

Egypt: Wind Farms - Zafarana I and II/III

Ex post evaluation report

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| OECD sector | Wind Turbine Generators - 23068 | |
| BMZ project IDs | Zafarana I: 1995 65 896 (Fixed Assets) Zafarana II: 1998 66 385 (Fixed Assets) Zafarana III: 1999 65 187 (Fixed Assets) | |
| Project executing agency | I: New and Renewable Energy Authority (NREA): Wind farms Egyptian Electricity Holding Company (EEHC): Grid connection II + III: NREA | |
| Consultant | DECON, Bad Homburg | |
| Year of ex post evaluation | 2009 | |
| | Project appraisal (planned) | Ex-post evaluation (actual) |
| Start of implementation | I) Q3 1996 II) Q1 1999 III) Q1 2000 | I) Q3 1997 II) Q3 1999 III) Q3 2001 |
| Period of implementation | I) 30 months II) 33 months III) 30 months | I) 44 months II) 60 months III) 36 months |
| Investment costs | I) EUR 47.6 million II) + III) EUR 49.7 million | I) EUR 50.1 million II) + III) EUR 42.0 million |
| Counterpart contribution | I) EUR 14.3 million II) + III) EUR 8.1 million | I) EUR 19.3 million II) + III) EUR 4.8 million |
| Financing, of which Financial Cooperation (FC) funds | I) EUR 33.3 million II) + III) EUR 41.6 million | I) EUR 30.8 million II) + III) EUR 37.2 million |
| Other institutions/donors involved | None | |
| | Zafarana I | Zafarana II + III |
| Performance rating | 2 | 3 |
| • Relevance | 2 | 2 |
| • Effectiveness | 1 | 2 |
| • Efficiency | 3 | 3 |
| • Overarching developmental impact | 1 | 1 |
| • Sustainability | 2 | 3 |

Brief description, overall objective and project objectives with indicators

The projects are comprised principally of the following elements:

Zafarana I:

- Supply and installation of a wind farm with a nominal capacity of 33 MW (55 x 600 kW Wind Turbine Generators; WTGs) including control systems, service parts, training of staff from the New and Renewable Energy Authority (NREA, a government body and project executing agency) and maintenance of the WTGs by the supplier during the warranty period (three years from commissioning)
- Supply and installation of equipment to connect the Zafarana wind farm to the Egyptian grid
- Consultancy services for the following activities: planning, construction supervision and plant acceptance at the end of the warranty period

Zafarana II and III¹:

- Supply and installation of 71 x 660 kW WTGs (total nominal capacity: 46.86 MW) including control systems, service parts, training of staff from the project executing agency NREA and maintenance of the WTGs by the supplier during the warranty period (three years from commissioning)
- Consultancy services for the following activities: planning, construction supervision and plant acceptance at the end of the warranty period

The overall objectives of the two projects were

- Environmental protection; indicator: CO₂ emissions avoided when compared with electricity generated from fossil fuels (indicator target level in Project Appraisal Report (PAR), Zafarana I: 64,250 t/a; indicator target level in PAR, Zafarana III for Zafarana II/III: 108,000 t/a)
- Economic efficiency in electricity generation, overall and by sub-category
 - a) Production efficiency at the project level; indicators:
 - Dynamic generation cost (Zafarana I: < EURc 4.5/kWh at 1995 prices, Zafarana II/III: < EURc 2.8/kWh at 1999 prices, including 6% present value factor)
 - CO₂ avoidance costs (Zafarana I: < EUR 19/t CO₂, Zafarana II/III: < EUR 7/t CO₂ , according to the GEF method)
 - b) Production efficiency at the system level; indicators:
 - Transmission and distribution losses < 20% and
 - Thermal power station availability factor assumed > 75% (operational appraisal criteria threshold values)
 - c) Allocative efficiency; indicator: cost recovery in the Egyptian power sector at the national economic level
 - Target in PAR, Zafarana I: tariff revenues from 1999 onward to cover the long-run marginal cost (LRMC) in full

¹ Zafarana II and III are officially two separate projects with different BMZ IDs, separate project appraisal reports and individual contracts with the Egyptian agencies. They have been evaluated as a single project since the funds of both loans and financial contributions financed the foreign currency costs of a single supply and service contract, and of the relevant consulting contract. It is neither practical nor possible to allocate individual project elements specifically to Zafarana II or Zafarana III. The separation into two FC projects was determined merely by the phased availability of FC funding at the time.

