Ex post evaluation – Morocco

Sector: Wind power (CRS Code 23068)
Programme/Project: Wind Farm Tangier II (BMZ No.: 2004 65 765)*
Implementing agency: Office National de l'Electricité et de l'eau Potable (ONEE)

Ex post evaluation report: 2015

		(Planned)	(Actual)
Investment costs (total)	EUR million	167.00	215.85
Counterpart contribution	EUR million	37.00	**0.00
Funding	EUR million	130.00	215.85
of which BMZ budget funds	EUR million	25.00	25.00

*) Random sample 2015
**) ONEE contribution unquantifiable
***) Including EUR 50 million in FC (composite loan)

Summary: The project comprises investments in the Tangier II wind farm (140 MW) in northern Morocco as part of a co-financing operation with the European Investment Bank (EIB) and the Spanish promotional bank Instituto de Crédito Oficial (ICO). The project involved the financing of 165 wind-power installations each with a capacity of 850 KW, the necessary connection and development measures as well as consulting services for the planning and implementation of the project.

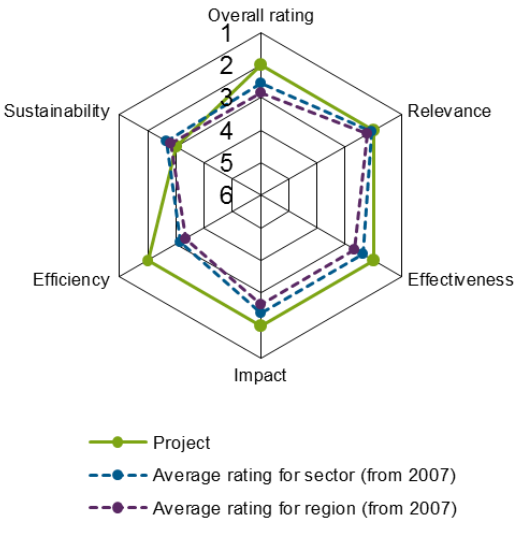
Objectives: The ultimate objective was to contribute to global climate protection. To this end, electrical energy was to be provided in a macro economically efficient and environmentally friendly manner, and fed into the national interconnected grid (module objective).

Target group: The target group of the project was all electricity users in the Moroccan grid.

Overall rating: 2

Rationale: The Tangier II wind farm (140 MW) was one of the first wind farms in Morocco, and even today numbers among the largest installations in the country. The significant expansion of wind energy in Morocco over recent years is attributed by the project partners in part to the successful implementation of the Tangier II wind farm. Overall the project was considered exemplary since the project objectives were achieved. That said, the sustainability of the economic situation of the Office National de l'Electricité et de l'Eau Potable, the project-executing agency, is limited.

Highlights: The project saves CO2 emissions in the region of 300,000 tonnes per year, and can generate electricity more cost-effectively than an oil or gas-fired power station.



Rating according to DAC criteria

Overall rating: 2

Relevance

The secure provision of nationally generated electrical energy is critical for the economic development of Morocco. A core problem of the Moroccan electricity sector has long been the scarcity of raw materials and the resulting degree of dependence on imported primary and secondary energy. At the same time, the demand for energy is growing rapidly, and meeting this demand will require significant investment. The project had the potential to help solve the core problem by increasing the installed capacity, thereby contributing to meeting the growing demand for electricity and thus reducing dependence on energy imports.

Through its approach of generating electricity from wind as a renewable energy source, the project supported the sustainable protection of natural resources (Millennium Development Goal No. 7). From today's perspective, two of the seventeen Sustainable Development Goals in effect since 2015 have been addressed: ensuring access to affordable, reliable, sustainable and modern energy for all (No. 7) and the implementation of rapid measures to combat climate change and its effects (No. 13). The project had the potential to contribute to the reduction of CO_2 emissions and to help combat climate change. Thus the project was in line with the German government's objectives in the cross-sectional topic of environmental and resource protection. Consequently, the project fitted seamlessly into the priority area strategy paper of Moroccan-German cooperation, which is aimed at developing a Green Economy and at making use of Morocco's great potential in the field of renewable energies (RE). The priority sector strategy is consistent with the Moroccan government's energy sector strategy. This specifies an ambitious expansion plan for RE for the next five years. Thus, by 2020, 42 percent of the installed power plant capacity in the country will come from RE installations, which – because of the capacity factor – should provide 28 percent of Moroccan electricity generation. With total installed capacity of 495 MW, wind turbines (WT) in Morocco contributed around 7 percent of the country's current total generation capacity in 2013 (2003: 1 percent). With the help of the national wind expansion plan (2000 MW by 2020), the share of electricity produced from wind power is set to increase to around 14 percent of the country's total generation capacity by 2020. To achieve this goal, the Moroccan government has launched special promotional programmes for wind energy.

