KfW Development Bank

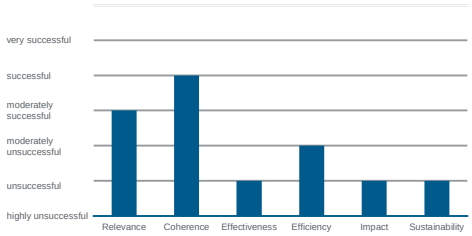
Ex-post evaluation
Environmental measures / Modernisation of thermal power plants, Phase III, Egypt

Title	Environmental measures / Modernisation of thermal power plants Phase III		
Sector and CRS code	Energy - Generation, non-renewable sources (23310)		
Project number	2009 66 952		
Commissioned by	Federal Ministry for Economic Cooperation and Development (BMZ)		
Recipient/Executing agency	Republic of Egypt represented by the Central Bank of Egypt/Egyptian Electricity Holding Company		
Project volume/ Financing instrument	EUR 24.0 million reduced-interest loan, EUR 6.0 million debt conversion		
Project duration	03/2014 – 12/2020		
Year of report	2024	**Year of random sample**	2022

Objectives and project outline

At outcome level, the underlying objective set forth by the evaluation was a more sustainable electricity generation at the Damanhour and Ataka power plants for feeding into the Egyptian transmission grid. The objective on the impact level was a more reliable, environmentally friendly and cost-efficient energy supply for the Egyptian population and businesses. To this end, the instrumentation and control system at the Damanhour power plant was essentially rehabilitated and two steam boilers were modernised at the Ataka power plant.

Overall rating:
unsuccessful



Key findings

Despite the successful implementation of the rehabilitation measures, the project was not able to achieve the planned developmental impacts. The project has been rated “unsuccessful” for the following reasons:

– The relevance was assessed as moderately successful, as the project was generally suitable for contributing to solving the core problem of unreliable electricity supply in Egypt.

– The modernisation work was implemented coherently and successfully overall. However, the project was implemented during a period characterised by significant political and sectoral change processes. Significant additional power plant constructions were initiated and completed, so that the power plants rehabilitated as part of the project continue to feed less electricity into the grid than planned.

– Against the background of the low availability of gas as fuel, heavy fuel oil was increasingly used, so that the target values for avoiding sulphur dioxide and carbon dioxide emissions were not met. The effectiveness and impact of the project are therefore rated as unsuccessful.

– The Ataka power plant is due to be decommissioned shortly, and the Damanhour power plant is expected to end operation in 2035. The very low utilisation of the two power plants and the planned decommissioning dates raise doubts about the meaningfulness of the project ex-post.

Conclusions

– Thermal power plant rehabilitations require an alignment with the overall expansion planning of power generation capacities to enable sustainable project success.

– Serious changes in the political or sectoral framework conditions necessitate a re-evaluation of the measures and, if necessary, early termination of the project.

– When training executing agency personnel, care must be taken to ensure that the expertise created can be used across locations and across the company or sector to the greatest extent possible.

Ex-post evaluation – Rating according to OECD-DAC criteria

Overview of sub-ratings:

Relevance	3
Coherence	2
Effectiveness	5
Efficiency	4
Impact	5
Sustainability	5
Overall rating:	**5**

Overall context

At the time of the project appraisal and at the time of the evaluation, Egypt's electricity generation was and is based on thermal power generation at a share of nearly 90 %. Nevertheless, Egypt significantly increased its climate protection targets in June 2023 as part of the Nationally Determined Contributions (NDCs) which were set during in the framework of the Paris Agreement. It is now aiming for a share of 42 % of electricity generation capacity from renewable energies by 2030. The electricity sector's greenhouse gas emissions (GHG) are expected to decrease by 37 % by 2030 compared to the business-as-usual scenario (2015). This is associated with the decommissioning of inefficient thermal power plants.

In the past, Egyptian-German financial cooperation (FC) in the energy sector focused not only on promoting renewable energies (hydropower and wind power), but also on guaranteeing a secure electricity supply through the modernisation and rehabilitation of thermal power plants. This project was as Phase III the completion of the Egyptian-German development cooperation (DC) commitment in the thermal energy sector. The implementation of Phase III was delayed by the start of the Arab Spring in 2011, so that the loan agreement could only be signed in 2014.

Project summary

The project is in line with Phases I and II of the open programme to reduce the environmental impact of Egyptian electricity generation. The overall programme essentially included modernisation measures at gas-fired power plants that were used to secure the electricity supply and aimed at positive environmental and climate protection effects through an improvement in efficiency. Specifically, the rehabilitation of the instrumentation and control (I&C) -system at the Damanhour power plant and the modernisation of two steam boilers at the Ataka power plant as well as the corresponding consulting services were financed as part of Phase III of the programme. The executing agency of Phase III was the Egyptian Electricity Holding Company (EEHC). Under EEHC's umbrella, the East Delta Electricity Production Company (EDEPCo) was responsible for the Ataka power plant, and the West Delta Electricity Production Company (WDEPCo) was in charge of the Damanhour power plant.

The work in Damanhour took place from January 2012 to August 2015. Final acceptance took place at the end of October 2015. Boiler renovations in Ataka started at the beginning of December 2014, the acceptance of works on boiler 3 took place in June 2018, and the acceptance of works on boiler 4 in October 2020.

The project's target group was all electricity consumers in the Egyptian interconnected grid, in particular the people who live in the catchment area of the included power plants and are therefore particularly affected by the pollution caused by power plant operation.

