

Jamaica: Rehabilitation of Five Small Hydropower Plants

Ex-post evaluation

OECD sector	23065 / Hydropower plants	
BMZ project ID	1993 65 941	
Project-executing agency	Jamaica Public Service Company, Ltd. (JPSCo)	
Consultant	Lahmeyer International	
Year of ex-post evaluation	2004	
	Project appraisal (planned)	Ex-post evaluation (actual)
Start of implementation	Q 1 1994	Q 2 1996
Period of implementation	45 months	80 months
Investment costs	EUR 10.4 million	EUR 16.2 million
Counterpart contribution	EUR 3.2 million	EUR 5.5 million
Financing, of which Financial Cooperation (FC) funds	EUR 7.2 million	EUR 10.7 million
Other institutions/donors involved	None	None
Performance rating	1	
• Significance / relevance	1	
• Effectiveness	1	
• Efficiency	1	

Brief Description, Overall Objective and Project Objectives with Indicators

The project comprised rehabilitation and modernization measures for the five relatively old and small hydropower plants Lower White River (4.8 MW), Upper White River (3.6 MW), Maggotty Falls (6.4 MW), Rio Bueno A (2.5 MW) and Roaring River (4.5 MW). To this end, electrotechnical equipment and auxiliary machines at risk of breaking down were repaired and modernized at all of the plants. At the Rio Bueno plant as well as at both plants located along the White River, additional measures were carried out to increase efficiency. A consultant was assigned to support the project-executing agency with the preparation and implementation of these measures.

The overall objective of the project was to contribute to reliable and, in macroeconomic terms, cost-efficient power supply, as this was one of the preconditions for expanding Jamaica's productive economic sectors. The following indicators were defined to measure the achievement of the overall objective:

- Share of hydropower in total power generated is at least 4%.
- Share of productive power consumption is at least 65%.
- Cost recovery ratio is at least 90%.

The project objective was the long-term maintenance of the generation capacity of five older hydropower plants. Achievement of the project purpose is measured against the average power generated annually by the five hydropower plants, which must be at least 121 GWh p.a. in the period from 1998 - 2005.

Project Design / Principal Deviations from the original Project Planning and their main Causes

For the most part, the rehabilitation measures targeting mechanical components, electrotechnical systems, control, protection and measuring technology as well as buildings were carried out as originally planned. However, some of the measures planned for the rehabilitation programme were cancelled because they were revealed to be either not urgent, not appropriate or too costly during the course of project implementation. Yet the measures that were not implemented do not have any considerable influence on the generation process.

According to the original planning, the rehabilitation work was to be performed at the five small hydropower plants from early 1995 until mid-1997. In actuality the measures were performed at three of the plants from early 2000 until mid-2001 and at the two remaining plants from early 2001 until early 2002 and 2003, respectively. The delays of between four and nearly six years were caused by a delay in the conclusion of the loan and the project agreement and by temporary decision-making deficiencies on the part of the project-executing agency prior to its privatization (see below).

As a consequence of these delays, the original budget could not be upheld since the offer prices were considerably higher than the cost estimates and the need for rehabilitation had increased in the meantime. The total cost was ultimately EUR 16.23 million, or 56% higher than the original projection. In order to fully finance the foreign exchange costs out of Financial Cooperation (FC) funds, the loan was increased in the year 2000 by EUR 3.58 million to EUR 10.74 million. The higher costs also played a role in the cancellation of some of the planned project measures.

Originally the plans called for performing the rehabilitation measures in two phases. In the first phase the measures necessary to maintain operation were to be carried out, and in the second phase those measures aiming to optimize plant performance were to be implemented. Due to the serious delays, in the end all measures were realized at around the same time.

