The Termosantander gas turbine project

Monica Cuellar

INTRODUCTION

A national Energy Expansion Plan was established in Colombia in 1993 to promote projects for electric generation from gas and coal, with the purpose of increasing national capacity and ensuring electricity supplies.

The project called Termosantander was carried out during October 1996 to October 1997. The purpose was to generate electricity by a gas turbine power station with an installed capacity of 2172 MW and gas consumption of 55 million cubic feet per day. The gas was brought from the gas facilities located about 350 m from the station site, where exploration and exploitation of crude oil is carried out for the company AMOCO COLOMBIA. The energy produced by the station power was conducted to the national electric system through a transmission line of tension intensity of 230 kV.

The project is located in the north east part of Colombia in the Department of Santander in the municipality of Cimitarra. It is located in the Magdalena River valley (the main river of Colombia which crosses the country from south to north) and the foothills of the Eastern chain of mountains of the Andes system. The area has various wetlands and marshes raging from 100 to 350 m above sea level. There is more variation in the topography in the vicinity of the station and within the first 20 km of the transmission line. There are erosive processes caused by natural and human factors (this includes removal of vegetation cover for small road construction and extraction of materials).

The temperature varies between 25 and 28 °C and the precipitation between 2800 and 3000mm. Humidity is between 82.8 and 86.4 per cent.

Estimated population of the area is 35 000, with the highest density in the municipality of Cimitarra. Economic activities are based mainly in agriculture and livestock, and there is insufficient infrastructure for education, health, housing, water supply and energy in this area.

The major influence of the project has been the acquisition of land for the power station and the 66 km for the line transmission.
Additionally, there is further land use for the construction of the workers houses, offices and storerooms. These areas were selected after an analysis of four alternative sites.

See Topic 4

UNEP EIA Training Resource Manual

Screening

The station power was donated and installed by the Westinghouse Electric Corporation, and it consists of two units of simple cycle with potential to generate 108.6 MW each, and operated by turbine gas and electric generators. The length of the pipe system transporting gas is 350 m. It was also designed with the purpose of increasing generation tension from 13.8 kV to 230 kV and in this way to be connected with the national transmission system. The transmission line has 161 steel towers, each 400m apart. The main activities for the construction included access adjustment, corridor clearing and adjustment of tower sites.

The Environmental Impact Study was implemented according to the Terms of Reference (ToR) provided by the Ministry of Environment and based on social, biological and physical criteria.

In November of 1998, the Termosantander Company asked the Ministry of Environment to cancel the environmental license because of the lack of a guaranteed gas supply. So the thermoelectric project had a life of only two months (from January to March 1998), even though it was built to operate for 25 years. This was a very complex situation because there were no established ToR for the dismantling of this kind of project. What was needed were specific guidelines for abandoning the project and restoring the landscape. The Termosantander Company spent three months in accomplishing this and the existing infrastructure of the station power was used to make a greenhouse and a kindergarten, both administered by the municipality. The productive capacity of the greenhouse was 8 000 000 plants/year and the kindergarten catered for 120 children.

Total cost of the project was approximately US$141 000 000 for the thermoelectric station and US$8 000 000 for the line transmission, financed totally with private capital from foreign investors. The costs for Environmental Management Plans were US$1 500 000 and US$430 000 respectively.

NATURE AND SCOPE OF ISSUES

Impacts were identified for both the construction and operating stage. In the former, the most significant issue was destruction of 40.7 ha of forest with its consequential habitat destruction and ecosystem fragmentation. In the later stage, noise, water and air pollution were identified as the most relevant impacts. All of them caused fauna displacement and environmental quality degradation.

The project was developed in a remote area, where local people had low incomes and difficulty in meeting basic needs, so expectations of employment and economic benefits were high and a massive immigration process occurred.

Special Terms of Reference were needed to dismantle the project and restore the landscape. Seminars, discussions and workshops with the community were necessary in order to make clear to them the reasons for closing the project. Programmes of social content for the long term had to be proposed including environmental education programmes and reforestation activities.

The fact that the project did not operate for more than two months and the cost of the project was so high, make visible the lack of provision in governmental planning. However, environmental assessment had been carried out.

The local environmental authority (CAS) was also involved in the EIA process, giving permission for cutting the forest and using water of two rivers located near the station. Each permission had determined the amount of natural resource to be used and under the figure of 'retributive taxes'; compensation programmes were enforced, such as reforestation activities and economic tariff.

