

Power Assessment

1.1. Electric Power.

The availability of electric power is a key consideration for any potential industrial operation. The primary industrial site and related supplier sites will require readily available and dependable power to operate. Everything from arc welders to building air conditioning systems will depend on the availability of electric power in the area of interest and industrial site. Most of the areas in which operations will be located will not have access to a centralized power grid connection. The lack of readily available power will require a significant investment in power generation capability for all extractive efforts.

The power delivery system most often encountered within the country is single-phase 240V for residential and 3-phase 240V for commercial locations. The Team did use a Voltage Converter to condition the voltage and current to consistent 240V and 50 Hz. Use of converters and conditioners will prevent the damage of circuits and devices.

The general population primarily depends on a distributed generation system consisting of a network of small scale power generation facilities, typically less than 25MW, with local transmission and distribution. A list of all known power plants is included below in Table 1. The actual locations of the listed power plants, and their viability to generate power, remain a question for future assessments. Frequent power outages, brown outs, and surges are a fact of life throughout the country. Many businesses employ diesel generator backup to ensure reliable, on-demand power.

The local distributed generation power grid is a loosely connected system of hydroelectric generation, fossil fuel and coal plants connected primarily to local transmission and distribution systems. The largest single centralized power generation system is through a local hydroelectric plant. See Figure . The facility supplies power to most primary and secondary Urban Centers. The high voltage transmission lines appear to be in good repair where they were observed along Highway 1