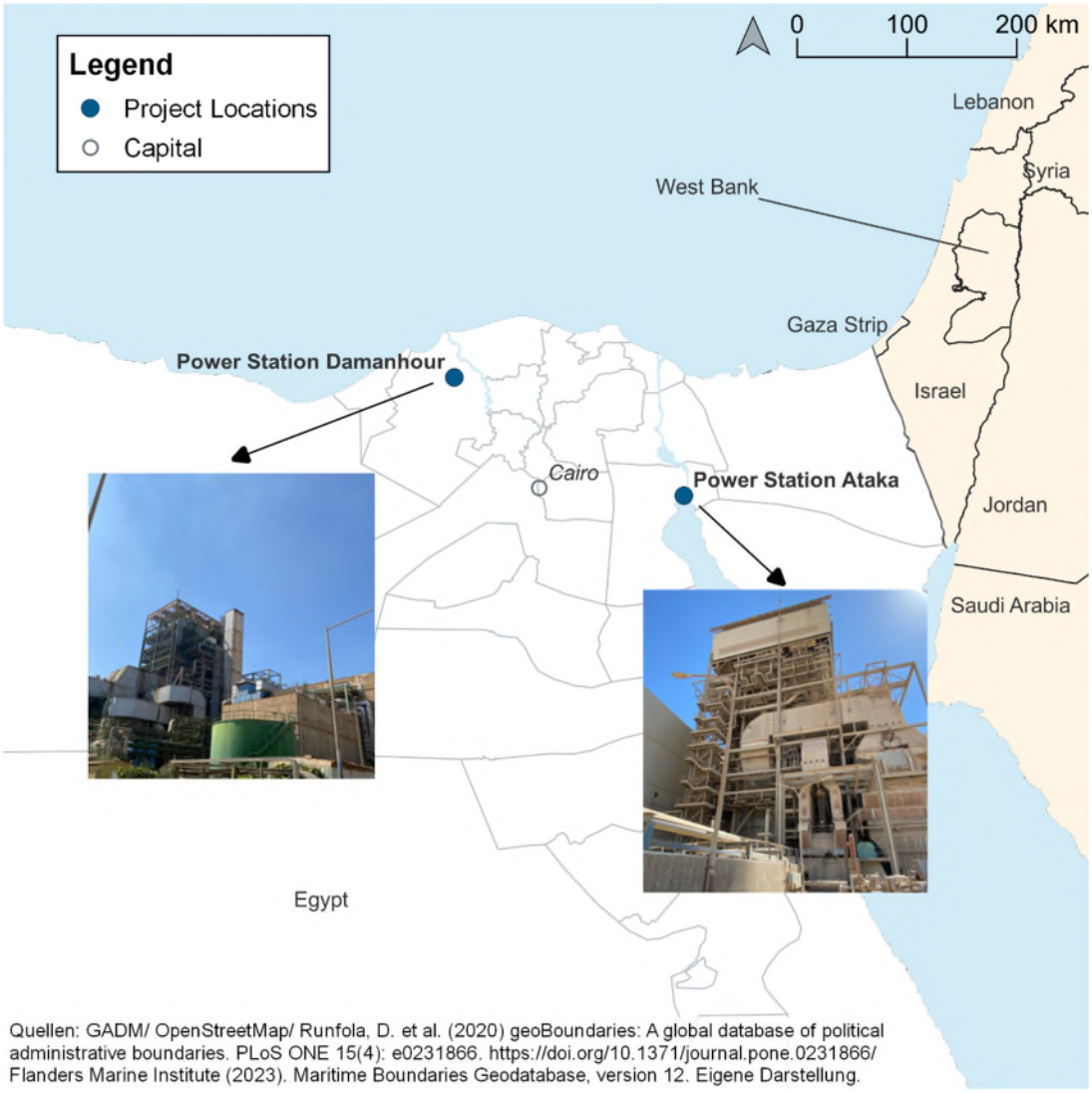
Total costs

Table 1: Total costs

In EUR million	Investment (planned)	Investment (actual)
Investment costs (total)	**34.8**	**32.9**
Counterpart contribution	4.8	5.4[1]
Debt financing	30.0	27.5
of which BMZ budget funds	*24.0*	*21.5*
of which funds from debt swap	*6.0*	*6.0*

Map of the project country including the project locations

Figure 1: Map of the project country incl. project location



Quellen: GADM/ OpenStreetMap/ Runfola, D. et al. (2020) geoBoundaries: A global database of political administrative boundaries. PLoS ONE 15(4): e0231866. https://doi.org/10.1371/journal.pone.0231866/ Flanders Marine Institute (2023). Maritime Boundaries Geodatabase, version 12. Eigene Darstellung.

[1] Based on the exchange rate as of March 2012 (EGP 7.92 = EUR 1.00), the counterpart contribution of EGP 42,992,553 amounted to around EUR 5,428,695. Based on the exchange rate from September 2023 (EGP 32.945 = EUR 1.00), the counterpart contribution amounts to EUR 1,304,980.

Rating according to OECD-DAC criteria

Relevance

1. Alignment with policies and priorities

Reducing the environmental impact and securing Egypt's electricity supply in the face of rapidly growing demand were the main challenges at the time of the project's appraisal in 2008.[2] The National Environmental Action Plan adopted in 2002 for the period up to 2017 defined the goal of reducing air pollutants such as sulphur dioxide, nitrogen oxide and particulate matter. Electricity demand increased by approximately 6.9 % per year at the time of the project appraisal. Accordingly, the authority responsible for the electricity sector, EEHC, planned an expansion of approximately 37GW from 2007 to 2022. In addition, Egypt ratified the Kyoto Protocol in 2005. As part of the 2015 Paris Agreement, Egypt defined its Nationally Determined Contributions (NDCs) for the first time. These were adjusted to be much more ambitious during the second update in June 2023, with the new target set at reducing CO_2 by 37 % by 2030 compared to the base year 2015 through a massive expansion of renewable energies and by decommissioning inefficient thermal power plants. This means that the project's objective and design are in line with Egyptian policies and priorities, even as things stand today.

The project was committed in 2008 as part of the German-Egyptian cooperation's existing focus on "Climate and Environmental Protection". The objectives of the project were based on the Millennium Development Goals (MDGs) at the time, in particular MDG 7 "Ensure environmental sustainability". The objective of the project was in line with the Federal Ministry for Economic Cooperation and Development's (BMZ) sector concept of "Sustainable Energy for Development" at the time, in which the objective was to cover the increasing energy demand in developing countries by improving the energy supply and limiting harmful environmental impacts.[3] At the time of the evaluation, however, the project is no longer compatible with the orientation of the valid BMZ core area strategy.[4] The project has made and continues to make a contribution to the 2030 Agenda, in particular to SDG 7 ("Affordable and clean energy")[5] and SDG 13 ("Climate action").[6] Conceptually, the project is consistent with the Paris Agreement from 2015 and the corresponding subsequent agreements, as it aimed to reduce greenhouse gas emissions at impact level.

2. Alignment with needs and capacities of persons concerned

A sustainable or reliable energy supply was not ensured in Egypt in the first and early second decade of the new millennium, especially during the Arab revolution. Due to increased demand, insufficient power generation capacities and underproduction of natural gas, there were recurring power outages. The core problems of an unreliable and non-environmentally friendly electricity supply were correctly identified during the project's appraisal.

In addition to private households, industry also suffered from insufficient electricity generation. The increase in electricity generation capacity planned by Egypt therefore addressed all electricity consumers in the Egyptian interconnected grid. Similarly, with the reduction of air pollutants such as sulphur dioxide intended by the project (via higher efficiency levels of the plants), the narrower target group "…and in particular the people who live in the vicinity of the power plants involved" was in principle adequately taken into account. The project was geared towards the developmental needs of the target group. No separate target group analysis was carried out during the appraisal period. Since the two sites considered in Ataka and Damanhour are located on the edge of towns and

---

2 In January 2012, the financing proposal for this project was submitted to the BMZ and it was confirmed that the statements of the FC module from 2008 are still correct.

3 Cf. Federal Ministry for Economic Cooperation and Development (BMZ) strategy paper: BMZ concepts 145 – Sector Concept "Sustainable Energy for Development" (01/2007).

4 See the BMZ core area strategy: "Responsibility for Our Planet – Climate and Energy" from June 2021, p. 16: "The BMZ also continues to work towards the German government adopting a wide-ranging resolution to eliminate fossil fuels in its international and national financing." However, financing in accordance with the "Paris-compatible sector guidelines of KfW Group" would still be possible under certain conditions and for a transitional period. (see pages 11 and 17 of the "Paris-compatible sector guidelines of KfW Group" from December 2023.)

5 Objective no. 7.3 "Doubling the global rate of improvement in energy efficiency by 2030", Indicator 7.3.1: Energy intensity measured by primary energy and gross domestic product.

