

Ex post evaluation – Egypt

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Sector: 23220 / Hydropower plants
Project: Refurbishment of the generators of the Aswan High Dam, BMZ No. 1999 66 565*
Implementing agency: Egyptian Electricity Holding Company (EEHC) and Hydro Plants Generation Company (HPGC), previously: Upper Egypt Electricity Company (UEEC)



Ex post evaluation report: 2016

		Project (planned)	Project (actual)
Investment costs (total)	EUR million	119.64	97.96
Counterpart contribution	EUR million	32.72	12.31
Funding**)	EUR million	86.92	85.65

*) Projects in the 2016 random sample
 **) FC development loan

Summary:

Refurbishment of the 12 generators of the hydropower plant on the Aswan High Dam. All the generators have a capacity of 175 MW each. The project measures comprised the refurbishment of the stator core, the stator coil and the rotor coil, as well as expansion measures on all generators and consulting services. The implementing agency is the "Hydro Plants Generation Company" (HPGC) as the legal successor of the "Upper Egypt Electricity Company" (UEEC), which is supported by its parent firm the "Egyptian Electricity Holding Company" (EEHC).

Objectives: The project objective ("outcome") was to ensure a safe supply of environmentally-friendly produced electrical energy from the hydropower plant on the Aswan High Dam. This was to contribute towards economic development and at the same time towards global climate protection (overarching development objective or "impact").

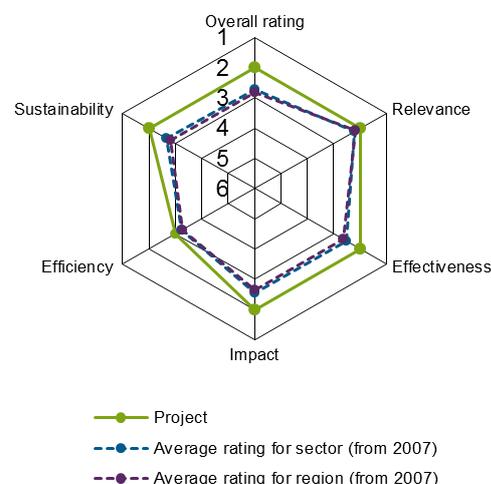
Target group:

From a supply perspective, the target group is all users of electricity in Egypt, particularly industrial and commercial users. From a global environment perspective it is not possible to define one target group.

Overall rating: 2

Rationale: At the time of the refurbishment the generators had been in operation for more than 30 years. Their service life was successfully extended thanks to the refurbishment, thereby ensuring that the Aswan High Dam continues to help generating electricity in Egypt from renewable sources.

Highlights: The High Dam in Aswan is one of the most pivotal structures in Egypt. Its construction and the associated impacts on the population around the upper reaches of the Nile and on the cultural assets there caused a stir for years. Nowadays, the dam and its power plant are crucial for irrigation in Upper Egypt and for securing stability in the Egyptian power grid. They are also an attraction worth seeing in the country. Provided the components of the power plant are refurbished regularly and to adequate standards, the useful life of the power plant can be extended further.



Rating according to DAC criteria

Overall rating: 2

Relevance

The Aswan High Dam is located in southern Egypt and dams the Nile into Nasser Lake which, at more than 500 km in length, is the second largest reservoir in the world. The power plant at the Aswan Dam has a nominal capacity of 2,100 MW and is thus the largest power plant in Egypt. In 2015, the dam produced 5.68% of the Egyptian electricity supply. The importance of the Aswan High Dam goes beyond just electricity generation, however. In addition to serving as a vehicle for irrigation and further water extraction in the downstream section of the Nile, the dam is an important tourist attraction.

Energy consumption in Egypt is high and has increased by around 6% each year since the project appraisal (PA). At the same time, approximately 91% of the country's electricity is produced from thermal energy, resulting in high greenhouse gas emissions. Even at the time of the appraisal of this project, the Egyptian government's objective was to increase the share of renewable energies in the network in order to meet these challenges. With the Renewable Energy (RE) Strategy published in 2015, the government once again confirmed its objective of generating 20% of its energy from RE by 2022. Today, hydroelectric power accounts for around 8% of the Egyptian energy mix. Since the potential of hydroelectric power in Egypt has almost been exhausted by the existing power stations, the share of hydropower will continue to fall (forecast: 3% for 2022). Nevertheless, from today's point of view, the dam and the energy produced there play an important role, above all in stabilizing the grid and covering peak loads.