In recent years, great progress has been made in improving the framework conditions in Morocco's energy sector. The Renewable Energy Sources Act, which came into force in 2009, provided not only a regulatory and institutional framework, but also an essential tool for accelerating the development of RE. As a result of various sector reforms, the liberalisation of the energy sector has progressed gradually since the mid-1990s. Technical cooperation was a vital factor in the improvement of these framework conditions, resulting in an effective interaction of the various instruments of development cooperation in the realisation of the evaluated project. The next necessary step for the Moroccan energy sector is the planned establishment of an independent regulatory authority.

Given Morocco's dynamic economic development, the provision of additional power generation capacities remains important. From today's perspective, the approach of generating environmentally friendly electricity from wind as a renewable energy source continues to be highly relevant.

Relevance rating: 2

Effectiveness

The module objective was defined as a contribution to the macro economically efficient and environmentally friendly provision of electrical energy and its being fed into the national grid. Overall, the target values of the indicators are assessed as realistic. The objectives are in line with current requirements and with the present state of knowledge.

The achievement of the programme objectives defined during the programme appraisal can be summarised as follows:

Indicator	Status PA	Ex post evaluation
(1) Average electrical energy fed into the national interconnected grid from the second full year of operation, as calculated over several years.	Status at PA: 0 GWh Target value: 500 GWh	Achieved. 502 GWh
(2) Annual CO_2 emissions avoided from the second full year of operation (as compared to fossil fuels)	Status at PA: 0 t CO_2 Target value: 340,000 t CO^2	Partially achieved. 342,066 t CO_2 (2013) 295,545 t CO_2 (2014)
(3) CO_2 avoidance costs (according to Grid Emission Factor (GEF)[1)] method)	Status at PA: 0 USD /t CO_2 Target value: <= 10 USD /t CO_2	Achieved. -7.5 USD/t CO_2 (2014) 9-10 USD/t CO_2 (2016) (depending on oil price)
(4) The bird mortality rate (bird collisions) per wind turbine and per year.[2)]	Status at PA: 0 Target value: < 2	Achieved. 1.79 (2012)

1) GEF factors are the CO_2 emissions per unit of electricity generated (tCO_2/KWh) in a given country. The GEF factor is used to calculate reductions in emissions, e.g. through the use of renewable energies. In the GEF method, CO_2 emissions are not discounted over the lifetime of the power plant.

2) Calculation method according to Johnson et al.

(1) From the second full year of operation (2013) and up to the time of the evaluation, an average of 502 GWh of electrical energy was fed into the national interconnected grid each year. The first indicator is therefore fulfilled, due not least to the fact that the Tangier-Tetouan region is ideally suited as a wind farm site, with an average wind speed of 9 m/s. Moreover, the capacity factor of the wind farm is almost 36 percent more than the average capacity factor for other wind farms across the world, which is between 25 to 30 percent.

(2) Emissions in the amount of 342,066 t CO_2 and 295,545 t CO_2 were avoided in the years 2013 and 2014 respectively, as compared to power generation based on fossil fuels. Consequently, the target value of the second indicator was achieved in 2013, but not in 2014. This is explained by the historically low wind yield in 2014, which resulted in a significantly lower electricity yield (a drop of around 15 percent), and which in turn limited the avoidance of CO_2 emissions.

(3) At -7.5 USD/t CO_2, the CO_2 avoidance costs for 2014 as calculated by the GEF method were significantly below the target value specified for the project of 10 USD/t CO_2, despite the fact that the investment costs were 29 percent higher than the planned costs calculated at the project appraisal. This is due to the fact that the prices of oil, coal and gas had all risen sharply in previous years. Following the sharp decline in oil prices to the current price of around 30 USD/barrel, CO_2 avoidance costs at the start of 2016 were at almost 10 USD/t CO_2 and are thus just below of the threshold.