6 Objective no. 13a "Capital mobilisation".

are in the immediate vicinity of small (Damanhour) or no (Ataka) population, a subsequent target group analysis as part of the evaluation does not seem adequate from a cost-benefit perspective.

Given that all population groups benefit equally from a better electricity supply, gender impact potentials were not particularly emphasised in the project's design and objectives. This also applies to the needs of particularly disadvantaged or vulnerable parts of the target group. It can be assumed that no effects on gender equality were expected at the time of the project appraisal. A measurable increase in the female employment rate was also not expected.[7] At the time of the evaluation, the intended impacts of the project are to be considered gender neutral. No further, notable gender impact potentials could have been expected from a different design.

With regard to the standards and principles of the BMZ Human Rights Guidelines, the project contributes to improving affordable access to a more sustainable and environmentally friendly energy supply. However, it should be noted that human rights abuses in Egypt continue to be diverse. For example, there are still severe restrictions on freedom of expression, assembly and association and authorities often proceed with arrests against employees and trade unionists who organise peaceful strikes and protests, e.g., for better working conditions or demanding justice.

3. Suitability of project concept

Based on the experience gained from the design of the preceding phases of the programme for the rehabilitation of the two power plants, the design of this project is comprehensible and was generally suitable for contributing to the solution of the core problem. The project was originally designed in a way that would implement different kinds of modernisation measures at the Walidia, Damanhour and Ataka power plants. Although the planned rehabilitation of the Walidia power plant was prepared by the consultant, the measures themselves were not financed under this project due to problems during the tendering process. As this decision was made before the loan was signed, the loan amount was adjusted accordingly.

A theory of change was created as part of the project design, but no explicit impact logic was formulated for the project.[8] The formulation of the target system as well as the indicators at outcome level were conceptually plausible, but it was not possible to fully understand how the quantitative values of the indicators at outcome level were derived (see also chapters "Effectiveness" and "Impact"). Figure 2 shows the theory of change developed as part of the evaluation, which takes into account the updated target formulations compared to the original results matrix and the rehabilitation measures at the two power plants Damanhour and Ataka.

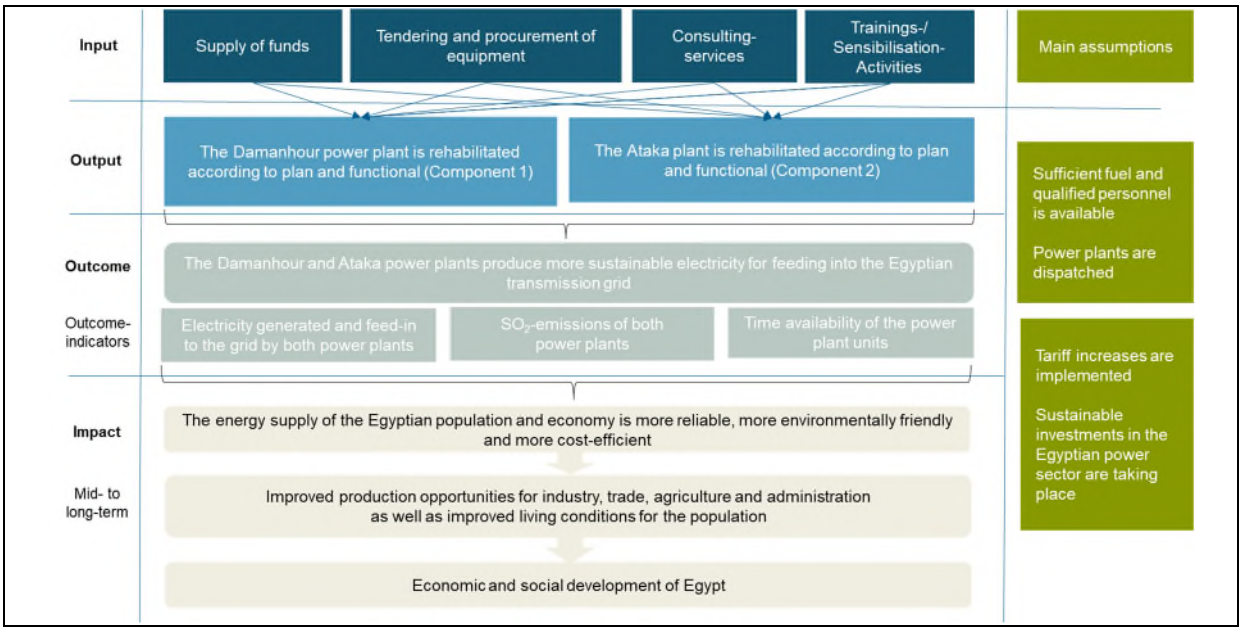
The design, which was updated after the cancellation of the planned measures at the Walidia power plant, intended for funds to be provided as part of the project for the financing of various rehabilitation measures at the Damanhour and Ataka power plants (in particular at the boilers, and information & control (I&C) technology) as well as consulting and training measures (input). After successful implementation, (partially) rehabilitated, functional power plants are therefore available to the executing agency (output). Assuming that sufficient fuel (natural gas) is available for power generation in the power plants, that sufficiently qualified personnel are available and that the power plant capacities are used, the two power plants feed sustainable electricity into the Egyptian electricity grid (outcome). Another intended positive effect is to improve the environmental quality at the power plant locations by avoiding SO_2 emissions. Under the assumption that increased tariffs will improve the financial viability of the Egyptian electricity system, thus triggering further investments, a more sustainable electricity supply will be achieved for Egyptian consumers overall (impact). This results in further positive medium- to long-term development effects, especially in form of improved production opportunities for industry, trade, agriculture and administration. It should be emphasised that the effects at impact level can only be achieved gradually and are very much at risks, e.g., depending on the further development of the Egyptian economy.

---

7 For the basic status of women's rights in Egypt, see the Country Fact Sheet Egypt/UN Women Data Hub.

8 The theory of change takes into account the target formulation that was updated compared to the original impact matrix (see chapter "Effectiveness").

Figure 2: Theory of change for the project



Source: Own illustration.

A need for environmental impact assessment action was identified as part of the project's design. From today's perspective, an explicit environmental and social impact assessment would be required and classification in category B would be appropriate. The rehabilitation/renewal of the I&C system was intended to contribute to digitalisation.