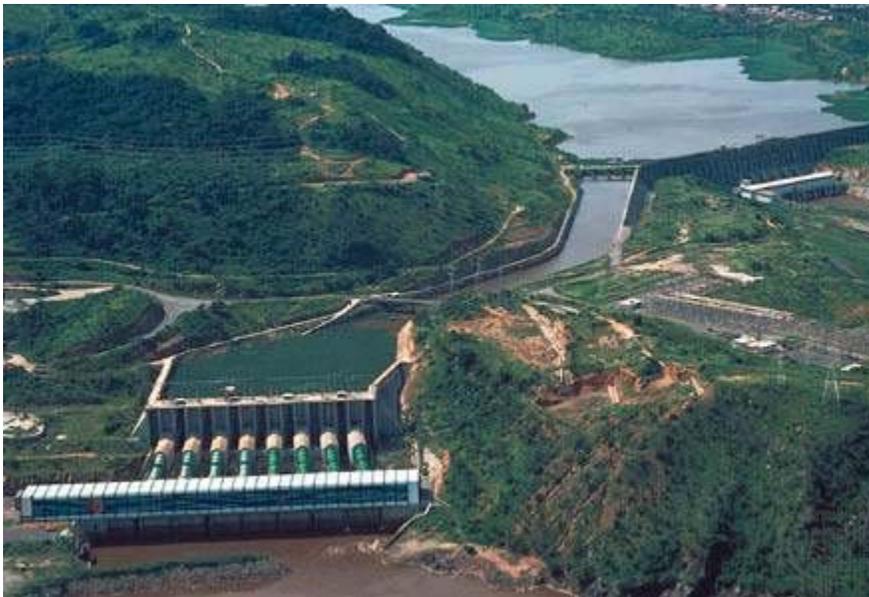


Figure 1 - Local Hydroelectric Complex

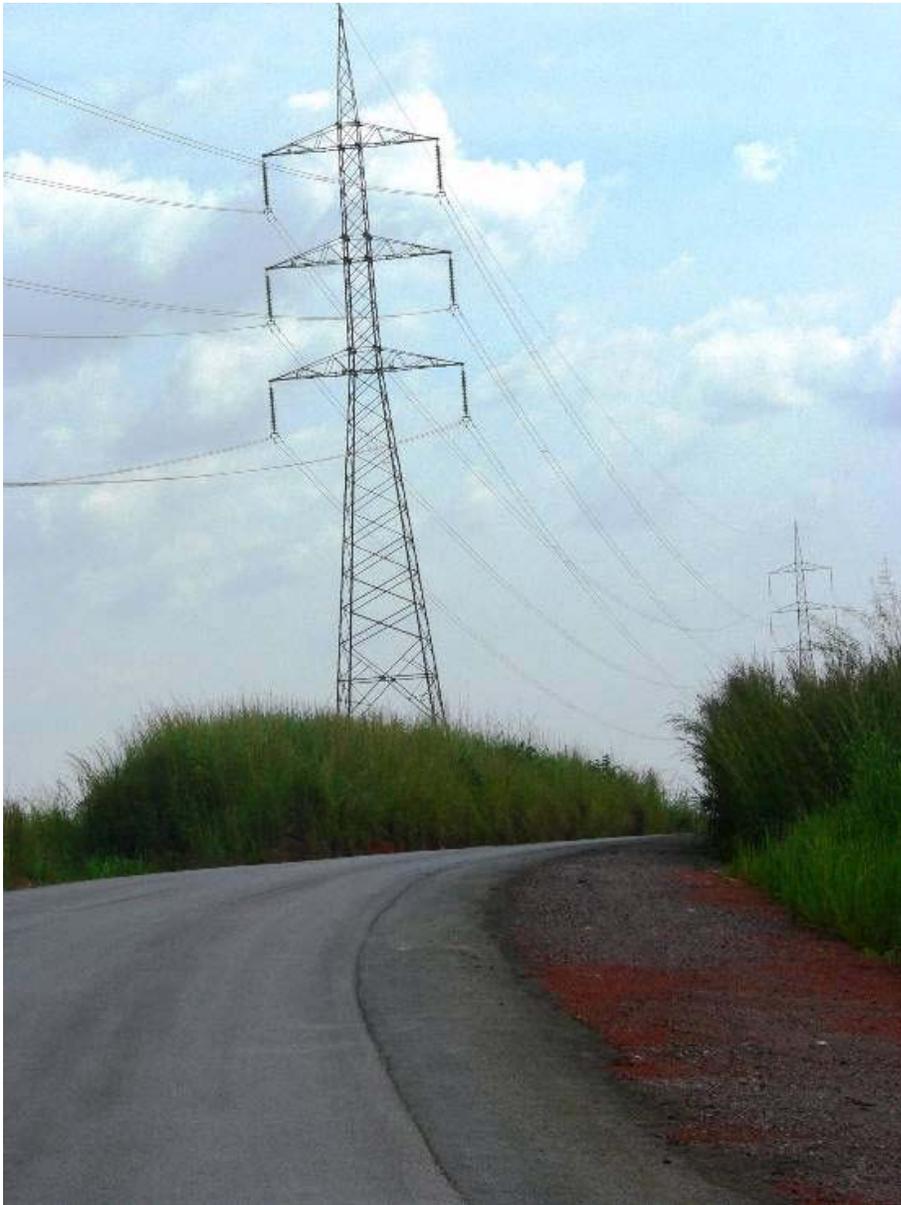


Figure 2 High voltage 3 phase lines

One of our local associates was knowledgeable of the power plants throughout the region. He indicated the only operational plants that feed the regions and Urban Center distribution grids were Plant 1 and Plant 2. Note: Both Plant 1 hydroelectric facilities are within the region, approximately 30 miles upriver from Urban Center 2. The Plant 1 facilities are reportedly running at about 30% of capacity due to maintenance and infrastructure issues. A local company announced in February, the signing of an agreement with the local Minister of Energy to develop the Plant 2 hydroelectric site on another river with the region approximately 80 km southwest of Urban Center 1.

1.2. Hybrid Power Options.

Electric Power generation and distribution on a grid network is unavailable in the concession areas. Though power generation is possible with basic diesel a long term cost effective solution will depend on some type of solar-diesel hybrid. Solar power (panels and arrays) is a proven technology but is an expensive option basic power generation and distribution. However, the TVA Team has experience with an emerging solar technology based on the Stirling engine powered solar heating technology. This technology offers high power generation with a much smaller footprint and a considerably smaller capital investment per kilowatt hour than traditional solar power options. They offer significant improvement over existing solar systems and would be well suited for use within the country. (See Figure)

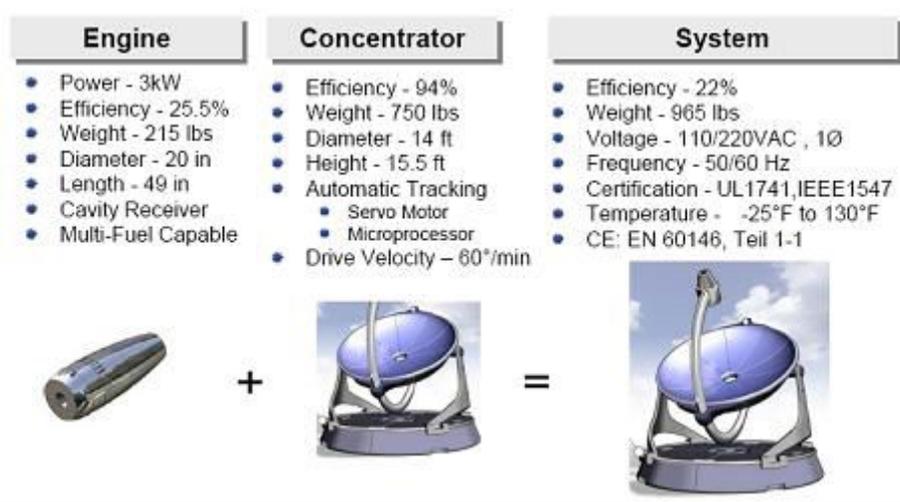


Figure 3 - Disk Stirling System

A disk Stirling system would be a suitable primary power source during daylight hours for most areas evaluated by the TVA Team. It would require a traditional diesel generator as backup. Diesel generators are found throughout the concession areas and are often tied to the "micro grids" that exist in certain areas. An expansion of the existing micro grids using the technologies mentioned above would provide an immediate feasible method of enhancing the power transmission and distribution. This concept is explored in detail in the paper by Petrie, Willis and Takahashi, Distributed Generation in Developing Countries.