- Target in PAR, Zafarana III for Zafarana II/III: tariff revenues from 1999 onward to cover > 90% of LRMC.

The project objective was to generate a specific volume of electricity and feed it into the Egyptian grid (Zafarana I: 70 GWh/a for 20 years from 1999; Zafarana II/III: 180 GWh/a for 20 years from 2002). The project objective has been surpassed at Zafarana I and largely achieved at Zafarana II/III, albeit with an average delay of two years. In particular, electricity generation at Zafarana I thus far has clearly exceeded the project objective of 70 GWh p.a. in every year since commissioning in 2001. This is mainly because the competitive tender for the equipment achieved results which allowed a wind farm with a nominal capacity of 33 MW to be installed at Zafarana I, instead of the 22 MW installation originally planned. At 197 GWh, electricity generation at Zafarana II/III in 2005 was markedly above the project objective of 180 GWh. In the other years to date since Zafarana II/III was commissioned in the first half of 2004, results fell only marginally short of the 180 GWh target.

Of the overall objectives, the environmental targets for both projects were achieved in full:

- Zafarana I: from today's perspective, CO₂ emissions avoided during electricity generation range from 83,500 t in 2002 to 53,600 t in 2008 (PAR: 64,000 t).
- Zafarana II/III: According to the PAR, annual electricity production of 193 GWh should avoid CO₂ emissions initially totalling 108,000 t. From today's perspective, following very good figures for electricity production figures in the first three years of operation and CO₂ savings which exceeded PAR assumptions, the baseline scenario for electricity production from 2010 on has been set at 160 GWh/a, which will avoid CO₂ emissions of 107,200 t per year. Although electricity production is somewhat below scheduled levels, the objective of avoiding 108,000 t of CO₂ emissions per year is virtually being achieved.

Both projects achieved in part the efficiency standards set under the overall objective (cf the performance evaluation section below).

Project design / major deviations from original planning and their main causes

By making use of the highly favourable wind conditions which prevail at the Red Sea, the projects contribute to the efficient and economic production of green electricity in Egypt. The plans set out in the PARs were achieved, with an average delay of two years. The installation of a 33 MW wind farm at Zafarana I, instead of the 22 MW originally planned, was a very positive development for the project (see above).

Main conclusions from the impact analysis and performance rating

We have reached the following conclusions in our evaluation of the developmental efficacy of these projects:

Relevance: The chain of effects assumed at project appraisal — that using the excellent wind conditions prevailing at the Red Sea to generate electricity would contribute to environmental protection — remains valid. However, to complement the supply-side contribution, a green energy strategy should also include measures to limit the demand for electricity.

Ratings:

| | |
|-----------------|---|
| Zafarana I | 2 |
| Zafarana II/III | 2 |

Effectiveness: Thanks to the excellent wind conditions which prevail at Zafarana, production figures for the WTGs at Zafarana I and Zafarana II/III have been very

good by international standards in most years since they were commissioned. Hence electricity generation at Zafarana has, in every year since commissioning took place in 2001, clearly surpassed the project objective of 70 GWh p.a. that was set in the PAR in 1995,. The PAR for Zafarana II/III anticipated annual electricity production of at least 180 GWh. In 2005 the actual value achieved stood at 197 GWh; in the remaining years since Zafarana II/III was commissioned in the first half of 2004, production has fallen only marginally short of the lower threshold of 180 GWh.