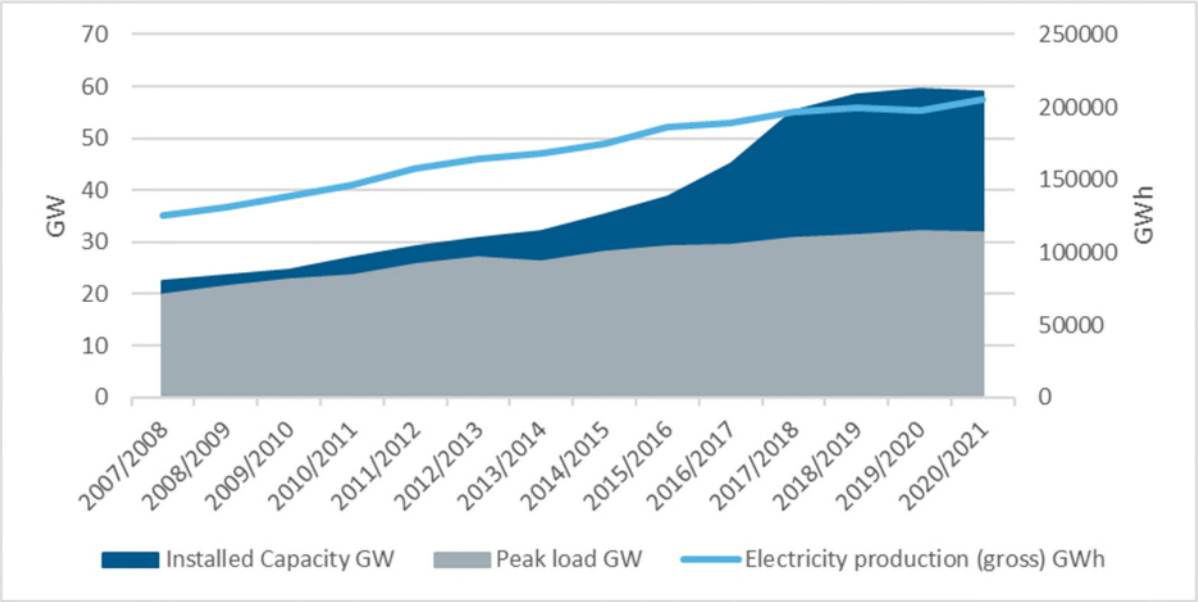
4. Reaction to changes/adaptability

A specific adjustment of the project's design was made by cancelling the measures at the Walidia power plant before the contract was signed (2014). Despite the ambitious Egyptian expansion plans, the project and its measures were not called into question (see chapter on "Effectiveness"). This would have been advisable given the developments in the Egyptian electricity sector.

At the time of the project appraisal in 2008, further high thermal power generation capacities were already planned from 2014 onwards in accordance with the Egyptian expansion plan. Despite the difficult political situation, the installed capacity based on thermal and renewable energy sources was increased by almost 12 GW from 2011 to 2016 to then 38.9 GW, which was only slightly below the original expansion plans. A new gas-fired power plant with a capacity of 640 MW was also commissioned at the Ataka site in 2015. The original planning was greatly exceeded in 2018 when three large combined cycle power plants with a total capacity of 14.4 GW were commissioned as part of the "Egypt Megaproject" announced in 2015. The combined cycle power plants built as part of this project are significantly more efficient than the pure steam power plants at Damanhour and Ataka.

In total, electricity generation capacities increased from approx. 22 GW in 2007/2008 to more than 59 GW at present. The installed capacity now exceeds the requested peak load by around 85 % with approx. 32 GW (Figure 3 – in addition, the requested peak load is far below the expansion planning at the time of the project's design.

Figure 3: Comparison of capacity, peak load, power generation



Source: Own illustration, data from EEHC annual reports.

Given that the supply and service contract for the implementation of the measures at the power plant in Ataka was only signed in 2014 and further power plant extensions were planned at this time or shortly before completion (including the above-mentioned 640 MW power plant at the same location), it would have been important to question at this point in time whether the measures were still meaningful in terms of the project's objectives. The rehabilitation of the power plant in Ataka, which is now about to be retired, has caused costs amounting to more than EUR 18 million, although the power plant was only rarely used after its rehabilitation, so that the measures remained virtually ineffective (for the planned retirement of the power plant in Ataka, see chapter on "Efficiency"). However, it is important to keep in mind that Egypt was in a very difficult and fragile political situation after the Arab Revolution and that any adjustments to the project would have led to lengthy and difficult discussions.

Rating summary

The project and its objectives were integrated into the Egyptian and German strategies and politics at the time of the design. The concept was generally suitable for contributing to solving the core problem of the unreliable electricity supply in Egypt. From today's perspective, the project would probably no longer be implemented. In retrospect, a review of the future viability of power plant renovations seems sensible in the course of the evolving developments in the Egyptian electricity sector and would have been possible due to the delays in the signing of the contract, at least in part. Viewed as a whole, the relevance of the project is rated as moderately successful.

Relevance: 3

Coherence

5. Internal coherence

The project was planned and committed as part of the priority area "Climate and environmental protection" for development cooperation with Egypt. The project built on experience from previous phases of the thermal power plant modernisation programme. Modernisation measures had already been carried out at the two power plants in Damanhour and Ataka as part of that programme. This exploited synergies, as the power plants were already known and the implementation consultant contracted in the previous phases also supported the evaluated project. There were no direct points of contact with German Technical Cooperation (TC), as TC focused on the German-Egyptian "Joint Committee for renewable energy, energy efficiency and environmental protection – JCEE" in the energy sector.

At the time of the original project design, there was neither a binding human rights concept nor the corresponding BMZ guideline, which was issued in 2011 and 2013. As part of the evaluation, no further information about inconsistencies with international norms and standards to which German DC is committed became known.

6. External coherence

The project complemented and supported Egypt's own efforts with regard to the provision of a stable electricity supply for the population and a lower environmental impact from electricity production. Increasing the efficiency and thus the efficiency levels of the power plants enables higher electricity production and has a lower specific environmental impact. At the time of the appraisal, the increase in power generation capacities in Egypt was only possible with the construction of higher power generation capacities from thermal power plants – flanked by the construction of the first wind farms. Overall, the principle of subsidiarity has been respected, as the project effectively supported the activities of the Egyptian government.

German development cooperation was closely coordinated with the activities of other donors in the "Climate and Environment" donor working group, led by Germany. The World Bank, EIB, AFD and JICA were primarily active in the energy sector at the time of the project's conception. Currently, only the World Bank and the IFC project are supporting the gas sector. German development cooperation no longer finances new projects in the area of thermal power generation.

Rating summary:

The project was designed and implemented within the priorities of German-Egyptian cooperation at the time. The good internal coherence is complemented by good external coherence due to the coordination with the other donors active in the sector at the time. Overall, coherence is rated as successful.

Coherence: 2

Effectiveness

7. Achievement of (intended) goals

The objective adjusted at outcome level as part of the evaluation was more sustainable electricity generation at the Damanhour and Ataka power plants for feeding into the Egyptian transmission grid.