Energy and, in particular, the promotion of renewable energies and energy efficiency, is one of the focal points of German-Egyptian cooperation. Furthermore, at the time of the project appraisal (PA), ensuring an environmentally friendly electricity supply was a secondary objective of German FC in Egypt. The refurbishment of existing hydropower plants is an explicit component of the BMZ's sectoral strategy for the promotion of sustainable energy. So the refurbishment of the generators at the High Dam – thereby maintaining its contribution to electricity generation – supports the implementation of the jointly defined objectives and contributes to the implementation of SDG 7, which comprises access to affordable, reliable, sustainable and modern energy for all. The German government is currently the only donor to support the refurbishment of existing hydropower plants.

The refurbishment of the twelve generators in the Aswan High Dam was the correct approach for safeguarding the technical availability and production of renewable energies in the Egyptian power grid. The project approach was suited for alleviating a major problem within the Egyptian energy sector. This ensured power generation at the hydropower station and thus also contributed to protecting the environment and stabilizing the Egyptian power supply. The underlying impact logic remains valid. In retrospect, in view of the high energy consumption, the parallel initiation of interventions in energy efficiency could also have been suggested at the PA.

Relevance rating: 2

Effectiveness

The objective of the project was to ensure the environmentally friendly power supply from the hydropower plant at the Aswan High Dam. Indicators for the attainment of the project objective include the amount of electrical energy input into the power grid per year as well as the technical availability of the generators¹. The attainment of the project objectives defined at the project appraisal can be summarised as follows:

¹ In the project appraisal report the "number of unplanned decommissionings of individual generators" is listed in the text section as an indicator, however the "technical availability of the generators" listed here is mentioned in the project matrix.

Indicator	Target value at PA	Ex post evaluation
(1) Average annual feed-in from the power station at the High Dam	approximately 8,000 GWh	The Aswan High Dam has produced more than 8,000 GWh annually over the last ten years, with a lower value of 9,000 GWh and an upper value of 11,370 GWh. The indicator has thus been exceeded.
(2) Technical availability of the 12 generators	≥ 98%	As part of a series of random checks, the availability of the generators for example in February 2016 averaged 99.25 %, which means that this indicator is considered met.
(3) NEW, previously overarching impact indicator: avoidance of CO ₂ emissions compared to alternative thermal generation	approximately 4.5 million t/p.a..	Even with a minimum production of 9,000 GWh, more than 4.5 million tonnes of CO ₂ will be saved if the currently valid emission factor of 0.55 t/MWh is used.

The twelve 175 MW generators of the Aswan High Dam were installed during its construction and became operational in 1964. At the time of the refurbishment they were already more than 30 years old, which justified their rehabilitation. In the course of the project, all 12 generators were renovated by means of the supply and assembly of the stator plates and stator and rotor coils, the replacement of the pipework for the oil supply in the supporting bearing and the replacement of the rotors in the excitation devices. The net capacity of the generators was increased to 200 MW and another 35 years were added to their lifetime thanks to this work. Looking at the production values over the past 10 years, these have consistently been above the desired target value.

HPGC is responsible for the operation and maintenance of all five hydropower plants in Egypt and has many years of experience in the planning and structuring of operation and maintenance processes. The national training centre for hydropower is also located on the site of the High Dam and is dedicated to training and further development in all specialist areas of mechanical and electrical engineering relating to hydropower. The plants are operated and maintained by three teams, each with 25 employees working in a three-shift model. HPGC has a total of 3,172 employees, of whom 862 are employed at the High Dam. These figures are high by international standards and explain the relatively high share of personnel costs in operating costs.

The technical availability of the generators is more than 99%. The average availability for the entire power plant at the High Dam over the last five years has been 92%, reflecting the high quality of the equipment. Almost the entire net capacity of the High Dam is used daily to ensure supply at peak load times between 6.00pm and 7.30pm. Water extraction and thus the maximum total production depends on the specifications of the Ministry of Water Resources and Irrigation.

Since the generators were renovated primarily because of their advanced service life and to a very limited extent due to technical defects, the target value of the produced GWh could have been set higher at the time of the project appraisal. In the future, it is expected that the planned additional refurbishment of the transformers will enable the entire installed capacity of 2,400 MW to be used.

Effectiveness rating: 2

Efficiency

The on-site inspection of the refurbished systems showed that the quality of the machines corresponds to international standards. There have been no serious faults since the refurbishments, which is due to the fact that a number of other relevant refurbishment measures have been carried out in recent years that have extended the lifetime of important plant parts.

In view of the low-cost generation of electricity, the allocation efficiency of the project “per se” can be regarded as high. At sector level, however, the cost recovery ratio of only 66% – insufficient in our opinion – presents significant limitations to the allocation efficiency. This is due to the low electricity tariffs (politically motivated) and favors the inefficient use of electrical energy.