Ratings:

| | |
|-----------------|---|
| Zafarana I | 1 |
| Zafarana II/III | 2 |

Efficiency: We assess production efficiency at the project level for Zafarana I and II/III as very good and good respectively (dynamic electricity generation cost for Zafarana I of EURc 2.9/kWh against PAR estimate of EURc 4.5/kWh; and for Zafarana II/III, EURc 3.7/kWh compared with EURc 2.8/kWh in the PAR, using a present value factor of 6%). Production efficiency at the system level for the Egyptian electricity sector is, assuming thermal power station availability of 90% and total system losses of 16%, good to satisfactory. Ratings: Zafarana I: 1, Zafarana II/III: 2.

In contrast, with cost recovery at the national economic level below 50%, allocative efficiency in the Egyptian electricity sector is inadequate. In all three PARs, expectations concerning the willingness of the Egyptian Government to enact reform were decidedly mistaken. Ratings: Zafarana I and Zafarana II/III: 5.

Weighing these production efficiency and allocative efficiency values yields the following ratings for overall efficiency:

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|-----------------|---|
| Zafarana I | 3 |
| Zafarana II/III | 3 |

Overarching developmental impact

The main developmental concern of the project was its contribution to environmental protection. The indicator for this was the quantity of CO₂ emissions avoided when compared with electricity generated using fossil fuels. Moreover, these projects, together with a Danish wind farm that was also erected at Zafarana, produced a positive structural effect: for the first time in Egypt, electricity was generated from wind power on a scale of commercial significance. This was an important step in the use of this environmentally sound resource. As a result, and on the basis of the operational performance of the WTGs to date, the following **ratings** have been derived:

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|-----------------|---|
| Zafarana I | 1 |
| Zafarana II/III | 1 |

Sustainability: Prospects for sustaining the success of the wind power projects essentially depend on the servicing and maintenance of the WTGs. The primary limiting factor here is the restricted technical and financial capability of the NREA. These shortcomings are attributable on the one hand to the extremely poor rate of remuneration for electricity fed into the grid and, on the other, to the bureaucracy evident in Egyptian state-owned enterprises (in particular, lengthy authorisation and ordering procedures and a salary structure which is detrimental to performance). Against this background, two different pictures emerge for the Zafarana I and Zafarana II/III projects with their different types of WTG:

- Zafarana I: Production figures have deteriorated slightly since the end of the warranty period in mid-2004. However, the machines are robust and relatively insensitive to deficiencies in maintenance. Taken overall, the NREA's maintenance of the equipment is far from ideal, but it is adequate for good production figures still to be expected in the future.
- Zafarana II/III: the warranty period ended in mid-2007. By that time the gearboxes on several machines were already showing significant technical faults. The gearbox defects are, in part, the manufacturer's responsibility; dispute remains whether some are secondary damage resulting from the faults attributable to the manufacturer, or whether they have occurred as a consequence of inadequate maintenance by the NREA. Furthermore, significant defects have arisen which can be traced back without question to lapses in NREA maintenance. By itself, the NREA is neither in a position to conduct the necessary negotiations with the equipment manufacturer, nor to resolve the existing technical problems then maintain the machines in line with procedures and keep them in good order thereafter. On the contrary, based on the status quo, it is to be expected that a good number of the machines on the Zafarana II/III project may come to a standstill within the foreseeable future. We therefore assume that KfW Entwicklungsbank will continue to support the project beyond ex post evaluation. With the support of the machine manufacturers and the consultant, the WTGs can then be expected to deliver a level of service which, whilst falling short of the initial peak performance, will still be acceptable.

