Rehabilitation of Small Hydropower Plants in Macedonia

Project Title: Rehabilitation of Small Hydropower Plants
Leader: Electric Power Company of Macedonia (Macedonia)
Partner: Elektroprojekt (Zagreb, Croatia)
Location: Macedonia
Project Duration: September 2000 - April 2001
EcoLinks Project Investment: Total Project Investment: $70,459; EcoLinks Grant Support: $49,266; Project Team Cost Share Contribution: $21,193.

Best Practice: Transferable Solution

This project is a Best Practice because it established a detailed model for maximizing the efficiency of electricity generation in Macedonia. More specifically, it established a technical, environmental and financial framework for rehabilitating older, hydropower plants. The project methodology can be easily transferred and implemented by other public or private organizations that involve hydropower production. Transferability is enhanced by (1) determining the energy production regime in which the rehabilitated plants work (base, variable or peak – typically, small hydropower plants perform as peak energy plants); and, (2) determining the price of energy that will be used as a baseline for financial/profitability analyses.

Project Summary

The system of electrical energy production and distribution in Macedonia is centralized and operated by the Electric Power Company of Macedonia. Macedonia produces 6500 GWh of electrical energy per year. The energy mainly comes from the combustion of lignite coal and heavy fuel oil which contributes to air pollution and greenhouse gas emissions. Hydropower is used to generate approximately 20% (i.e., 1300 GWh) of the total electrical energy produced in Macedonia. Of this 20%, 170

GWh are produced by small hydropower plants (SHPPs). Seven of the 18 SHPPs have been in operation for more than 40 years. The equipment installed in these older plants is obsolete and deteriorated. Disconnecting these plants from the system would require replacing the energy they produce with energy from thermal plants that would then increase greenhouse gas emissions. To rehabilitate the seven older plants, more information was needed on the technical requirements, costs, financing options, and environmental impacts of rehabilitation.

The goal of this EcoLinks project was to analyze the basic technical, financial and environmental aspects of rehabilitating the seven, small-scale hydropower plants. The project was lead by the Electric Power Company of Macedonia in cooperation with Elektroprojekt, a Croatian consulting firm. Additional assistance was provided by the faculty of mechanical engineering at the Hydraulic Engineering and Automation Institute in Macedonia. A Rehabilitation Study was prepared and is to be used to obtain rehabilitation financing.

This project provided sound findings that rehabilitation of the seven SHPPs is a feasible and profitable venture. Rehabilitation will result in increased generation of electric energy by 17% from 86.4 GWh to 101.4 GWh annually. With this increase in production, an additional income of $320,000 to $640,000 per year is expected. In addition, the rehabilitation of the SHPPs will result in avoided emissions of 136.3 tons of CO_2/year and other important environmental and social effects.

Based on the project findings, the Electric Power Company of Macedonia decided to finance the rehabilitation of the analyzed SHPPs through a rehabilitate-operate-transfer model. The procedure for the selection of an investor/co-owner was initiated during the project. The EcoLinks Challenge Grant ultimately led to $21 million of private funding for the rehabilitation, operation and transfer of the seven, small, hydroelectric power plants. The Electric Power Company of Macedonia signed a concession contract with Hydropol Management, a consortium of British and Czech investors, to establish a joint venture that will modernize all seven plants over a period of eleven years and extend their useful lives well into the future.

Project Activities

The goal of the project was to analyze the technical, financial and environmental aspects of rehabilitating the seven older SHPPs. A feasibility study was conducted and to be used as a basis for obtaining financing for plant rehabilitation.

1. Visited each of the seven hydropower plants

Action: Each plant was visited providing a visual review of each facility and its current condition. The powerhouses, mechanical and electrical equipment, and intake facilities were reviewed in detail. Also, the civil works that need to be undertaken were noted.

Product(s): 1) Method for data collection and processing and for identifying and filling gaps in the data 2) Work plan.

2. Collected and analyzed data

Action: All existing data and documentation from the project leader's database on SHPPs were collected. This activity was crucial because it set up the basis for all of the following activities. Documents collected for each plant included development plans, tariff information, plant location maps, monthly generation figures, information on traffic connections, coverage of water management issues, technical data and documentation, maps of the electric power system, and single line diagrams of the plant's grid connections.

The collected data and documentation were reviewed and analyzed to determine the present condition of each plant.

Product(s): Clear and updated information data base on the technical condition of the seven plants regarding the following categories: Electric Power Company, Plant Location, Technical Data and Documentation, and Electric Power System .