The costs of refurbishment were 32% below the estimate owing to a number of factors, including the fact that the generator coolers (approximately EUR 0.2 million) were excluded from the original scope of delivery. The refurbishment of two autotransformers was funded from residual funds. A further EUR 1.27 million in residual funds is set to be used to purchase spare parts. It is worth mentioning that, by international standards, refurbishment measures of this type often result in additional costs during implementation; this was not the case here and speaks for the efficient implementation of the measures.

At the time of the PA it had been assumed that the project would last six years and that it would thus end in 2008. Due to delays in the tendering process, coordination difficulties within the delivery and assembly syndicate and a defect during the warranty period, the generators were not put into operation until 2007/2008. The final tests continued until 2013, and the final payment was not made to the suppliers until 2015.

With a good production efficiency (above all in terms of the refurbishment costs, see above) and an allocation efficiency which is at the very least ambiguous, the efficiency can still be rated as satisfactory overall.

Efficiency rating: 3

Impact

The achievement of the above-mentioned project objective should contribute to the economic development of the country (overall development goal I). At the same time, the so far hydroelectrically produced energy was to be prevented from being produced thermally, as this would have had a considerable environmental impact, in particular due to the CO₂ emissions. Thus, a contribution to global climate protection (overall development goal II) was envisioned – this step has given rise to the special eligibility of the project in terms of development policy. According to current standards, the CO₂ emissions avoided are classed as an indicator under “Effectiveness” (i.e. at outcome level, see above). The ratio between installed power (30-35 GW depending on the source) and peak load (29 GW) remains a quantifiable indicator in the country; this is – still – reached with a value of >1, which means that, where applicable, in the case of an unscheduled failure of the largest production unit, no shutdowns are necessary.

By producing renewable energy from hydropower instead of from thermal energy, it is possible to avoid the CO₂ emissions generated through alternative thermal production, which contributes to international climate and environmental protection. In addition, the High Dam region plays a key role, particularly in grid stabilization at base load as well as peak load times. The operation of the power station is limited by the extraction quotas specified by the Ministry of Water Resources and Irrigation (see above).

The project measures involved classical refurbishment work. Thanks to the refurbishment work, both past and ongoing, it has been possible to extend the service life of the power plant and to maintain the contribution to the overall development goals. In future, further refurbishment will be necessary to maintain this contribution.

The refurbishment work carried out at the power plant had no impact on the social environment or on the environment itself.

Impact rating: 2

Sustainability

The sustainability of the generators alone can only be assessed to a limited extent. The technical availability of the generators and of the entire system, however, provides an initial indication of the high quality of HPGC operation and maintenance (see “Effectiveness” above).

HPGC currently receives a rate of EGP 0.057 / kWh (about EUR 0.6 / kWh) from the transmission company EETC (single buyer). The tariff is determined annually by EEHC on the basis of HPGC’s production and refurbishment costs as well as against alternative types of energy generation. In the past five years, the company has made profits of between EGP 80 and 450 million (approximately EUR 8 to 45 million). Still, international financing plays an important role for HPGC due to the comparatively low interest rates, the high refurbishment costs and the knowledge transfer associated with the projects.

At present, turbine controllers, excitation systems and voltage regulators are being refurbished as part of an ongoing FC-financed project. In addition, the refurbishment of the transformers is planned, which could increase the net capacity of the entire power plant to 2,400 MW. A detailed “residual analysis” should be carried out for the sustainability of the power plant; future replacement and revision work should then be planned on this basis. It is foreseeable that the control room, the water/wastewater installations and the ancillary facilities must be refurbished in the near future. Thanks to the rising tariffs and profits of HPGC, own funds can increasingly be used for this purpose.

The reliance on possible climatic changes is potentially high. However, these changes are not considered significant for the upper reaches of the Nile or for the reservoir, due to its high storage volume. From today’s point of view, there is a potential risk in relation to sustainability from the “Renaissance” hydropower plant currently under construction on the upper reaches of the Nile in Ethiopia. Egyptian studies and HPGC assess the risk as low. Nonetheless, there are still no official agreements between the two governments with regard to reservoir filling and the associated consequences for the power plants in Aswan.

Sustainability rating: 2

Notes on the methods used to evaluate project success (project rating)

Projects (and programmes) are evaluated on a six-point scale, the criteria being **relevance**, **effectiveness**, **efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's development effectiveness. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The development effectiveness of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): The development effectiveness of the project (positive to date) is very likely to decline only minimally but remain positive overall (this is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The development effectiveness of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive development effectiveness.

Sustainability level 4 (inadequate sustainability): The development effectiveness of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a “successful” project while rating levels 4-6 denote an “unsuccessful” project. It should be noted that a project can generally be considered developmentally “successful” only if the achievement of the project objective (“effectiveness”), the impact on the overall development goal (“impact”) **and** the sustainability are rated at least “satisfactory” (level 3).