This gives rise to the following sustainability ratings:

| | |
|-----------------|---|
| Zafarana I | 2 |
| Zafarana II/III | 3 |

Overall developmental efficacy

When seeking to contribute to the supply of green electricity from renewable sources in developing countries, this is not the best route for German FC to follow if, as here, conditions in the market sector are poor but wind conditions are exceptionally favourable, resulting in minimal allocative efficiency. At the same time consideration must be given to the Federal Government's discrete objective of extending the use of energy from renewable sources in developing countries. On the other hand, poor economic efficiency in the use of electrical energy, which is evident in Egypt from the extremely low tariff and the high level of electricity consumption relative to income, must also be considered when evaluating the project. For even though these projects proved efficient and environmentally sound at the project level, the question of the 'tariff increase' option still arises. Alongside lowering costs to the national economy, this would decrease environmental pollution from fossil fuels by reducing electricity consumption and, furthermore, would raise the allocative efficiency of electricity supply. Against this background our overall assessments for these two evaluated projects are:

- Zafarana I: Good level of developmental efficacy (rating 2), since, allocative efficiency aside, targets were met for the remaining aspects of the overall objective (environmental protection and production efficiency), as well as for the project objective, and these achievements are likely to be maintained.
- Zafarana II/III: Satisfactory developmental efficacy (rating 3), since, alongside the unsatisfactory level of allocative efficiency, there are obvious risks to the sustained achievement of both the project objective and the overall objective.

General conclusions and recommendations

With regard to the general conclusions on inadequate allocative efficiency for FC with Egypt in the electricity sector, we refer to the ex post evaluation on the Refurbishment of Substations II (BMZ No 1994 65 022) dated 3 November 2008. The following conclusions were reached, which are available for future collaborations on the development of wind power potential in Egypt, and are also transferable to other developing countries with good wind power potential and weak project executing agencies:

- When reviewing tender documentation for WTGs, KfW should pay particular attention to equipment maintainability, and look for the lowest possible level of technical demand on project executing agency staff (for example, by using direct-drive [gearless] WTGs; but not stall-controlled machines). In locations rich in wind resources, the increase in investment costs required for maintenance-friendly equipment with generous component clearances is relatively insignificant at the macroeconomic level when compared with extended plant downtimes.

- A large and rapidly growing number of WTGs should drive forward the use of wind power, according to the plans of the government and the donor community. The NREA, in its current form as part of the Ministry for Energy, will not be in a position to manage their efficient operation in the foreseeable future. Whilst external support from equipment manufacturers and consultants can help to resolve problems in the short term, they do not address the NREA's long term weaknesses. Therefore in the future German FC should only sponsor wind power projects in Egypt if the WTGs are serviced, maintained and, as far as possible, operated by private companies with a clear interest in the long-term success of the project. Joint ventures between foreign and Egyptian companies — with a growing proportion on the Egyptian side — could make sound developmental sense here. KfW Entwicklungsbank is already planning to take a step in this direction with a long-term contract for the service and maintenance of the WTGs for the new wind farm on the Gulf of El Zayt.

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

Projects are evaluated on a six-point scale, the criteria being relevance, effectiveness (outcome), “overarching developmental impact” and efficiency. The ratings are also used to arrive at a final assessment of a project’s overall developmental efficacy. The scale is as follows:

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

A rating of 1 to 3 is a positive assessment and indicates a successful project while a rating of 4 to 6 is a negative assessment and indicates a project which has no sufficiently positive results.

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

Sustainability level 1 (very good sustainability)

The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability)

The developmental efficacy 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 developmental efficacy 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 developmental efficacy.

Sustainability level 4 (inadequate sustainability)

The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and an improvement is very unlikely. 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. A rating of 1 to 3 indicates a “successful” project while a rating of 4 to 6 indicates an “unsuccessful” project. In using (with a project-specific weighting) the five key factors to form an overall rating, it should be noted that a project can generally only be considered developmentally “successful” if the achievement of the project objective (“effectiveness”), the impact on the overall objective (“overarching developmental impact”) and the sustainability are considered at least “satisfactory” (rating 3).