(4) After the wind farm was fully commissioned in September 2011, the supplier, together with the consultant, monitored bird collisions in the period from November 2011 to November 2012. Three dead birds were discovered and a mortality rate of 1.79 per WT and per year was calculated. This mortality rate is considerably lower than the values for North America, Canada and Europe. This result was attributed to the optimum positioning of the wind turbine. Additional data on the bird collisions from the years which followed is not available.

Overall, the module objective was largely achieved. Since the limitations in relation to electricity production and thus also in relation to the prevention of CO_2 emissions in 2014 were only of a temporary nature, the effectiveness of the project can be assessed as “good”.

Effectiveness rating: 2

Efficiency

The allocation efficiency can be demonstrated on the basis of the dynamic production costs of the wind farm as compared with the thermal generation alternative. At 5.50 EUR cents/KWh (both microeconomic and macroeconomic), the dynamic generation costs of the wind farm are lower than the dynamic production costs of the generation alternative, which lie at 6.60 EUR cents/KWh (microeconomic) and 6.75 EUR cents/KWh (macroeconomic), with both values applying for the year 2014. At EUR 5.50 cents/KWh, the dynamic production costs of the wind farm are higher today than was anticipated at the project appraisal (4.30 EUR cents/KWh). This is firstly because power generation in the wind farm failed to meet the targets in the first six years of operation, caused by the delayed start of the second part of the wind farm, and secondly because the investment cost was significantly higher than expected (by around 30 percent). During the design phase, the cost of the project was estimated at EUR 167 million, however, the actual costs amounted to EUR 216 million. This cost overrun was due to higher land prices in the project region, higher expenses for the reclamation of the project area, price increases for wind turbines due to an overheating of the market for wind turbines as well as higher steel, aluminium, copper and oil prices, among other factors. In addition, some cost-relevant measures were taken to reduce the impact of the wind farm on the bird population. These included the repositioning of some WTs and the laying of underground cables for grid connections. At around 5 percent of the total investment costs, the grid connection costs are therefore significantly higher than originally planned, but are still within the permissible range. The use of 850 kW turbines was usual and in line with the state-of-the-art at the time of project design. As the technology has evolved considerably in the past decade, the choice today, however, would be for a WT with a nominal output of more than one megawatt.

The wind farm was not put into operation until 25 months later than planned. Taking into consideration the project environment and the pilot nature of the project, this delay is nevertheless seen as acceptable. According to the project-executing agency, the main reasons for the extended construction phase were the unresolved land usage rights situation in Morocco, the repositioning of individual WTs to reduce the negative impact on the residents in the project area, the climatic and weather conditions and the laying of underground cables for grid connections, instead of the planned overhead line.

The microeconomic cost recovery ratio of electricity tariffs in Morocco has improved somewhat since 2010 and in 2013, at around 85 %, was higher than the 80 % threshold stipulated in the operational appraisal criteria (OAC): a conventional sector standard for assessing the efficiency of energy projects. As a result of the low tariff policy applied by the Moroccan government over several years, the recovery ratio of the long-run marginal cost (LRMC) for power generation has steadily deteriorated due to the average tariff revenues. Since the ONEE, in its own words, no longer systematically determines the LRMC, the exact macroeconomic cost recovery ratio could not be assessed (project proposal from 15/10/2004: estimated at 83 percent). In principle it can be assumed that the macroeconomic cost recovery ratio will be further improved in future by the gradual approach to implementing tariff increases in the years 2014-2017.

The transmission and distribution losses in the Moroccan electricity grid are around 18 percent, and thus lower than the OAC guideline of 20 percent. The power consumed by the Tangier II wind farm itself totals 2.89 percent. The negative CO_2 avoidance costs during the period of high oil prices were well below the acceptable limit of 10 EUR/t CO_2 for the WT and thus met this efficiency criterion. In early 2016, at a very low oil price of around 30 USD/barrel, the avoidance costs were just below of the threshold value. The current OAC guidelines were thus generally respected.

Due to the CO_2 avoidance costs, which can largely be assessed as positive, the efficiency is rated as good despite the delays and cost increases.

Efficiency rating: 2

Impact

Producing electricity from renewable energies helps reduce the economic costs of electricity generation in Morocco, as this results in a reduction in the consumption of (expensive and state-subsidised) fuels which are mainly obtained from abroad and therefore also reduces the dependence on imports. At the macroeconomic level, we assume that the general expansion of generating capacity in Morocco, to which the evaluated project has also contributed, will have a positive impact on national economic development through the growth of local production capacity. In addition, WT components were manufactured in Morocco, which strengthened the local economy, creating jobs and generating additional income. The construction and operation of the wind farm has created more jobs that have been filled by local workers.

