Rexel foundation
FOR A BETTER ENERGY FUTURE

Microsol

Study of the potential to spread energy efficiency's carbon programs in Andean countries

Executive Summary

Paris, February 2014

Executive summary

This report provides an analysis of the potential to spread energy efficiency's carbon programs in Latin America, focusing on 5 Andean countries (Colombia, Ecuador, Peru, Bolivia and Chile) and two main issues: access to **electricity** and **lighting** for poor people. The study was led by Microsol and funded by the Rexel Foundation, from June 2013 to May 2014. Methods of investigation include: (i) and (ii) an analysis of projects' potential (needs of the population, available technologies, projects' success criteria), (iii) a carbon analysis (eligibility criteria, assessment of the economic interest for projects to enter the carbon market) and (iv) a feasibility assessment related to the carbon market for electricity and lighting projects, (v) with recommendations on the different options. The results of this study are based on interviews of key actors in the five countries considered (175 people interviewed from 97 institutions), field visits of ten renewable energy projects and literature review. The recommendations are made on basis of Microsol's experience and anticipations.

Limitations

The analysis conducted has limitations, including differences in statistics according to the sources. The statistics presented here are the most recent and from sources that were considered as the most reliable. For international comparisons, we used as much as possible data from international statistics agency such as ECLAC. In addition, there is no clear definition of what "access to electricity" means. For example, in Colchane (Chile), close to the Bolivian border, the city is considered as electrified even if people have only 3 hours a day of light.

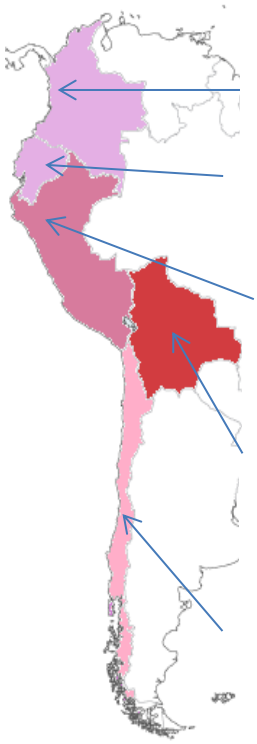
Electricity and lighting context in the Andean countries

Although the area of the study is large and extremely diverse, it can be divided into three very different areas, relatively homogeneous in terms of culture and climate: the Highlands, the Coast and the Amazon rainforest. The cultural and productive activities of these three areas are various, impacting needs for energy. Nonetheless, all the off-grid households share the same basic use of electricity: **the most widespread uses of electricity for households are lighting, radio** (for local news, music and communication) **and charging cellphones**. For health centers, electricity is necessary for many activities, including to **store vaccines and to perform activities by night** (childbirth for example). For education, electricity is necessary to use **modern pedagogical tools** (computers, videos, etc.) and to **fight the technological gap** between urban and rural children.

To perform these activities, candles, kerosene and diesel lamps (also called wick lamps) as well as non-rechargeable batteries are the most frequent solutions. Small businesses sometimes use more expensive solutions such as a diesel generator or car batteries.

This lack of efficient electricity and lighting access is limiting development, preventing improvements in education, health, security and economic situation at households´ and communities´ level. The environment is also impacted at an international level through greenhouse gas emissions, which increase global warming.

6.1 million rural people in the five countries are in this situation, lacking proper electricity access, although with great variations between the five countries.



COLOMBIA
13 % of rural households without electricity (1,5 million rural people)
46% of people are poor in rural areas

ECUADOR
10 % of rural households without electricity (0,5 million rural people)
39% of people are poor in rural areas

PERU
36 % of rural households without electricity (2,4 million rural people)
50% of people are poor in rural areas

BOLIVIA
42 % of rural households without electricity (1,6 million rural people)
55% of people are poor in rural areas

CHILE
6 % of rural households without electricity (0,1 million rural people)
9% of people are poor in rural areas

Bolivia has by far the lowest rural electricity rate even if it is in Peru that the absolute number of rural people without electricity access is the highest, followed by Bolivia and closely by Colombia. Chile almost completed its rural electrification process.