Key Results of the Impact Analysis and Performance Rating

The project at hand rehabilitated small hydropower plants with an installed capacity totaling 21.36 MW so successfully that, assuming they are maintained properly, their economic life is now estimated to be 20-25 years. Apart from the small hydropower plants rehabilitated under the project there are only three other similar plants in Jamaica with a total capacity of 2.3 MW. According to the project-executing agency, the JPSCo, the total installed plant capacity in Jamaica is 785 MW, with the hydropower plants contributing only 3% of the total power generated. Since the expansion plans of the JPSCo do not mention any further hydropower plants, this percentage will decrease further in the future. The share of hydropower plants in the total power generated is around 4%, or somewhat higher than its share of the installed capacity since the low operating costs of hydropower plants make it possible to operate them at higher capacity on average than thermal power plants. In terms of power generation, however, the share produced by the hydropower plants can be expected to decline further in the future. Therefore, the indicator of achievement of the overall objective - according to which the share attributed to hydropower must be at least 4% - will probably no longer be met in the near future. Yet, this is not very relevant because a decrease below the stated figure is a result of the cost-

efficient method of expansion and does not affect the appropriateness and significance of this project. In view of the situation described, it seems that the choice of indicators was unfortunate rather than that the overall objective was not sufficiently achieved.

The following table contains the operating results thus far of the five small hydropower plants:

Hydropower plant	Inst. capacity (MW)	2002		2003		2004 (Jan. - Sept.)	
		Generation (MWh)	Availability	Generation (MWh)	Availability	Generation (MWh)	Availability
MAGGOTTY	6.4	32,625	91%	37,758	97%	25,527	97%
L/WHITE RIVER	4.8	27,433	94%	34,570	100%	23,270	94%
U/WHITE RIVER	3.6	18,972	94%	25,254	100%	17,708	99%
ROARING RIVER	4.5	18,043	60%	32,899	99%	23,295	98%
RIO BUENO A	2.5	617	3%	12,358	91%	10,670	92%
Total	21.8	97,690	76%	142,839	98%	100,470	96%

The indicator of achievement of the project objectives requires the five small hydropower plants to generate 121 GWh of power annually. This figure was considerably exceeded in 2003. For 2004 the generated power will attain 130 GWh. In the year 2002 the target figure was not yet achieved due to the delay in completion of the project measures at the Roaring River and Rio Bueno A plants. The available capacity of the plants since 2003 ranges from acceptable to good. Due to the low operating costs of the systems, higher utilization of their capacity is also expected in the future. Altogether, the project objectives were achieved.

During the ex-post evaluation we recalculated the internal dynamic production costs. They range from EUR 14 (Roaring River) to EUR 34 (Rio Bueno A) per MWh. The weighted average is EUR 21 per MWh. Thus, they exceed the figures stated in the project appraisal report by far (EUR 12-13 per MWh based on the 2002 price level), which is mainly the result of an increase in the investment costs. Since the electrical energy generated by the small hydropower plants substitutes for the corresponding energy generated by thermal power plants, which costs an estimated EUR 50 per MWh (excluding the rise in fuel costs in 2004), the project is still highly lucrative in microeconomic terms for the project-executing agency. The internal rate of return is around 28%.

In macroeconomic terms, the internal rate of return is similar to the rate in microeconomic terms since in both alternatives, similar factors are applied for converting microeconomic costs and revenues into macroeconomic costs and revenues. One aspect worth pointing out is that fuel imports in particular are avoided, so that the project has a positive effect on Jamaica's balance of payments.

Since it was a rehabilitation project, its implementation did not have any noticeable negative impacts on the environment. It basically did not intervene in the ecological system of the rivers being used. The environmental impacts resulting from the operation are positive. A high volume of CO₂ emissions is avoided due to the annual generation of approx. 135 GWh by the five small hydropower plants. Since the thermal power plants in Jamaica are mostly oil-fired, the specific emissions can be estimated at around 0.8 tons of CO₂ per MWh. This results in a decrease in CO₂ emissions of approx. 108,000 tons annually.

