energy systems based on renewable sources. One way to face the challenge of supply the growing demand for energy is through the use of solar energy at community level. This option has received much attention in recent years due to their ability to be integrated through both large energy systems, as smaller scale systems. In this session plenary, we focus on the use of solar energy solutions at community level.

There is a substantial need to accelerate the advancement and implementation of innovative clean technologies based on solar energy to solve the challenges of the energy demand, climate change, and sustainable processes. In this sense, one of the main problem of promote energy solar solutions of community scale is to ensure the sustainability of the initiatives. Many energy projects in rural areas around the world have presented technical problems reducing the expected benefits. For example, The World Bank, one of the most important supporters of rural electrification projects, has identified that some cases with little or no community involvement, can suffer from several problems soon after installation due to a lack of local capabilities and proper maintenance procedures. Thus, the community participation has been recognized as a powerful tool for the project sustainability.

In communities, people are seeking alternatives to conventional energy sources. Whether they aim to increase energy independence, hedge against rising fuel costs, cut carbon emissions, provide local jobs or develop productive activities. These community energy projects are a growing around the world. People are adopting sustainable energy technology, such as energy solar, together with group work strategies, in contrast to traditional individualistic adoption. The energy solar that reaches the Earth can be converted into other forms of energy, such as heat and electricity, and be used to: lighting, food cooking, refrigeration, water purification, pumping, different production processes, and more.

The above becomes a paradigm shift, being the community that produces part (or all) of the energy needed for their different activities. The idea of energy production and consumption at the community level leads to energy production systems radically different from the standard: small scale, locally appropriate, environmentally and socially benign, centered in benefits to the community and not only to investors. However, the adoption of new technologies in the communities, is necessarily a social and cultural transformation that implies adaptation to a new context, in this case the introduction of solar energy technologies. This process is co-created by the interaction between the intervened and interveners. Finally, a sustainable technology project should be aimed to preserve basic functions of the communal system, while limiting evolution of unsustainable practices.

Efforts to define, promote, categorize, intervene, and assess the energy solar projects in communities are necessary but must incorporate multi-criteria approaches, that recognize the diverse issues involved. In this plenary session, a variety of topics are presented. The first presentation shows the challenge of integrating solar energy at a residential level from a technological point of view. The second presentation performs an analysis from the regulatory perspective. Next, the third presentation presents the case of an application in an agricultural community. Finally, the last presentation shows the case of applications at the community level.

II. Chair and Speakers Biographies

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III. Summary of Presentations

Impact of rooftop PV systems in large scale distribution networks: A case study

Gustavo Valverde, *Member, IEEE*

Rooftop Photovoltaic (PV) systems at Low Voltage (LV) levels is one of the most popular Distributed Generation (DG) technologies around the world. In the last five years, Costa Rican power utilities have also experienced an increasing adoption of PV systems for self-generation. This has brought new technical questions to be answered: what is the hosting capacity of local distribution networks? Where, when and how many problems are expected to occur due to massive penetration of rooftop PV systems? This surely calls for simulation-based impact studied. Although these utilities can set up scenarios with different penetration levels, they will not be able to foresee the location of problems in the grid without a proper criterion to estimate the future PV locations. This is crucial considering that the impacts depend on the size and location of the PV systems in the network.

This presentation reports on a methodology to realistically assess the impact of rooftop PV systems in distribution networks. More specifically, it presents a case study in a suburban Costa Rican circuit of CNFL (by the acronym in Spanish of *Compañía Nacional de Fuerza y Luz*), one of the largest power utilities in the country. The proposed PV allocation assigns a PV capacity and probability of installation to each customer based on a socio-economic study. The study makes use of Geographical Information Systems (GIS) to model the network in detail, including thousands of residential and commercial customers. The simulation results show that the proposed methodology can capture the effects of clusters of customers with high probability of installing PV systems.

Finally, the modeling requirements of the study opened new opportunities to develop sophisticated tools to integrate GIS and power system software. This presentation will also report on new simulations tools that will help local power utilities to carry out detailed impact studies in open source and free software.

Solar distributed generation in Costa Rica: A regulatory analysis

Natalia Alvarado

Until April 2016, regulation came into force DECREE-39220, containing a contract between generators and interested parties to install their own systems. The distribution companies have tariff methodologies, procedures, requirements, deadlines and technical conditions according to the regulations issued by MINAE -Ministry of Environment and Energy and the operating and tariff regulations of the ARESEP- Public Services Regulatory Authority. This stage is considered as a reopening of the solar energy sector in Costa Rica within the framework of distributed generation for self-consumption in which it does not include the sale of energy.