Efficient electricity and lighting solutions

Relevance of decentralized electricity and lighting systems in the Andean countries

Even if grid extension and grid densification are the governments' preferred options for electrification, they are sometimes not suitable in rural areas. Decentralized electricity generation solutions such as renewable energy solutions can be relevant for electricity and lighting if they are cost-competitive (compared to grid extension), technically and legally feasible, with the following remarks:

1. Andean countries have a **very low population density** compared to the rest of the world, reducing the relevance of the extension of national grid in remote areas. Nevertheless, the situation is far from being homogeneous, with Bolivia having less than 10 inhabitants/km^2 and Ecuador, more than 60 inhabitants/km^2 (as a comparison, France's density of population reaches almost 100 inhabitants/km^2).

2. **House dispersion is high** in the five countries since the communities needing electrification are usually the smallest ones. Farming activities is one of the reasons of the extreme dispersion of houses.

3. **Non-electrified communities are difficult to access** in the five countries, because they are usually located in the jungle or in the highlands, with only a few or no roads at all.

4. **The government willingness** to pay for grid extension is very different in the five countries, impacting the interest in renewable energy based systems. For example, in Bolivia, the government is willing to pay 950€ for grid extension per household, while Chile can invest up to 13,800€.

5. **Lighting needs** are a special case: apart from lighting houses, farmers frequently need a moveable lighting solution to be able to work in the fields outside of daylight hours.

Choosing the right technology

Choosing the right renewable energy solution depends on the availability of natural resources, cultural habits, costs, needs and the distribution system (energy hubs, mini-grids, individual systems). This study focused on five technologies: solar panels, micro hydro turbines, biodigesters for electricity generation, wind turbines and

stand-alone lighting devices, with the following remarks:

1. **Biodigesters** for electricity generation are not suitable for a single family (too expensive) and there are very few biodigesters for electricity generation at a community level because of the deficiency of organic inputs.

2. When houses are close to each other and when water is available all year long, **hydro** tends to be the cheapest technology. Nonetheless, these two specific conditions make it difficult to implement micro hydro at a large scale.

3. **Wind turbines** are not used a lot in the Andean countries. Limitations include lack of detailed wind maps.

4. **Solar** works almost in every region of Andean countries thanks to high solar radiations. It is by far the most frequent solution for off-grid rural electrification, despite of its higher costs.

5. In Latin America, only **solar lanterns** are currently used as lighting stand-alone devices.

Creating a successful energy project

After more than a decade of renewable energy projects for rural electrification, technologies are well known and technical failures are relatively limited. The greatest challenges for renewable energy projects, is the necessity to foster a sense of **ownership and care** by end-users and stakeholders during the five stages of the project: (i) the project's design should allow the creation of (ii) a proper management model, which will define (iii) the implementation process, (iv) operations and (v) long-term sustainability.

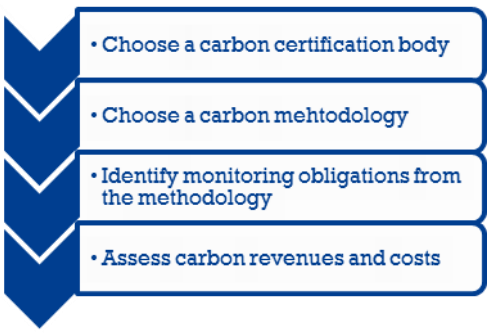
During the project design, it is important to create the conditions for **project's ownership**, through a close identification of needs, the participation of end-users and the implication of stakeholders in the whole decision-making process.

The **management model** should be agreed during the project design: it should define who is responsible for the installations, service and maintenance, and how the costs are covered.

Many management models already exist, ranging from totally private initiatives, to philanthropic models where the beneficiaries do not cover any costs, including cooperative management systems, through community electricity committees, etc. The choice of the managing model depends on the actors' willingness to pay, the organization of the community, the stakeholders' implication…

As a third step, users and stakeholders participation during the project implementation is necessary for their good acceptance of both the project and their own responsibility in it.

To guarantee the sustainability of the project, installations should be used in a proper way. The **training of end-users** is of the utmost importance: the training should be understandable and adapted, at a collective and individual level; instructions for use should be explained several times to several members of the households. If possible, **local technicians** should be trained, especially if the community is very remote. For solar projects for example, the most common problems lie in the battery use: the lack of distillated water, its overuse, or its misuse for cars, reduce its lifespan.



Even if the projects are successful in the short term, the long-term success is not guaranteed: funds are often lacking for **follow-up visits** or to deal with **recycling issues**.