Two of the indicators of achievement of the overall objective are related to the efficiency of Jamaica's interconnected network. Overall, it can be said that the situation in Jamaica's power sector is in order. At the end of the 1990s the Office of Utilities Regulation was created which monitors the JPSCo, among others. The JPSCo was partially privatized in 2001. 80% of the

shares were purchased by the US firm Mirant Corporation and the Jamaican government kept the remaining 20%. The JPSCo has a monopoly in the field of power transmission and distribution. It has a generation capacity of around 640 MW; three independent generating companies feed another 160 MW into the grid on the basis of long-term agreements. The degree of electrification is approx. 90%. The JPSCo sells 38% of the electrical energy to private customers. However, since the industry - especially energy-intensive bauxite and aluminum production - has the capacity to generate some 600 MW of its own, the share of power consumed for productive purposes of at least 65% as required for the achievement of the overall objective is exceeded by a wide margin. Grid losses are currently 18%, half of which are caused by power theft even though the JPSCo is undertaking great efforts to combat it. The thermal power plants are available 80% of the time. Whereas load shedding was quite frequent until recently, the reliability of the power supply improved substantially when a new plant with a capacity of 120 MW took up operation in 2003. The tariff system is based on the long-run marginal costs of power deliveries on the various voltage levels and also provides for different price levels for different times of the day. It contains adjustment mechanisms for exchange rate changes and price fluctuations on the international fuel markets. The average tariff revenues amounted to approx. EUR 0.12 per KWh in 2003 and are therefore high in international comparison. Customer receivables amount to less than two months' revenues and do not constitute a risk. Recovery of the long-run marginal costs through effective tariff revenues is over 100%. Overall, the sector conditions range from satisfactory to good. The operational appraisal criteria have been met in full.

In September 2004 hurricane Ivan caused extensive damage to Jamaica's electricity system. The JPSCo again proved how efficient it is by repairing practically all of the damage within only one month. The hydropower plants financed out of FC funds were not damaged.

Our overall assessment of the project's developmental effectiveness is as follows:

- The rehabilitated small hydropower plants are used intensively. It is to be expected that this will remain the case in the future since their operating costs are lower than those of the thermal power plants. The project objective was achieved. Therefore, we classify the project's effectiveness as good (sub-rating 1).
- The project rationale of providing low-cost energy generated in an environmentally compatible manner for primarily productive purposes by prolonging the economic life of the small hydropower plants still makes sense today. Thus, its relevance is given. The project contributed to reliable and economically efficient electricity supply, even if potential for improvement remains. Thus, the overall objective was achieved, even if hydropower will play a lesser role in the medium term. We classify the project's relevance and significance as overall sufficient (sub-rating 2).
- In view of the project's high microeconomic and macroeconomic profitability, we judge its efficiency to be good despite the delays that occurred (sub-rating 1).

After considering the three key developmental criteria mentioned above, we classify the project overall as having a high degree of developmental effectiveness (rating 1).

General Conclusions

None.

Legend

Developmentally successful: Ratings 1 to 3	
Rating 1	Very high or high degree of developmental effectiveness
Rating 2	Satisfactory developmental effectiveness
Rating 3	Overall sufficient degree of developmental effectiveness
Developmental failures: Ratings 4 to 6	
Rating 4	Overall slightly insufficient degree of developmental effectiveness
Rating 5	Clearly insufficient degree of developmental effectiveness
Rating 6	The project is a total failure

Criteria for the Evaluation of Project Success

The evaluation of the "developmental effectiveness" of a project and its classification during the ex-post evaluation into one of the various levels of success described in more detail below concentrate on the following fundamental questions:

- Are the **project objectives** reached to a sufficient degree (aspect of project **effectiveness**)?
- Does the project generate sufficient **significant developmental effects** (project **relevance** and **significance** measured by the achievement of the overall development-policy objective defined beforehand and its effects in political, institutional, socio-economic and socio-cultural as well as ecological terms)?
- Are the **funds/expenses** that were and are being employed/incurred to reach the objectives **appropriate** and how can the project's microeconomic and macroeconomic impact be measured (aspect of **efficiency** of the project conception)?
- To the extent that undesired (**side**) **effects** occur, are these tolerable?

We do not treat **sustainability**, a key aspect to consider for project evaluation, as a separate category of evaluation but instead as a cross-cutting element of all four fundamental questions on project success. A project is sustainable if the project-executing agency and/or the target group are able to continue to use the project facilities that have been built for a period of time that is, overall, adequate in economic terms, or to carry on with the project activities on their own and generate positive results after the financial, organisational and/or technical support has come to an end.