The target achievement at outcome level is summarised in Table 2 below:

Table 2: Target achievement at outcome level

Indicator	Status at PA	Target value at PA/EPE	Actual value at final inspection	Actual value at EPE
(1) Generated energy quantity	4,884 GWh/year	5,500 GWh/year (target value at PA and EPE)	approx. 1,830 GWh/year	1,907 GWh/year (Not achieved)
(2) Sulphur dioxide emissions (SO_2)	Not determined	0 t/y (Target value at EPE)	Not determined	10,500 t/y (Not achieved)
(3) Time availability of power plant units	Not determined	90–95 % (Target value at EPE)	Not determined	Average 85 % (Not achieved)

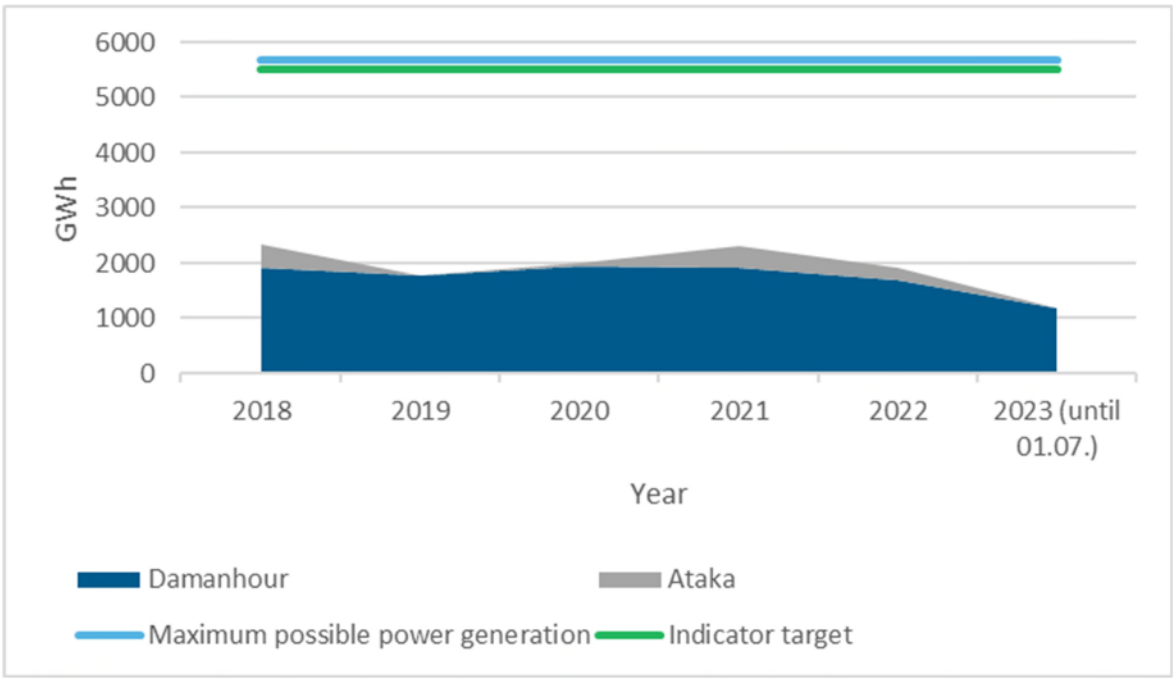
8. *Contribution to goal achievement*

Although the project's planned outputs (power plant modernisation measures) were delivered as planned, the indicators were not met in all three cases.

Indicator 1: Generated energy quantity

However, the power plants are far from being used as planned. Instead of up to 5,500GWh per year, far less than half is produced (Figure):

Figure 4: Power generation at Damanhour and Ataka power plants



Source: Own illustration, data: EDEPCo, WDEPCo

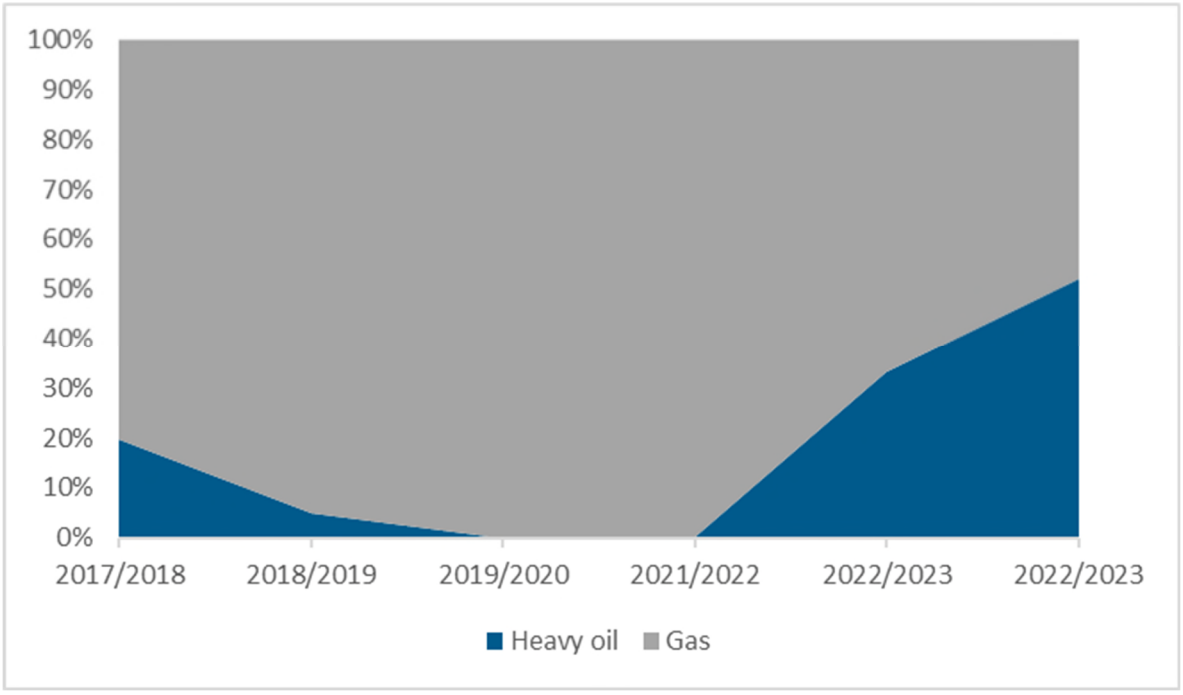
The low power generation can be attributed to the following causes: Egypt's power generation capacity has been significantly increased over the last decade to overcome power bottlenecks and reduce specific CO_2-emissions from new and highly efficient power plants (e.g., the mega projects). The specific average fuel consumption of electricity generation from thermal power plants in Egypt was reduced from 215 g_{oe}/kWh[9] (in 2014) to 173 g_{oe}/kWh at the time of the evaluation. Egypt also wants to reduce its dependence on fossil fuels, resulting in a focus on increasing the share of renewable energy. Currently, Egypt has a surplus of electricity generation capacity with a total capacity of 59 MW, while having a simultaneous peak load of currently only 35 GW (see Figure 3 in the chapter "Relevance"). This has helped to limit power bottlenecks. However, power outages continue to occur due to insufficient natural gas production. In order to reduce costs and emissions, the most efficient power plants are used to generate electricity first. Since the power plants in Damanhour and Ataka were built in the late 80s / early 90s, their efficiency is significantly lower compared to the newly built plants. The use of all power plants in Egypt is controlled via the EEHC's dispatch centre, i.e., all power plants receive precise instructions on when, with what load and with what fuel they should operate their individual units. The power plant in Ataka has therefore been used very little in recent years. The Damanhour power plant is used almost continuously for power generation, as it has a slightly higher efficiency and is needed to ensure grid stability due to its location in the grid.

[9] oe = oil equivalent.

