Limits of Grid Extension in the Lao PDR: A Financial Perspective

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ABSTRACT: *This paper articulates a financial model for estimating the limits of grid extension in the Lao People's Democratic Republic versus three decentralised renewable energy (DRE) options: micro-hydropower, pico-hydropower and solar photovoltaic. The model is based on a comparison which determines the prices of grid extension vs decentralized renewable generation, based on how much it costs per unit of energy (kWh) generated, over the lifetime of the grid and the DRE. The amount of electricity supplied is estimated based on the forecast electricity demand of a typical rural Lao household. This is in contrast to more conventional approaches, where grid extension is compared to DRE systems of typically lower capacities (e.g. grid extension compared against 50 W solar home systems). The limits of grid extension are expressed in terms of a break-even distance, which is the maximum distance from a village at which grid extension is the more cost-effective option. Beyond this break-even distance, DRE technologies can be installed at a lower cost, while providing the same amount of electricity to the end-use*

KEYWORDS*:* RURAL ELECTRIFICATION, GRID EXTENSION, DISTRIBUTED RENEWABLE ENERGY, LAO PDR

INTRODUCTION: The Lao PDR is a small landlocked country in Southeast Asia that is considered by the United Nations to be among the least developed countries. As part of a bid to graduate to developing country status, the Lao government has set an ambitious target to provide 90% of households with electricity by 2020. Starting from a low base of around 15% in 1995, the electrification rate has improved considerably, rising to a rate of 73% in 2010 (EdL, 2011). Throughout this period, the majority of new electricity connections were made via extension of the existing grid. This was reasonably cost-effective for connecting denser population centres, but this may not continue to be the most efficient option given that a large proportion of the remaining un-electrified households are located in the remote, less dense parts of the country. Depending on the remoteness of an unelectrified village, the costs of grid extension may become less financially feasible and off-grid distributed renewable energy (DRE) sources may be a more economical option. This paper presents a financial framework for analysing grid and off-grid electricity options for unelectrified villages in the Lao PDR, with the aim of investigating the limits to grid extension. For the purposes of this paper, it is best to clarify the following:
- A micro-hydropower system is a water-based energy generation system, large enough to supply power to up to a few dozen households or an entire village, depending on their consumption.
- A pico-hydro system, is a water-based energy generation system, which only large enough to supply power to around three small households, which consume very little power. They are often used to run small water pumps and supply power for lighting in small communities.
- A pico-hydro system is usually around 5kW in size, and a micro-hydro system is usually up to 100kW.

METHODOLOGY: Obtaining the levelized cost of electricity from DRE technologies involves taking into account the capital cost, operation and maintenance costs and the cost of replacement of system components. All of these must be divided by the energy which the system is meant to be able to provide during its 20 year lifetime, to give us a cost per unit (kW) of electric power.

Obtaining the levelized cost of grid extension takes into account the long run marginal cost of electricity (LRMC), the capital cost of the grid extension and the operation and maintenance cost for the lifetime of the project. LMRC is what we get when we combine the cost of increasing a grid's power generation capacity, plus the cost of fuel and divide this by the energy which be generated from the use of the fuel in the grid's added capacity.

All of these factors are expressed in terms of what they would cost today, taking into account the expected costs throughout their expected period of usability.

BASELINE ELECTRICITY DEMAND: A major issue in comparing the option of extending the grid as opposed to generating energy with decentralized renewable energy generators, is the fact that grid energy has the ability to supply a lot more power (not taking into consideration potentially poor power quality at certain points of the grid). There is also the issue of renewable energy generation capacity varying throughout the day, if no storage system is used in the system.

POWER DEMAND CHARACTERISTICS: The two major times of the day, where the demand for power is usually at its highest, occur between 5-9AM and 6-9PM.

PITFALLS/OVERSIGHTS OF ANALYSIS: - This model assumes that there are viable renewable energy sources in the locations being analysed, even though this may not be the case.

- The model does not quantify or take into account non economic factors which may influence choosing between grid extension and a DRE option (e.g. meeting baseline power energy demand).
- The costing modelling is all assumed to be linear (the price per unit or power is kept the same regardless of demand) even though the cost of grid electricity rises as the load demand crosses certain thresholds and the cost of DRE drops per installed kW capacity.
- The annual growth rates in electricity demand are assumed to be static across the range of villages. However, the relationship between the demand for electricity (and energy in general) and economic activity is asymmetrical.

CONCLUSION: The results show that given available natural resources, the DRE options are viable, compared to grid extension. However, solar PV, is definitely too costly on a like-for-like basis and any comparison with grid extension can only be made at reduced power outputs. While this model has its limitation, it can still be helpful as a screening tool, to assist in the selection of which would be cheaper between extending the grid or installing a DRE system. It could be used in conjunction with natural resource assessments village surveys.