3. Established rehabilitation needs

Action: The present condition of each plant's status was evaluated to determine the need for rehabilitation and the possibilities for enlargement of the installed capacity.

Product(s): Rehabilitation needs for each plant.

4. Formulated and analyzed alternatives for rehabilitation

Action: Three possible alternatives (i.e., case studies) were formulated regarding the rehabilitation of the plants. Case study 1 involved rehabilitation of the existing equipment without enlargement of its basic technical and operational performances. Case study 2 provided rehabilitation and upgrading of the equipment with possible increases in the installed flow within existing dimensions. Case study 3 required a full replacement of main and ancillary equipment with the ability to increase the installed flow.

Product(s): Three case studies, covering all the possible technical options for plant rehabilitation.

5. Developed technical solution alternatives for the rehabilitation of each SHPP

Action: Based on the findings during plants inspections and the analyses completed during the previous activities, recommendations for the reconstruction of civil engineering works as well as hydro-mechanical and electrical equipment rehabilitation were presented for each plant.

Product(s): Clear set of technical solutions for each plant's rehabilitation plan.

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6. Assessed the costs and benefits of rehabilitation

Action: The costs and benefits of each solution alternative were computed for the rehabilitation of all seven plants. The best option for rehabilitation was retained for each plant.

Product(s): Financial analyses regarding each plant rehabilitation program.

7. Selected financing approach

Action: Two financing options were considered:

a) Foreign commercial bank loan to owner (EMS) using standard credit terms (10 tenor, 3-5 % spread over LIBOR, 6 –12 months grace period) and
b) ROT (Rehabilitate, Operate and Transfer).

Based on the company's present financial status, the Company decided to use a Rehabilitate-Operate-Transfer (ROT) financing model for financing the rehabilitation of all seven SHPPs.

Product(s): Decision to pursue ROT financing model.

8. Finalized Rehabilitation Program

Action: Information and results regarding technical solutions, economic and financial assessments, proposed strategies for project implementation, and the assessment of project financing schemes were discussed within the team. Recommendations for rehabilitation were developed and included the following:

(1) All seven SHPPs are to be maintained in a condition that justifies their rehabilitation;
(2) Rehabilitation should be completed in a manner that allows the plants to operate as variable or peak (energy production) plants. This results in the construction of daily inflow compensation reservoirs for the plants where construction is possible;
(3) The existing hydro-mechanical equipment should be partially replaced and upgraded in all seven SHPPs. The extent of rehabilitation depends on the existing condition of the equipment and is based on the feasibility of rehabilitation and/or upgrading for each plant; and
(4) The existing electrical equipment should be rehabilitated on all seven SHPPs.

Product(s): A report on each of the seven SHPPs with options for rehabilitation and cost/benefits analyses

Project Benefits

This project generated several benefits. It built the capacity of the Electric Company of Macedonia to collaborate and improve operations. This project improves energy production producing both environmental and economic benefits.

Capacity Building Benefits

This project strengthened the Electric Company's capacity to structure a public-private partnership that addressed both its energy production needs and its financial situation. With more experience working with other firms, the Electric Power Company of Macedonia further strengthened its capacity to work collaboratively to improve efficiency and prevent further environmental impacts of energy production. The Electric Power Company can now implement other similar feasibility studies as needed to improve their operations.

Environmental Benefits

The rehabilitation of the seven SHPPs will result in avoided emissions of 136.3 tons of CO_2 by avoiding alternative energy production methods and resources (e.g., coal and fossil fuel combustion). In addition, since all seven SHPPs are an integral part of the water management system in Macedonia, the rehabilitation and life extension of the hydropower plants will result in sustained water management and reduced soil deterioration.

Economic Benefits

Plant rehabilitation will increase the generation of electric energy by 17% from 86.4 GWh to 101.4 GWh annually. With this increase in production, an additional income of $320,000 to $640,000 per year is expected.

The total investment outlays for the rehabilitation amount to $14.5 million. For all seven plants, the Internal Rate of Return (IRR) ranges from 45.8% to 16.9%. IRR for one of the analyzed plants has a negative value, -6%, but this plant will also be rehabilitated using the increased income of the other six plants to cover costs.

Lessons Learned

The following lessons were learned during this project:

- Rehabilitating existing hydropower plants can lead to an increase in electricity generation as well as positive environmental effects, and should be considered a favorable alternative to developing new facilities.

- A critical factor for the successful implementation of similar projects is the scope and reliability of existing data on flow measurements, electrical energy production records, and technical documentation for the plants.

- The Rehabilitate-Operate-Transfer (ROT) financing model is a viable option for many enterprises in the region that have limited financial resources.

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