The third section of the report studies the relevance of carbon markets to address the issues renewable and lighting projects are facing.

Carbon markets

Carbon markets allow a **continuous improvement**, **impacts certification** and **long-term financial support** for projects that reduce the emissions of greenhouse gases.

There are two main mechanisms for the carbon market:

- the **compliance market**, linked to the Kyoto protocol and legal obligations to reduce emissions,
- the **voluntary carbon market**

Microsol works primarily with the voluntary market: not only the market entrance process is shorter (about 2 years) but it is also possible to generate more financial resources in the voluntary market than in the compliance market, due to carbon credits´ flexible prices in the first one.

The calculation of carbon emissions' reduction is based on a methodology, created by a carbon certification body (the United Nations (UNFCCC) or other certification standards like the Gold Standard, Verified Carbon Standard, etc). The carbon revenues depend on the reduction of emissions and on the price of carbon credits while the carbon costs will depend on the monitoring requirements. Carbon monitoring is different if the installations are connected through a mini-grid (several households are connected to one electricity generator) or if installations are disseminated (for example, each household has its own solar panel or its own wind turbine).

Carbon methodologies for lighting and electricity projects

This study focused on two carbon methodologies:

- For renewable energy projects: the Gold Standard methodology, "Micro-scale electrification and energization"

- For lighting: UNFCCC, AMS-III.AR, "Substituting fuel based lighting with LED/CFL lighting systems"

The following remarks can be observed:

For renewable energy:

	5,000 households	**10,000 households**
Potential carbon revenues	*In the case of mini-grids:* 12 to 70 kUSD per year *In the case of disseminated devices:* 5 to 20 kUSD per year	*In the case of mini-grids:* 24 to 100 kUSD per year *In the case of disseminated devices:* 10 to 40 kUSD per year

Projects of electricity generation through renewable energy may not be easy to implement on the carbon market. They require a lot of work throughout the crediting period, which will depend on the technology and the type of installation. However, it may be worth it for the project developer to enter the carbon market, if the size of the project is big enough.

For lighting:

Potential carbon revenues	**10,000 lamps**	**50,000 lamps**
	60-120 kUSD	300-600 kUSD

Projects of solar lighting devices distribution appear to be quite easy to set in place through the carbon market. In addition, solar lamps are relatively cheap (USD 15 – USD 80). Monitoring requirements and eligibility criteria are not very stringent. However, carbon revenues are not very high and a consistent amount of lanterns seems required to achieve profitability.

Carbon market opportunities in Andean countries

The carbon market can be a relevant option if two conditions are met:

- Carbon mechanisms must have been considered during the Project's design step and must be necessary to increase the emissions' reduction. This is the "additionality" or "previous consideration" criterion.

- The benefits from the carbon credits sales must be higher than the costs linked to the carbon market certification.

The amount of claimable carbon credits depends on the **size of the project** and on the **efficiency** of the installations (for example, if a solar lantern is not working anymore, or if it is not used by the family, it will not generate any emission reduction).

We evaluated the minimum project size to reach the break-even point after 8 years on the carbon market. In other words, we calculated what the minimum size of a project is so that, after 8 years on the carbon market, costs are equal to revenues:

- 9,000 – 14,000 families electrified with **disseminated** renewable energy installations, considering a total installed power of 1,150 kW (except for energy resulting from biodigesters[1]).
- 8,000 – 12,000 **very poor families**[2] electrified with **mini-grid** renewable energy installations (except biodigesters) with a daily consumption of 500 Wh, or 2,000-3,000 families with a slightly better living conditions (2kWh/day).
- 900 – 1,300 schools electrified with **mini-grid** renewable energy installations (except biodigesters).
- 1,200 – 1,800 health centers electrified with **mini-grid** renewable energy installations (except biodigesters).
- 13,000 – 19,000 lanterns (a family can own several lanterns).

The next section provides recommendations on the minimum amount of installations that would be necessary to generate enough benefits with the carbon market.

Conclusions on the relevance of carbon market for projects set up in the 5 Andean countries

1. While Chile, Peru and Colombia promote both the voluntary and the compliance carbon markets, Bolivia and Ecuador have an intermediate position. In Ecuador, the compliance market is well developed but there is only one project registered on the voluntary carbon market. As far as Bolivia is concerned, there is no compliance market and a few projects on the voluntary carbon

1 Another methodology should be used to calculate biodigester´ s emissions reduction: this study does not detail such methodology because of the lack of projects dealing with biodigesters for electricity generation in the Andean countries.