Indicator 2: Sulphur dioxide emissions

As the gas supply situation becomes increasingly inadequate, the use of heavy fuel oil instead of gas increased. This supply gap has arisen due to high gas export obligations and unexpected low exploration rates at existing and new gas fields. Therefore, the Damanhour power plant was operated with 52 % heavy fuel oil (HFO) in the 2022/2023 financial year (after 33 % the previous year, see Figure 5). During the few hours the Ataka power plant was in operation, only gas has been used in recent years. The existing gas is used to secure the supply of the newer combined power plants, which are much more efficient than steam power plants.

Figure 5: Use of heavy fuel oil vs. gas at the Damanhour power plant in %



Source: Own illustration, EDEPCo data.

Due to the high proportion of heavy fuel oil currently being used at the Damanhour power plant, the objective of reducing environmental impact cannot be met with this project. This is also reflected in the actual sulphur dioxide emissions, which should actually have been 0 due to the planned 100 percent supply of gas to the power plants. However, in the past year (2022/2023), approx. 10,500t of SO_2 was emitted due to the use of heavy fuel oil at the Damanhour power plant. The issue of using heavy oil has been discussed several times in the German-Egyptian dialogue in recent years.

The increased use of heavy fuel oil contradicts the original intention of the project but is understandable from an Egyptian perspective. Due to the large number of new gas-fired power plants, which were mostly built as combined gas and steam power plants and are significantly more efficient, only the most efficient power plants are used to generate electricity. This saves Egypt fuel costs on the one hand and benefits the environment on the other, as it emits significantly less greenhouse gases and other air pollutants than if the outdated steam power plants were used. The firing of heavy fuel oil in the older power plants designed for this purpose also serves to secure the natural gas supply for the new gas and steam combined power plants.

Indicator 3: Time availability of power plant units

Typical average availability of gas power plants is 90 – 95 %. However, this is not achieved in the power plants evaluated. For example, the availability of the Damanhour power plant in the period 2015 to 2022 was approximately 88 %, that of Unit 3 in Ataka was 89 % and that of Unit 4 in Ataka was 79 % (Ataka: period from 2018 to 2022). The rather low value for Unit 4 in Ataka is due to major damage in 2020 and 2022 with outages of 150 and 99 days respectively.

9. Quality of implementation

A visual inspection of the rehabilitated power plant units was carried out as part of the evaluation. Taking into account the ambient conditions (e.g., sandy environment in Ataka), the systems are in proper condition. The agreed rehabilitation measures at both power plants have been implemented with good quality and the maintenance is satisfactory so far. Nevertheless, all three power plant units do not achieve the average availability that is common in gas-fired power plants. Overall, the Arab Spring caused significant delays in implementation. Technical problems also led to further delays, but all of them were resolved satisfactorily.

The audit of the use of funds as part of the final inspection did not reveal any anomalies or indications of misuse of funds. Similarly, no indications of possible misuse of funds became known to the mission as part of the evaluation.

Unintended effects (positive or negative)

The further firing of heavy fuel oil at the Damanhour power plant represents an unintended negative effect due to the high air pollution, as the high sulphur content of the fuel greatly increases the SO_2 load compared to only firing natural gas. The assumption during the project appraisal was that the use of heavy fuel oil could be dispensed with in the future. The use of heavy fuel oil is not only harmful to the environment, but also to the power plant itself, as firing heavy fuel oil places greater demands on the power plant's equipment. This increases maintenance costs and the risk of necessary repairs. A positive unintended impact is the importance of the Damanhour power plant for guaranteeing grid stability in western Egypt.

There were no major accidents during the construction phase.

Rating summary

The project was unable to achieve the objectives at outcome level. Although the measures have been properly implemented, the entirely changed current framework conditions for electricity generation in Egypt are the main cause of this non-performance. With regard to effectiveness, the project is unsuccessful; despite some positive partial results, the negative results clearly dominate.

Effectiveness: 5

Efficiency

10. Production efficiency

The total costs of the measures amounted to around EUR 27.5 million for the implementation consultant and the suppliers plus the partner's own share of around EGP 43.0 million.[10] Around EUR 2.1 million was used for the implementation consultant (including EUR 0.37 million for the measure originally planned at the Walidia power plant, which was not financed from FC funds due to the postponed signing of the loan agreement). For the measures in the Damanhour and Ataka power plants, the consultancy costs amount to 5.4 % (around EUR 1.8 million) of the total investment costs,[11] which is slightly higher than originally planned, but still seems reasonable. The total costs for the project were around EUR 2.5 million higher than the planned costs at the time the contractual documentation was signed in 2014. This cost increase is in the usual range of around 10 %.

There were major delays in both sub-projects for many reasons: e.g., the Egyptian revolution, longer tendering procedures, delays in the signing of financing contracts, elimination of defects. In relation to the originally planned completion of the project (December 2011), the project was delayed by 66 months in Ataka and by 48 months in Damanhour. However, it can be noted that production efficiency with regard to the outputs is given, as implementation activities and consultancy services have been achieved in an economically justifiable way.

---

[10] At the exchange rate from March 2012 (EGP 7.9195 = EUR 1.00), the counterpart contribution of EGP 42,992,553 corresponds to EUR 5,428,695. At the exchange rate from September 2023 (EGP 32.945 = EUR 1.00), the counterpart contribution would only be EUR 1,304,980.

[11] At the exchange rate from March 2012.

11. Allocation efficiency

From today's perspective, it can be noted that the use of the power plant in Ataka does not meet the intended objective for the reasons set out in the "Efficiency" chapter. In addition, the low electricity production combined with the very low tariffs does not generate enough revenue to cover the costs of the plant. The majority of the costs are covered by EDEPCo through its stable revenues from other power plants as well as from grants from EEHC. Although the electricity generation in Damanhour is satisfactory, the revenue is not sufficient for covering the costs due to the low tariffs.

With the available funds, no alternative measures to achieve the intended results could be identified at the time of the project's design. This is also considered to be verifiable retrospectively.

From a macroeconomic point of view, the rehabilitation of the power plant in Ataka, which is now about to be retired, was inefficient with costs amounting to more than EUR 18 million, as the power plant was rarely used after the rehabilitation and the measures therefore remained virtually ineffective. In addition, there are plans to retire the power plant in Ataka (see the chapter on "Efficiency").

Rating summary

Overall, the project is rated as moderately unsuccessful in terms of its efficiency. Efficiency is significantly below expectations and despite recognisable positive results in terms of efficient use of funds to provide the output, the negative results in terms of allocation efficiency dominate.