Apart from the impacts caused by the construction of the power station, there was also a need to identify impacts associated with the pipe installation for gas transport and the installation of the transmission line for electricity conduction. In the first case, the pipes were laid 1m deep in the soil. Where the pipes crossed water surfaces a superficial infrastructure was used to minimize negatives effects if the pipes became damaged. The route for the transmission line was selected to run in less forested areas and the line ran for only 66 km before it was connected to the national transmission system.

Access was limited due to the topography and lack of infrastructure, so materials and equipment were transported with helicopters, except those easily transported by cars or small trucks on very simple unmade roads. However, it was necessary to improve the existing road and construction of seven bridges was needed for transporting the two generators. Material for construction such as sand, stones, and clay among others, was provided by the rivers in the area and the local authority gave the administrative permission for this.

PROCESS AND PROCEDURAL CONTEXT

Legal issues

The Ministry of Environment is the head of the national environmental system, which is composed of 35 regional authorities and five research institutions. The Ministry gives environmental licences for high impact projects, which are designated by law. Local authorities regulate small-scale projects.

This project was referred to the Ministry, which provides specific Terms of References for different sectors such as energy, transport, chemical, mining, industry, and agriculture. EIA is mandatory.

The sequence of the EIA process

The first step includes an Environmental Diagnostic of Alternatives, which basically is to guarantee that the best place has been chosen for developing the project. Normally three different options must be analyzed, but in the Termosantander project four were studied. The differences between them were not only in economic aspects but also in selecting a place with the lowest environmental impact and a better location considering access, resources availability and minor impact to the community.

Because there was not any doubt that the place suggested was the best, taking into account environmental, technical and social aspects, there was no need to meet this requirement and no detailed studies for each alternative were ordered.

Terms of Reference for EIA were established and Environmental Impact Study was submitted to the Ministry for evaluation by an interdisciplinary team. A technical concept was developed in two months, giving the environmental licence for developing the project, and mitigation measures for controlling negative impacts were fixed. By law there is a maximum of six months for evaluating the EIA. However, the administrative process, lack of trained practitioners, number of concerns and lack of appropriate technical information make it impossible to fill this obligation and normally the time used for this purpose ranges between one and three years. Given this scenario, the evaluation of Termosantander was done in a very short period of time.

The EIA components were as follows:

- Justification of the project.
- Description of the project.
- Definition of influence area.
- Baseline considering physical, biotic and social components.
- Zoning of critical environmental areas.
- Identification and evaluation of impacts according to the aspects considered in the baseline.
- Establishment of environmental plan management.
- Risk analysis and contingency plans.
- Monitoring programme.

The aspects mentioned above are included in the ToR produced by the Ministry and are based on the Law 99 of 1993 and Dec.1753 of 1994.

The EIA process also had to include local public participation with community consultation about the design of the project and the environmental management plan. The mechanism for this was through continuous workshops and meetings with local leaders, regional authorities, NGO's and environmental institutions.

Agreements were reached between the owners of the project and other stakeholders. Local people had priority when engaging workers for the project. Regional authorities were responsible for providing permits for using water and forestry utilization and for controlling effluents and emissions discharges.

In order to develop the project the following resources were needed:

RESOURCE	AMOUNT
Forest	17 ha of secondary forest
	11 ha of high stubble
	2.7 ha of low stubble
	1.7 ha of grass
Soil	28305 m3 removal
Water	180l/h/day
Gas	55 millions
Manpower	300 people

Direct and indirect areas of influence were established. The first one was considered to be about 2142 ha, where the power station, encampments and transmission line were settled, and the second one of about 26 537 ha, where indirect impacts on physical, biotic and social effects occurred.

Briefly, the major negative impacts identified are summarized in Table 1:

The methodology used to predict impacts was based upon a matrix, which associated the activity developed and the effect produced on the environment.

The impacts were ranked according to five characteristics:

- Type: positive or negative.
- Magnitude: high, medium and low scale.
- Duration: short term (less than one month), medium term (up to ten months) and long term (life long of the project).
- Tendency: increasing, stable and decreasing.
- Alternative of management: prevent, mitigate, correct or compensate.

Indicators of physical, biotic and social components were also used in order to identify impact.

APPROACHES TAKEN

In order to contribute to the effectiveness of EIA process, different studies were carried out, starting with the analysis of four alternatives for selecting the site for the station and to open the transept to install the transmission line. This process of characterization and analysis was supported with basic general and thematic cartography, aerial photography, satellite images and specialized software.

The selection of the best alternative was based on the use of Geographic Information Systems (GIS), which enabled the establishment of the relation and comparison of variables which would take place in the project. The use of GIS was important because by overlapping thematic layers, it was possible to identify vulnerable and critical areas.