2 Situation of very poor beneficiaries who own the bare minimum (they may own lamps, and radios for example, but nor fans neither fridges).

market. The position of the Mother Earth Office, responsible for the official position of the Bolivian government on carbon markets, is still unclear on this issue but might evolve in 2014.

2. All the Andean countries have currently renewable energies projects, but only a few projects match the carbon market requirements, especially the size criterion.

3. Apart from Chile where the electrification rate is very high, all the Andean countries aim to reach a universal (or almost universal) access to electricity within 15 years, which should result in the development of consistent solar projects in rural areas carried on by the national governments. At this stage, Ecuador and Colombia are developing solar pilot projects in order to replicate them by 2016. Bolivia and Peru benefit from a greater previous experience regarding isolated solar panels implementation.

4. Independent lighting solutions are only considered by government programs in Bolivia. In Peru, the private sector is getting organized with the support of the Endev program (coordinated by GIZ, German cooperation) to spread this technology.

Eligible projects in the short term

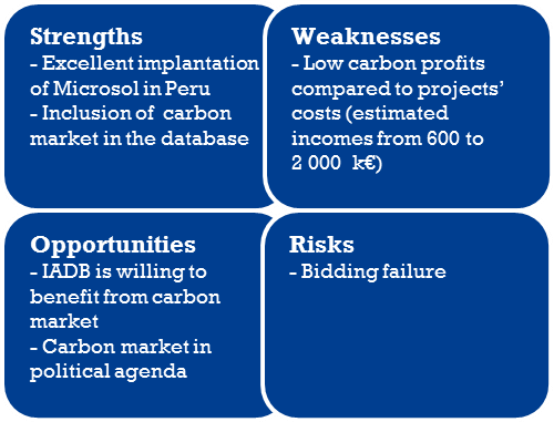
Two projects in the Andean regions could benefit from carbon credits:

1. In September 2013, the Peruvian Energy Ministry published an invitation to **tender to electrify up to 410,000 households, 7,530 health centers and 2,100 schools** through **solar panels**. Up to 3 companies can win the tender; each of them would be responsible for one region (Northern, Center or Southern Peru).

The tender is supervised by Osinergmin, the country's supervisory agency for investments in energy and mining, with consultancy from the InterAmerican Development Bank (IADB). The bidding results will be published on September 12th, 2014.

For this project, there should be no problems with the previous consideration of carbon market criteria since it is included in the project database: all the bidders are likely to include carbon consideration within their project. In addition, carbon market is a hot topic in Peru since the 20th conference on climate change (Conference of Parties – COP) will be held in Lima in November 2014. But there is a risk that this ambitious bidding fails.

The graph below summarizes Microsol´s analysis regarding the relevance of integrating this project on carbon market:



2. In Bolivia, the **InterAmerican Development Bank is funding a solar lantern project** (Phocos model, 80$), which will be implemented by the NGO Energética. **10,000 lamps** should be distributed in a first step, and **5,000** more it the test is successful.

The project will be implemented in the second semester of 2014, for 5 years.

This project is big enough to generate revenues that offset the costs associated to carbon market integration. Nevertheless, the net profits are limited: it could be a good

opportunity if the solar lanterns market increase in Bolivia which is likely to happen since many actors promote this technology. In addition, key actors such as Energética are already familiar with carbon market process and the methodology for solar lanterns is relatively easy to implement. Nevertheless, before integrating this project on carbon markets, it would be first necessary to get the government support regarding carbon market relevance for the national political orientations.

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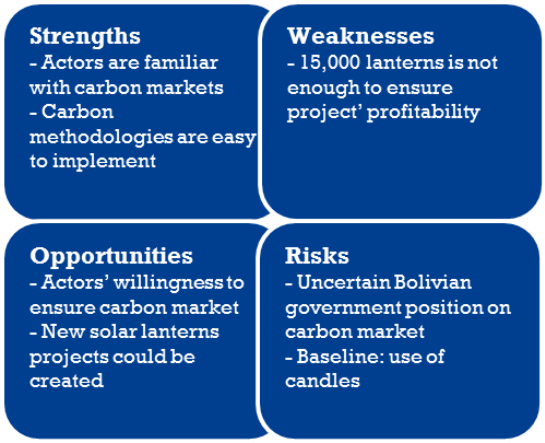

Conclusions and recommendations

Cost-benefits analysis: find the equilibrium between scale and economic viability

Microsol produced a cost-benefit analysis of renewable electrification and lighting in order to find the equilibrium between scale and economic viability on the carbon market.