The system must be designed according to a consumption profile of the interested party and the system cost is usually calculated per unit price, normally measured in dollars per installed watt ($/W). Equal power projects should be compared, for example, a small residential project can cost approximately $ 2.2/W, but an industrial project can cost $ 1.4/W.

Challenges for Distributed Generation in Costa Rica:

- There is opposition to Article 34 of DE-39220, because it implies a non-technical limitation to the withdrawal of energy from the network for the producer-consumers.
- A law is needed for distributed generation for self-consumption.
- The equipment FV for solar projects have the exemption of taxes, however the updating of the lists of equipment is necessary, is anticipated for the year 2017.
- Incentives for the promotion of solar energy in general are important.
- The use of renewable energy means a change in the way in in which we have historically understood the generation and regulation of electricity in Costa Rica.

The supply of electrical energy for an irrigation system through solar PV panels

Rosa Mejia, *Member, IEEE*

The city of El Progreso is a village with limited economic resources, located south of El Salvador, where its main economic activity is the cultivation of vegetables. The community is composed of approximately 25 families. When winter has erratic rainfall, farmers can suffer crop losses due to lack of water for irrigation. In some years, losses have reached almost 60% of their crops. This has produced a low economic income in the residents of the city. In order to reduce the impact of the lack of water for irrigation, the municipality proposed to develop a system of irrigation by means of water pumps. With the objective of provide electrical power through a PV system on grid connected mode was also proposed. The idea was design, construct and maintenance the power supply of electric of the pumping system for irrigation of vegetables.

A model of Buy-Sell of energy for the payment of electricity consumption of the water pumps through the sale of energy was initially analyzed. However, the families of the community of El Progreso do not have sufficient economic income for the payment of electric energy consumed. Thus, by means of international cooperation the donation of a completed irrigation system was achieved. The surplus of electricity generated it is exported to the main grid and additional economic resources are received. When the community water pump system requires more energy than the produced with its PV system, power is taken from the main grid. In this case, a model of net balance or net measurement is used, enabling to the community become in generators of electricity by means of a non-conventional renewable energy (ERNC) system.

In conclusion, using the electricity generated by a renewable system it is possible to meet the energy needs of a community. This reduces the monthly bill, and promotes its development.

Co-construction method to develop community solar energy solutions: The Ayllu Solar Project

Marcia Montedonico

The introduction of new energy technologies in communities is a challenge, since it generates changes in patters of energy use that affect the demand of the system. Adoption and adaptation to these new technologies will depend on the characteristics of each community, but it can be enhanced when participation shapes the evolution of the technological intervention. In this work, we focus on presenting the experience gained in the development of energy projects based on solar energy at community level in Northern Chile.

The approach is based in a community involvement method called co-construction. This methodological plays a key role in the whole project execution; this is because all the reference projects rely on it. The methodology involves the following main steps: participatory diagnosis and team building; socio-technical system design and sustainability plan; implementation and first impression; operation, evaluation and dissemination. The experience clearly has shown that a more proactive mindset is needed for face the new paradigms in the energy supply.

SERC is developing the Ayllu[1] Solar Project in urban and rural communities of Arica and Parinacota Region with the co-construction method. The project's overall objective is to create human capital to foster sustainable development in urban and rural communities. The implementation of solutions involves concrete solar energy projects that will be carried out in the following main areas: reference projects, project calls, and other pilot projects. On the other hand, human capital development activities will be performed for general public, schools, technical education, and higher education institutions. Activities related to sustainability, coordination, and institutional development are supported by the communication and promotion plan of the project.

The following summarizes some aspects of learning that the project has reached:

- The information given to the participants should be accurate, clear, timely and transparent.
- The constitution of the work team (technical + community) must have clear "rules".
- Facilitators should be able to generate positive group dynamics, conditions of trust, promoting participation and reflection.
- It is recommended to use boundary objects to facilitate dialogue between actors (e.g. participatory mapping, maps).
- It is necessary to design and adapt the process and techniques of participation to the specific context of the project.

[1] Ayllu: means “community” in native language Aymara and Quechua

- Avoid using participation to legitimize decisions already made; rather, participation should only take place when there is a possibility that it may influence the decision-making process.
- The co-construction process requires periodic, constructive and transparent evaluation.

IV. Conclusion and Future Works

This memory presents different topics about the opportunities and challenges for the integration of solar energy in Latin American at community level. The presentations showed the need to deepen this topic, in order to improve and expand initiatives around the use of energy solar in communities to promote their sustainability.

As future works, a cooperation network is envisioned based on the IEEE activities at Latin America level. In this plenary session was presented a draft version of a web based cooperation platform (www.comunidadsolar.cl, http://comunidadsolar.centroenergia.cl/).

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