Only one area with problems was identified: it corresponded to the first 28 km of the transmission line, located in a hilly topography and with a dense forest cover. As a consequence this section of the line was replanned with towers placed on higher ground and in open spaces.

In order to carried out the baseline investigation, the area of influence was divided into five sectors. Characterization of physical, biotic and social components was implemented for each sector and using the same methodology.

- For the physical component the geology, geomorphology, climatology and hydrology were studied. Field work was carried out by specialists and a database was created.
- For biotic components the fauna and flora (vegetation cover) were studied.
- For the social component interviews and meetings were undertaken with the community, and secondary information was also used.
- The thematic base for the geospheric analysis was obtained from general cartography with a scale of 1:75 000 and thematic cartography with a scale of 1:200 000. The result was a map characterizing relief, rocks and soil of the area in a scale of 1:25 000 with field verification.

SYSTEM	*COMPONENT*	*IMPACT*
PHYSICAL	Atmospheric	Mobile gas emissions
		Dust emissions
		Noise mobile and fixed sources
		NOx emissions
		SOx emissions
		CO emissions
	Hydrologic	Sediments
		Bacteriologic pollution
		Grease and oil pollution
		Water waste
		Fluvial dynamic alteration
		Solid waste
		Changes in the physical and chemical characteristics of water
	Geospheric, Geology, Soils	Removal of Soil
		Increased hydrological erosion
		Mass remove
		Permanent and temporal changes in use of the soil
BIOTIC	Vegetation Cover and Ecosystems	Landscape alterations
		Damages in vegetal cover
		Decrease vegetal cover
	WILDLIFE	Pressure upon the resource
		Decrease nesting areas and food
		Hunting pressure
		Fragmentation of Ecosystems
		Noise displacement
		Death by car accidents
		Risk of collision with cables
		Alterations of wildlife ecosystems

Table 1. Gas turbine station and transmission line: environmental impacts

This analysis permitted identification of places with more potential for erosion and defined better conditions for locating both the power station and the towers. The air quality of the area was researched, involving parameters for different classes of pollutants and noise. Results were used to identify possible impacts during different phases of the projects.

STAGE	*ACTIVITIES*
PRELIMINARY ACTIVITIES	Acquiring land
	Finding and contract of hand work
	Construction of encampments
	Construction of storerooms
	Location of infrastructure
	Opening access
CONSTRUCTION ACTIVITIES	Operation of encampments
	Excavation for the infrastructure
	Obtaining material (sand, clays etc)
	Material transport
	Construction of appropriate infrastructure for drainage
	Opening channels for pipes
	Hydrostatic proof of the pipe system
	Construction of foundations
	Installation of infrastructure and equipment
	Installation of towers
	Construction of control building
	Construction of infrastructure for protection
	Establishment of the corridor for the transmission line
	Installation of the energy conductors
	Material disposal
	Revision
OPERATION ACTIVITIES	Operation of the generation plant
	Operation of the line transmission
	Maintenance of the line and the corridor
	Maintenance of the equipment of generation
DISMANTLE ACTIVITIES	Packing of equipment
	Disposal of material
	Restoring of the station site as a greenhouse and kinder garten
	Reforestation of open areas
	Transfer of the infrastructure to environmental and regional authorities

Table 2: Main activities of the project

A Pasquill-Guildford model for dispersion of atmospheric contaminants was run, according to the meteorological characteristics of the zone. Results of the modeling showed that emissions would be below the permitted levels established in policy guidelines.

Monitoring during the two months of the operation of the project showed that equipment and controlling measures established were appropriate and there were no significant impacts on the air quality.

The main water bodies were also identified and divided into four hydrologic categories: macro river basins, micro river basins, small river basins and water bodies. Additionally, an evaluation of hydrological information was produced by the IDEAM with physical, chemical and biological characteristics of all water systems in the area.

It was found that the river quality was not appropriate for human consumption due to the high amount of microbiological contamination especially of the *Troulodus spp*, and offer of nutrients was low (oligotrophic). Consequently, water treatment was needed before using the resource.

Characterization of fauna was undertaken using secondary and primary information. Statistical analysis was used to establish population density, habitat preferences and food consumption. Results showed that some species of mammals were in danger of extinction: *Myrmecophaga tridactyla, Bradypus variegatus, Felix wiedii* and *Panthera onca.*

The actions oriented to the protection of the fauna were focused on the prohibition of hunting, signs on the road to prevent death of the animals by cars and enforcement of environmental education programmes.