All economical analysis are based on :

- Conservative assumptions in terms of price (10 USD / issued carbon credit);
- The standard business model of Microsol regarding division of responsibilities :
  - **The LPP (Local Project Participant)**: the owner of the project that is considered for inclusion within the carbon scheme. He is in charge of installation of units, sustainability activities, and his own monitoring.
  - **The CME (Carbon Managing Entity)**: the owner and manager of the carbon scheme. He is in charge of all carbon-related activities except the LPP monitoring.
- The standard business model of Microsol regarding revenues collection:
  - 70% for the Local Project Participant
  - 30% for the Carbon Managing Entity

Microsol analysed cost-benefits to certify (i) lighting and (ii) renewable energy projects on the carbon market.

(i) The calculations are based on a 15,000 solar lamps project such as the one in Bolivia:

There is no carbon certification modality that would reasonably allow a 15,000 units lighting program to certify its impacts on the carbon market. Volumes must be much higher than the best opportunities identified in the Andean region to be interesting for inclusion in the carbon market. Alternatively, prices of carbon credits in the international market for such projects would need to be much higher.

(ii) The calculations are based on a 410,000 households solar pannels project, divided into clusters of 50,000 households, such as the current bidding in Peru:

A multi-project approach like a PoA is an average investment for the CME and would result in profits for the LPP. It is reasonable to think that joining sufficient projects to reach a breakeven point at year 5 is feasible in the Andean region: the perspective of the Peruvian bid allows us to make this assumption.

To secure a more reasonable trend, it would be probably necessary to secure higher prices for the carbon credits.

The need for an innovative approach in the valorization of access to energy services

There are two main strategies that could be implemented for improving the carbon sales assumptions:

1) Improving the final price of the social carbon credits

2) Changing the nature of the certification to certify and then value much better the social impacts than the carbon market does. The singularity of access-to-electricity and lighting projects are not in favor of carbon market certification: even if these projects have high social impacts, they do not save as much greenhouse emissions as other technologies such as clean cook stoves.

Partners:

Rexel Foundation and Microsol

Rexel Foundation for a Better Energy Future

Energy is the underpinning of our entire society. It makes possible heating, transportation, communication, industry, etc. Yet today 1.3 billion people worldwide still have no access to electricity. The **Rexel Foundation for a Better Energy Future,** under the aegis of the Fondation de France, is dedicated to promoting access to energy efficiency for all with a three-pronged approach. The aim of the first, "Knowledge," is to improve understanding and awareness of energy efficiency. The Rexel Foundation helps to interpret and inform by conducting studies and holding conferences.

Microsol, serving community projects

Microsol is a social enterprise that has been working since 2007 in Latin America to provide access to basic energy services. It allows companies to offset their carbon footprint through projects that benefit rural communities, in partnership with NGOs and development bodies. The projects are selected by Microsol for their environmental qualities – reducing greenhouse gas emissions and control of local environmental impact – but also for their strong social dimensions; Microsol favors projects that ensure progress toward poverty reduction and improvement of health and living conditions.

Microsol has developed expertise in increasing the value of these projects in the voluntary carbon offset market. Located in Mexico and Peru, it supports projects throughout the South American continent.

Its core business, building partnerships between development bodies and companies, covers all stages of a project: bringing local players together within the same program, certification of impact, the sale of impact certificates, the promotion of the actions of partner companies and support for NGOs in the field.

Study Methodology:

1. What are the needs and challenges in terms of electrification and lighting in the five countries studied?
2. What electrification and lighting solutions exist for isolated rural populations in the Andean region?
   - What are the technical solutions?
   - What theoretical, practical, financial and cultural constraints are involved in the development of these solutions?
3. In theory, can carbon mechanisms accelerate the rollout of energy-efficient solutions?
4. Is the use of carbon markets in the Andean region possible and appropriate for electrification and lighting projects using renewable energy?
5. How should these carbon mechanisms be designed to ensure better efficiency and greater financial sustainability over the long term?

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of the Fondation de France

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