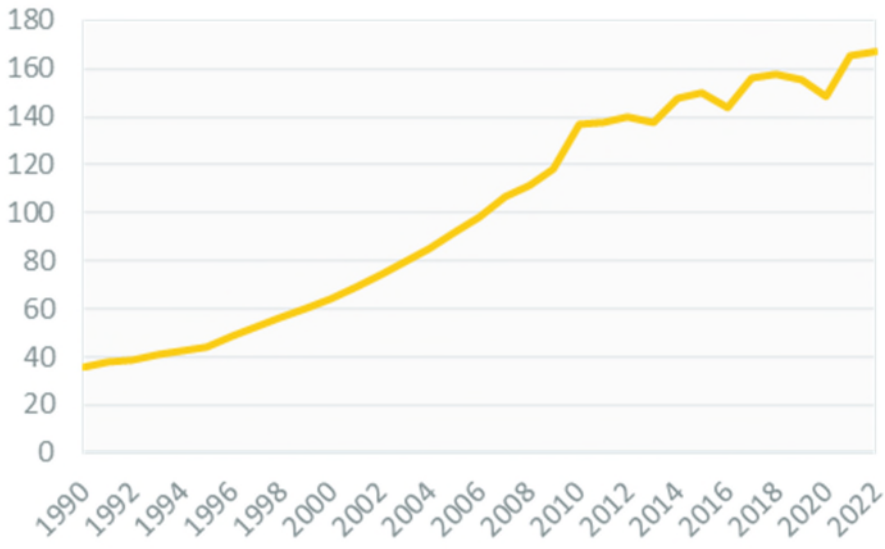
Efficiency: 4

Impact

12. Overarching (intended) developmental changes

Egypt's electricity consumption has increased in recent years and amounted to around 168 TWh in 2022 (Figure). However, the growth rates in the last ten years were significantly lower than before. Despite the sharp increase in power generation capacities (see Figure 3 in the chapter "Relevance"), power shutdowns are occurring again due to the lack of gas.

Figure 6: Electricity consumption in Egypt 1990–2022 (TWh)



Source: own illustration, data: Egypt Energy Information | Enerdata.

The updated objective at impact level underlying the evaluation was: The energy supply for the Egyptian population and businesses is more reliable, environmentally friendly and cost-efficient. The objective's achievement at the impact level can be summarised as presented in Table 3:

Table 3: Target achievement at impact level

Indicator	Status at PA	Target value at PA/EPE	Actual value at final inspection (optional)	Actual value at EPE
(1) Reduction of CO_2-emissions	Not specified	150,000 t/y (PA) 110,000 t/y (EPE)	Not determined	Increase in CO_2-emissions by approx. 170,000 t/y (Not achieved)

13. Contribution to overarching (intended) developmental changes

The target value for the reduction of CO_2-emissions was set at 150,000 t/y during the project appraisal. It was not possible to achieve this figure because in 2022, despite the significantly lower volume of electricity generation, approx. 170,000 t of CO_2 more than planned were emitted. This is mainly due to the use of heavy fuel oil instead of gas, as the supply situation with gas is currently insufficient (see chapter "Efficiency"). Due to a maximum achievable CO_2-emission reduction of 110,000 t/y with the exclusive use of gas as a fuel (see Table 4), the indicator was adjusted as part of the evaluation.

Based on the successfully implemented measures, it is possible to calculate how high the savings in CO_2 emissions would be with maximum electricity generation and with the use of different proportions of gas and heavy fuel oil (HFO) due to the improvement in efficiency.

Table 4: CO_2 avoidance per year with a maximum electricity generation volume of 5,678GWh due to improvements in efficiency

Fuel input	CO_2-avoidance [in t/y]				CO_2-emissions [in t/y][12]
	Damanhour	Ataka Unit 3	Ataka Unit 4	Total	Total
100 % gas	45,914	53,356	11,056	110,326	2,908,691
50 % gas / 50 % HFO[13]*	55,931	64,900	13,291	134,122	3,536,239
100 % HFO	65,788	76,452	15,842	158,082	4,167,299

Source: Own illustration and calculations based on available data (including final report from the consultant and information from operators).

Although this shows the positive effect of the project, i.e., when using 100 % natural gas, CO_2-emissions are reduced by approx. 110,000 tonnes per year at maximum electricity generation, however, CO_2-emissions increase sharply as the use of heavy fuel oil increases. If the saved emissions are set into relation to the total CO_2 emissions emitted (right-hand column of the table), it is shown that the savings are only approx. 3.8 % of the total emissions.

It is worth highlighting the positive effect of the power plant rehabilitation in terms of stabilising and increasing the security of supply of Egyptian electricity supply through electricity production (mainly the Damanhour power plant) or the provision of reserve capacity (both power plants). The Damanhour power plant in particular is also important for grid stability in western Egypt. The project therefore makes a positive contribution to regional added value through increased supply security, especially for companies producing in the area. Even though it was not possible to quantify this effect during the evaluation, it seemed plausible. The rehabilitation has also helped to extend the life of the power plants and reduce the number of days of unexpected downtime due to urgent repairs.

12 CO_2-emissions at maximum power generation of all power plants.

13 Percentage split according to the heat content of the respective fuel.

14. Contribution to overarching (unintended) developmental changes

The now very high use of heavy fuel oil at the Damanhour power plant is to be seen as a negative, unintended effect. The use of heavy fuel oil is not only harmful to the environment (including SO_2-emissions), but also to the power plant itself, as burning heavy fuel oil places greater demands on the power plant's technology than pure gas does. This increases maintenance costs and the risk of necessary repairs.

Rating summary

Instead of decreased, the annual CO_2-emissions of the two power plants have increased significantly since the implementation of the measures. Due to the significant failure to meet the planned emission reduction target as well as various unintended negative effects (SO_2-emissions, increased wear and tear), the project is rated as unsuccessful with regard to the overarching developmental impacts: despite some positive partial results, the negative results clearly dominate.

Impact: 5

Sustainability

15. Capacities of persons concerned

WDEPCo's financial situation is stable, with steadily increasing turnover in recent years and steadily increasing profits (except for the end of the 2022/23 financial year). Despite several requests, EDEPCo did not provide any relevant information on the financial situation. Both institutions have a large power plant park. WDEPCo has a total of nine power plants with an installed capacity of 4,362 MW, EDEPCo has 16 power plants with a total capacity of 10,204 MW. EDEPCo managers confirmed that cross-financing takes place within the companies, i.e., profitable power plants subsidise any loss-generating units.

In general, the tariffs paid by end-users are too low to cover operating and maintenance costs. The tariffs currently amount to an average of EGP 1.2/kWh (approx. 0.036 ct_{EUR}) and thus only cover approx. 50 % of the generation costs according to EEHC. For social policy reasons, tariffs have not been increased for a long time. The next increase is expected to take place in 2024/2025. However, EEHC ensures that each power plant has sufficient funds for operation and maintenance, including spare parts. In addition to annually scheduled routine maintenance, major maintenance is usually only carried out when it is absolutely necessary and not after a defined maintenance interval.

16. Contribution to support for sustainable capacities

The operation and maintenance activities were initially carried out by the power plant personnel with the support of experts from the suppliers. In principle, the two operators' personnel would also be qualified to ensure the best possible operation.

The personnel responsible for the operation and maintenance of the power plants were trained as part of the project. Overall, the evaluation mission gained the impression that the executing agencies are in principle able and willing to achieve positive effects. However, power plant scheduling is not the responsibility of the power plant operators, so the direct influence of the executing agency personnel is rather low.

17. Durability of effects over time

From a climate policy perspective, the Egyptian government's decision in June 2023 to increase its Nationally Determined Contributions (NDCs) can be rated positively. According to the NDCs, 10 GW of renewable energy will be built by 2030. At the same time, 5 GW of thermal power plants will be decommissioned. This also applies to the power plant in Ataka. According to information from EEHC, the power plant will be decommissioned as soon as the financing for the 10 GW of renewable energy is secured. It is currently unclear when exactly the financing will be secured. However, a memorandum of understanding was signed with a Chinese company for the development of a 10 GW solar farm in December 2023. If the power plant is to be decommissioned and dismantled, it would be worthwhile for the trained personnel to be used in other gas-fired power plants, if necessary, in order to be able to continue to use the expertise created.