The flora was characterized and quantified by using 45 small holdings for a total area of 1532 m^2. The data obtained was analyzed ecologically and statistically and the GIS was used in order to see geographical distribution and produce a map of vegetation cover.

The socioeconomic component was studied, based upon secondary information existing in the plans of development for the regions produced by the governmental institutions and by primary information obtained directly by meetings and interviews with the community. Additionally, there were workshops with the leaders and other members of the community, in order to tell them about the project and its possible effects (negative and positive). The objective was to develop the environmental management plan.

An archaeological study was implemented, oriented towards identifying and evaluating potential places of cultural heritage and consequently developing a plan for rescuing archaeological objects before constructing the project. For this purpose photo-interpretation activities and revision of cartography were needed, complemented with field work and laboratory analysis of the samples found. As a result, the presence of archaeological material was established, together with its exact locations. This formed the basis for the implementation of control measures.

RESULTS AND IMPLICATIONS

The EIA of the project identified environmental components (physical, biotic and social) of the influence area of the project both direct and indirect. It was also possible to identify the activities causing degradation of the

environment and define environmental management measures to prevent, control, mitigate, compensate and correct impacts caused by the development of the project.

It has to be mentioned as a deficiency of the EIA that measurements for conservation of fauna were restricted to installing information signs and meeting with workers and local people. This situation indicated a lack of existing information about the region because there was little research into this aspect.

Environmental legislation for EIA has been an important factor in whole process. Without proper policies and environmental legislation it would have been impossible to enforce any mitigation measure.

Even if the project had a short life span, it can be said that environmental management was appropriate and that relations between Termosantander and the community were established properly. Local people recognized the benefits of the project and its economic importance, not only because people had employment opportunities but also because infrastructure were built for the welfare of the community.

Plans for implementation of EIA for a project were made using specific ToR which reflect current environmental policies. However, this case study has shown that ToR for dismantling and abandoning a project still need to be developed.

Cumulative impacts that could be produced by this project were not properly identified because of a lack of scientific knowledge. Also a lack of appropriate and holistic databases makes prediction and management of these kind of effects impossible. It is also necessary to mention that in the area in which the project was developed several industries for crude oil exploitation and exploring and electricity production have been established.

The transmission line was not dismantled because of the possibility that it could be used to be used in a future for connecting remote areas with the national electric system. Consequently, the government and Termosantander negotiated that for the 66 km of transmission line all the environmental obligations were assumed by ISA - a public company that is administrating the line.

Environmental and administrative agreements were made with the local municipality, which undertook certain obligations. The local community was involved in this.

LESSONS LEARNED

- EIA for the construction and operation and dismantling phase of this project, were key factors in developing the project in an environmentally friendly way.
- Environmental Analysis of Alternatives allows a better decision

making process.

- Social participation in different phases of the project, from the initial conception of the project to its operation and dismantle, guarantees the maximization of the objective of the EIA.
- The short operation time of the project meant huge economic loss for the investor who developed the project for 25 years of duration. There was no guaranteed gas supply. Termosantander depended on one gas reservoir and its capacity was over estimated. In this situation there is evidence of a lack of Colombian Government support for investors in searching for solutions.
- It is important that the State through different institutions elaborates TOR for all kinds of projects in their different stages. Also it is important to start considering the significance of cumulative effects and identify scientific and technical knowledge resources for developing methodologies for this.
- The development of an environmental network which allows a better understanding and comprehension of the situation for an efficient decision making processes is also important.

LIST OF RELEVANT PUBLISHED PAPERS OR OTHER SOURCE MATERIAL

Consultoria Colombiana S.A. (1996). Central Generadora y Subestación Electrica de Opón. Estudio de Impacto Ambiental, dos (2) volúmenes. Ministerio del Medio Ambiente, Santa Fe de Bogotá, Colombia.

Consultoria Colombiana S.A. (1996). Linea de Interconexión Eléctrica a 230 kV Opón. Subestación Nueva Malena. Estudio de Impacto Ambiental, dos (2) volúmenes. Ministerio del Medio Ambiente, Santa Fe de Bogotá, Colombia.

Republica de Colombia - Law 99 of 1993.

Republica de Colombia - Decreto 1753 of 1994.

The author:

Monica Cuellar
Institute of Hydrological, Meteorological and Environmental Studies - IDEAM
Transversal 10 A No. 129 25 Apto. 101
Santa Fe de Bogotá COLOMBIA .

Key words

EIA process

terms of reference

cumulative effects

public participation