South America: A Case for Decentralized Energy Solutions

By Karl Reinhard Kolmsee*

Introduction

Energy in South America is often synonymous with large hydro power systems. Approximately 60% of installed electrical capacity comes from hydropower – slightly less in Chile, even more in Brazil. In all South American countries, hydropower remains the source with the greatest development potential. Existing hydropower in South America is centralized. The grid pathways which transport electricity along the 7.600 km extension from North to South are fed by few sources. South American countries differ in many ways, but from an energy management perspective, they all face an overarching challenge: how to guarantee a reliable and affordable electricity supply to a growing population and industry.

Infrastructure Costs

In the late 19th century, when electricity infrastructure was in development in Europe and the United States, the high-energy consuming industries such as steel were located close to the most relevant sources of power, such as coal mines or hydropower systems. Because rivers ensured dependable transportation of coal for power production, population and demand expanded around them. At the same time, electricity distribution was dominated by its thermal sources that required building up a system of interconnected local grids with a multitude of sources and sinks.

Hydropowers projects—the single most important source in South America's energy matrix—are inherently defined by their geographical source and not by where demand exists. On this continent, the main energy sources and the sites of major demand tend to lie great distances from one another. The large hydropower plants in the Andes and Brazilian Itapúa, required large investments in the grid infrastructure connecting the industrial centers of Lima, Santiago or Sao Paulo. Even once a grid is installed, operations remain expensive, with losses three times greater than in Europe and low reliability of technical structure. Taking a look at Brazil´s transparent pricing system which presumably reflects the cost of generation and transport, peak electricity prices for industrial clients can be more than triple the base price.

Therefore, new hydropower plants in South America are challenged not only by environmental reasoning but also an economic factor: infrastructure is expensive.

Some Arguments for Decentralized Energy

There are three main arguments for a more decentralized energy system in South America: (1) centralized systems increase the costs of the grid network, (2) the demand in South America is shifting, (3) South America has a unique potential with renewable sources. As argument one has been addressed, arguments two and three will now be explained.

Many South American countries are experiencing growth rates of above 5%. Much of this growth is coming from emerging industries and companies. An example: In Brazil the market for eggs and chicken is growing by more than 10%. Most of these producers are either entirely new or only a few years old. The largest egg producer is currently constructing the world's largest production facility in Mato Grosso – far away from the traditional centers in southern Brazil. From an energy management perspective, these economic developments require a rapidly changing electricity network. Centers of demand are relocating and expanding at a much faster rate than the infrastructure can be adapted. This increases the challenges for modern grid management.

Bio-ethanol plants and food processing plants are just two examples of growing industries that have the opportunity to use their own organic residuals for energy production. Compared with Europe, where decentralized energy generation is mainly spurred by subsidies, South America is naturally inclined towards its application because of a strong agricultural industry and unique geography.

Both arguments might convince policy makers with a long term perspective. But energy users look only at costs. This is especially true for emerging markets where the payback period is not expected to exceed three years. The main argument in favor of the centralized, hydropower-dominated electricity system is obvious: electricity prices for low voltage industrial consumers (even if not subsidized) are as low as 0.10 USD for base price power including grid costs.

* Karl Kolmsee is with Smart Utilities Solutions, GmbH, in Feldafing, Germany. He may be reached at karl.kolmsee@smart-utilities.de

Waste to Energy

Agriculture and adjoining industries account for approximately 30% of South America's GDP. Manure, bagasse, vinasse, waste from slaughterhouses or fish processing plants, are some of the major organic residual streams of these industries and can be used for generating energy.

While the level of automation in agro-industrial plants is growing, yet still varying widely by industry and country, there are four characteristics nearly all agro-industrial production processes have in common. (1) They combine the need for electricity with a strong demand for heat or steam. (2) They are volatile or seasonal with regard to energy demand. (3) Sudden energy shortages can cause high losses. (4) Treatment of residuals is expensive. One might add that many agro-industrial plants are in remote areas where levels of noise and smell do not affect neighboring populations. All four characteristics make the case for decentralized energy as they either drive the electricity price from the grid, (constant demand in peak hours) or they give some additional value (waste treatment) to decentralized energy generation.

While semi-liquid organic residuals can be used as input for anaerobic digestion in biogas plants, solid residuals can go into gasification plants or boiler houses. In all three cases there is a by-product besides the generation of gas, heat, or (using a small gas turbine or Combined Heat Power Plant - CHP) electricity. Anaerobic digestion as gasification and combustion transforms the organic waste so it can be used as fertilizer without harming the environment or endangering health.

While in the past, the treatment of organic residuals was mainly driven by projects in the scope of United Nations Clean Development Mechanism (CDM) which produced more or less successful Certified Emission Reductions (tradable CERs), recent projects show a more explicit focus on energy. Peru's largest egg producer uses its daily 150 tons of chicken manure for biogas production which makes the farm independent of propane or carbon. The residuals from the biogas plant are used directly in the irrigation system, thus reducing the need for chemical fertilizers. One of the large slaughterhouse companies in Brazil is redesigning existing CDM projects towards co-generation in order to decrease the high costs for peak electricity.

Micro Hydro Power

While waste-to-energy is attractive for many agro-industrial sites regardless of where they are; micro hydro power serves a very particular South American market. The large river systems of Amazonas in the North and the Parana-Paraguay in the South remain accessible only with difficulty; large areas of Bolivia, Brazil, Columbia, Paraguay and Peru are still without consistent electricity. Depending on legislation, the national utilities and/or, local political bodies have the mandate for electrifying these rural areas. There are two main alternatives: (1) build up large local grids fed by mid size hydropower plants, (up to 50 MW) or in some cases diesel generator systems; or (2) implement many small generators between 5 to 50 kW capacity, supplying micro-grids, or even individual sites. A third, although not a technically or economically desirable option, would be to connect these areas to the national grid.

Local grids are an interesting option wherever (a) hydropower plants can be realized, (b) a larger population with some industrial activity promises a base load demand, and (c) the area is accessible for grid construction. Each of the three premises is difficult to realize; the probability that all three factors exist is rather low. Centralized hydropower applications can seem less attractive when faced with the environmental issues associated with using the river for a local grid establishment. If these grids are to be sustained by diesel generators, the generation costs increase dramatically. As diesel has to be transported by motor vehicle or boat in the Amazonas, prices vary between 1.15 USD per L in the main centers, to up to 15 USD per L in remote areas. Average electricity from diesel generators is at 0.32- 0.42 USD per kWh.

The high prices for electricity from diesel generation also apply to small generation sets, which makes their implementation unattractive. But, there is an alternative technology based on micro hydropower plants which is currently developed in Brazil, Columbia and Peru. These micro hydropower plants are using the kinetic power or linear flow of rivers only and are, therefore, limited to 5 to 10 kW at average river flow and depth. Even if the investment per kW is close to photovoltaic, due to 95% efficiency, (8300 hours p.a.) generation costs can be reduced to 0.12 - 0.18 USD per kWh. This becomes the most competitive option.

Conclusions

South America has a case for decentralized electricity generation. Large scale, central power plants – most importantly hydropower – must remain for a stable base power supply. But under South American conditions, biomass and micro-hydropower as decentralized energy forms can economically compete against centralized forms. No form of decentralized energy will ever dominate the energy matrix, but they are complimentary in meeting the growing South American demand for reliable and affordable electricity.