The Damanhour power plant is expected to remain in operation until 2035, taking into account the technically feasible service life. However, the technical useful life also depends on the use of heavy fuel oil, as firing heavy fuel oil places a higher burden on the equipment than gas does.

Rating summary

As it is expected that the Ataka power plant will be shut down in the coming years and the combustion of heavy fuel oil at the Damanhour power plant cannot currently be avoided, the sustainability of the project is rated as unsuccessful.

Sustainability: 5

Overall rating: 5

Although the individual measures of the project, i.e., the actual rehabilitation of the power plants, were successfully implemented and maintenance is appropriate according to the current assessment, the desired effects could not be achieved. However, this is not within the power plant operators' sphere of influence, but rather due to the fact that the investments made in new power plant construction in the last ten years have meanwhile created an enormous excess capacity of installed output in Egypt in terms of electricity demand. This means that only the most efficient power plants, which are therefore most beneficial for the environment, are usually used. This does not include the gas-fired power plants in Damanhour and Ataka that were modernised or rehabilitated as part of the project. The current scarcity of gas, which has arisen due to high gas export obligations and unexpected low exploration rates at existing and new gas fields, has also negative impact on the evaluated project. This is why heavy fuel oil (mazut) is increasingly being used again at the Damanhour power plant. Overall, the project has largely failed to achieve successful results with regard to the decisive criteria (effectiveness, overarching developmental impacts, sustainability) and can therefore only be considered as unsuccessful in the overall evaluation.

Contributions to Agenda 2030

The objectives of the project were based on the Millennium Development Goals (MDGs) at the time of the project design. The intent was for the project to make the following contributions to the 2030 Agenda: In particular, SDG 7 ("Affordable and clean energy") and SDG 13 ("Climate action"). Conceptually, the project is consistent with the Paris Agreement from 2015 and the corresponding subsequent agreements, as it aimed to reduce greenhouse gas emissions at impact level. A reliable energy supply also contributes to economic growth (SDG 8) and promotes resilient infrastructure and industry (SDG 9).

Project specific strengths/weaknesses and general conclusions/lessons learned

The project had the following strengths and weaknesses in particular:

- The modernisation work was successfully implemented, and the quality of the work was satisfactory.
- In principle, the Damanhour and Ataka power plants would have been able to make the required contribution to a more reliable and environmentally friendly electricity supply for Egypt. The personnel of both operators are qualified to ensure the best possible operation. So far, funds have been made available for necessary maintenance and repair work.
- The lack of availability of natural gas makes the use of heavy fuel oil necessary. This leads to increased environmental pollution and increased wear on the systems.
- The project was implemented during a period of significant change processes. This concerns, on the one hand, the political changes in the context of the Arab Spring, and on the other hand, the framework conditions in the electricity sector. Significant additional power plant constructions have been initiated and completed, resulting in a capacity surplus. In combination with a shortage of gas as a fuel for the power plants, there was only limited use of the rehabilitated power plants – especially the Ataka power plant. In Damanhour heavy fuel oil was increasingly used again.

- The Ataka power plant is due to be decommissioned shortly, and the Damanhour power plant is expected to end operation in 2035. The very low utilisation of the two power plants and the planned decommissioning dates call into question the meaningfulness of the project ex-post.

General conclusions and lessons learned:

- The rehabilitation of thermal power plants requires a comparison with the overall expansion planning of electricity generation capacities, the existing energy resources and the climate policy goals of the partner country in order to enable sustainable project success.
- Serious changes in the political or sectoral framework conditions can greatly delay the implementation of projects. In these cases, a re-evaluation of the measures and, if necessary, an early termination of the project as part of the political dialogue are necessary.
- When training executing agency personnel, care must be taken to ensure that the expertise created can be used across locations and across the company or sector to the greatest degree possible.

Evaluation approach and methodology

Ex-post evaluation methodology

Ex-post evaluations follow the approach of a rapid appraisal, i.e., a data-supported, qualitative contribution analysis resulting in an expert opinion. Effects are attributed to the project considering plausibility, based on thorough analysis of documents, facts and impressions. This includes – if possible – the use of advanced technology (e.g., satellite imagery, online interviews, geocoding). There is a follow-up on possible conflicting information, attempting to eliminate inconsistencies and to base the rating on information that – to the extent possible – has been confirmed through different sources (triangulation).

Documents:
Internal project documents (programme proposal, reports, final audit report, correspondence with the executing agency and operators, etc.), secondary specialist literature, strategy papers, context, country and sector analyses incl. annual reports of the Egyptian energy authority, impact evaluations, media reports.

Data sources and tools for analysis:
Monitoring data from the project-executing agency, measurement data from the operators and consultants, satellite images, interviews (see below)

Interview partners:
Representatives of the project-executing agency, the operators and the ministry

The analysis of project effects is based on the theory of change defined at project appraisal and documented within the impact matrix, which may be updated for the purposes of the evaluation. The evaluation report argues which factors contributed to the observed effects and why – as well as the probable extent of the project´s contribution (contribution analysis). The context of the project is taken into account concerning its influence on the results. The conclusions are put into perspective regarding the availability and accuracy of the available data. An evaluation concept is the frame of reference for the evaluation.

This method provides a balance between cost and usefulness, generating evaluation findings with appropriate effort and expense. Also, it allows for a systematic success rating across the FC projects. Thus, an isolated ex post evaluation cannot fulfil the requirements of a scientific assessment in the sense of a strict causality analysis.

The following aspects caused limitations for the evaluation:
None

Rating methodology

Projects are rated on a six-point scale for each of the OECD DAC criteria. The scale is as follows:

Level 1 very successful: result that clearly exceeds expectations

Level 2 successful: fully in line with expectations and without any significant shortcomings

Level 3 moderately successful: project falls short of expectations but the positive results dominate

Level 4 moderately unsuccessful: significantly below expectations, with negative results dominating despite discernible positive results

Level 5 unsuccessful: despite some positive partial results, the negative results clearly dominate

Level 6 highly unsuccessful: the project has no impact or the situation has actually deteriorated

The overall rating on the six-point-scale is compiled by weighting all six 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 objective (“impact”) and the sustainability are rated at least “moderately successful” (level 3).

List of abbreviations:

AK	Final inspection
GDP	Gross domestic product
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
DAC	Development Assistance Committee
EUR	Euro
FC	Financial cooperation
FC E	FC evaluation
HDI	Human Development Index
PA	Project appraisal
PAR	Project appraisal report
PP	Project or programme proposal
GHG	Greenhouse gases
TC	Technical cooperation

The annex to this report is available upon request (german only).

About this publication

Responsible
FC E
Evaluation unit of KfW Development Bank
FZ-Evaluierung@kfw.de

KfW Group
Palmengartenstrasse 5–9
60325 Frankfurt am Main, Germany