

# Guri Dam: Project Management Brings Reliable Power and Growth To Remote Venezuelan Region

Commonly known as Guri Dam, the *Central Hidroeléctrica Raúl Leoni* (Raul Leoni Hydroelectric Center) is one of the largest operating hydroelectric projects in the world. It is located in the Bolívar State in Venezuela's Guayana region, and was built over a 23-year period using a phased construction concept. This design minimized the project's initial investment and matched power supply to the growth in demand on Venezuela's electrical system.

At 1,300 meters long and 162 meters high, the massive Guri Dam now supplies as much as 70 percent of Venezuela's electricity, saving the country 300,000 barrels of oil a day.

## Background

Venezuela's government recognized in the 1940s that the country's oil reserves would be fundamental to long-term economic development and stability. To free a greater proportion of the country's petroleum for sale and export, the Venezuelan government made the bold move to transition from hydrocarbon- to hydroelectric-generated power as the country's primary electricity source.

An international consulting firm was hired in 1949 to develop a national electric power plan. Engineering studies performed from 1953–1963 showed the great hydroelectric power of the Caroní River, Venezuela's second largest river. As a result, the Necuima Canyon, located 100 km upstream from the outlet of the Caroní River into the Orinoco River, was chosen as the Guri Dam site.

## Challenges

- The dam construction site was located in an extremely remote location, with a relatively small population and no communications system
- A countrywide lack of the technical knowledge needed to perform studies of the river's hydroelectric potential required experienced use of overseas companies
- A lack of national knowledge in dam construction meant only non-Venezuelan companies would compete for construction contracts

## Solutions

In 1960, the Venezuelan government created Corporacion Venezolana de Guayana (CVG) to lead the development of the Guayana region. The CVG would study, develop and organize the hydroelectric potential of the Caroní River and promote the industrial development of the region in both the private and public sectors. In 1961, CVG authorized preliminary economical and technical studies, which were conducted by a North American company and completed in 1962.

In 1963, with significant funding from the World Bank, CVG created Electrificadora del Caroni, C.A. (EDELCA) to coordinate the size the Guri project. EDELCA became the agency in charge of the project and its subsequent operations.

During the project's inception, cost estimates included all sub-projects and bids from different consortiums. This allowed for comparison, and was critical in the shift from using international companies during the first stage of the project to domestic companies for the second phase and operation of the dam. A plan was developed to encourage the transnational companies to train and involve Venezuelan employees in the dam's construction and operation. This increased participation of Venezuelan contractors from 30 percent in the initial project phases to 60 percent during the final phase.

The companies and consortiums working on the project were selected through a bidding, evaluation and selection process, which was supervised by EDELCA. With more than 70 national and transnational organizations participating in the project's development, ensuring the quality of the finished product was a main concern of both CVG and EDELCA. Skipping any preliminary steps could have resulted in additional time and cost.

To mitigate these problems, all potential contractors were required to have:

- a minimum of five years of operations in the market
- a verifiable executed work curriculum
- an appropriate credit line to ensure their ability to respond to the project's financial obligations
- defined guarantees for quality

Critical steps aimed at preventing quality issues in the project's final stages included:

- identifying and implementing critical provisions during initial planning stages
- conducting internal and international inspections
- obtaining signatures of guarantee from vendors and contractors

The project also focused heavily on risk management and prevention. EDELCA integrated a communication program into the project, which included a central telephone network, mobile radio service connecting the operations, construction, guards, administration and hydrology, and a VHF system controlling the lake's navigation.

In addition, a Hydro-meteorological Forecast Center generated and disseminated hydrological, meteorological and climatological forecasts and studies, which would help prevent or diagnose any potential natural threat to the dam. EDELCA also mitigated environmental risks that could have impacted popular support by including plans to relocate both the hamlets and animal life threatened by the dam's construction and subsequent reservoir.

When construction commenced in 1963, the project utilized a unique concept for the time: using phased construction to minimize initial investment and match power supply to the growth in electrical system demand. Planning for this project proved to be a very complex job, as the design had to acknowledge the interface between the old and new concrete with each increase in height. The design team developed the solution for future extensions at the start of the project, resulting in few difficulties during the final raising of the dam.

During first phase construction, functionality success, coupled with the fast-growing demand for electric power in the Guayana Region and throughout Venezuela, resulted in a major change in the number of power units—from five to 10.

These changes were implemented within the expected time and budget, and the final stage of construction was initiated earlier than planned thanks to corrective actions taken to improve cost surpluses during construction. During the project's final stage, energy sales produced by the first

stage operation not only helped finance the project, but also helped CVG and EDELCA account for the devaluation of Venezuela's currency during the project's closing stages.

## **Results**

The economic efficiency of Guri Dam's construction can be attributed to its phased development. While other concepts called for the dam to be built to the final height at the first stage—a much easier design—the region would not have been able to absorb all of the generated power, making it more difficult to finance.

In addition, the compact and incremental design of the dam resulted in inexpensive power at the time—approximately \$550 (US) per kW—which attracted aluminum and iron ore smelting industries to the area.

## **Key Achievements**

- Completed 15 days ahead of schedule and in line with expected budget
- Raised EDELCA's contribution to the Venezuelan national electrical power grid from 22 percent in 1963 to as much as 70 percent today
- Fulfilled government's goal to significantly decrease dependence on petroleum as a domestic power source: ability to generate more than 10,000MW and produce up to 50,000GWh per year—the equivalent of 300,000 barrels of oil per day
- Extremely reliable source of power generation, with only one partial system failure since completion, which was solved in less than three hours