The underlying ultimate objective for the “Environment and Climate Change” priority area as set at the project appraisal is to contribute to global climate protection. Meanwhile, however, the DC programme objective has been redefined: Morocco is being supported in introducing a development model which reduces the negative impact on the environment and on the climate and makes provisions for climate change. According to today's standards, projects in the energy sector at development policy level should also promote the social and economic development of the country, going beyond the contribution to global climate protection. This additional component of the DC programme objective is indirectly realised through the “introduction of a development model”.

It can be assumed that the project has helped improve Morocco’s economic efficiency. In the last decade, economic growth has stabilised with average annual growth rates of 4.32 percent, as compared to more volatile values in previous years with average growth rates of 4 percent. Positive economic development leads to an improvement in the living standards of the Moroccan population, thus reducing the risk of social and political protests and riots.

It is difficult to quantify to what extent the projects implemented as part of DC can actually contribute to the introduction of a new development model for Morocco. A central component of the Moroccan development model is the change to a Green Economy, in which RE have a high priority. The evaluated projects contributed to the expansion of the installed generating capacity in the field of RE in Morocco and thus supported the introduction of the new development model. With an average annual reduction of around 300,000 t CO_2 emissions as compared to power generation based on fossil fuels, the project also contributes to climate protection and prevents climate change.

No significant damage to flora and fauna could be detected as a result of the construction of the Tangier II wind farm. As the project area is located along one of the main bird migratory routes, corresponding alternate routes were created in the wind farm. A bird collision monitoring project implemented after completion of the first year of operation confirmed the wind farm’s very low negative impact on the bird population.

In contrast to the privately financed El Haouma wind farm, the IFC Environmental, Health, and Safety (EHS) Guidelines for Wind Energy were not followed in the construction phase of the Tangier II wind farm, as these did not exist at that time. In the absence of national environmental and social responsibility standards, the Spanish equivalent guidelines – which are largely in line with international standards – were followed instead. Although the land in the project area of the Tangier II wind farm is exclusively under state ownership and despite the relocation of 20 households, there are still a number of illegally built houses in the project area. The distance between these houses and the WTs is significantly below the safety distance required by current EHS standards. However, according to a noise control study carried out in 2012, the noise limit values are compliant. As a result of the rights of use granted to the local population allowing them to use the roads and the wind farm’s own motor vehicles for the transport of people and goods, a type of local transport system has emerged in the project area.

In an oral statement, the Moroccan Ministry of Energy, Mines, Water and Environment (MEME) attested that the successful implementation of the Tangier II wind farm project encouraged the Moroccan government to develop national capacities in the field of wind energy and to improve the corresponding framework conditions. This highlights the exemplary nature of the project.

In the mid-1990s, FC funded the Tangier I wind farm (3.5 MW) as a pilot project and introduced the production of electricity from wind power: a technology which was novel for Morocco at the time. As the result of several technical defects, a financing gap for operating and maintenance measures, and faulty measurement systems, it was not possible to achieve the target production power during the commissioning of

Tangier I. These inadequacies have been avoided in the implementation of the Tangier II wind farm, thus allowing for its smooth operation. Within the context of co-financing with the European Investment Bank (EIB) and the Spanish development bank Instituto de Crédito Oficial (ICO), FC adopted an important advisory role in the design and implementation of the project. FC work in Morocco is valued very highly by the project partners.

The significant expansion of wind energy in Morocco (currently 13 wind farms with a total capacity of nearly 800 MW) is attributed by the project partners to the successful implementation of the Tangier II wind farm. Thanks to the integrated (i.e. Public Private Partnership) wind programme (1000 MW) supported as part of FC, it has been possible to further develop the concept of wind power promotion in recent years; private investors are increasingly involved in the financing of wind farms, thereby reducing the dependence on donor funding. In retrospect, the Tangier II wind farm played a determining role in the spread of a climate-relevant future technology, ensuring that electricity in Morocco can be generated on the basis of wind power to a significant commercial extent in future.

Impact sub-rating: 2

Sustainability

The economic situation of the project-executing agency ONEE has been unsustainable for a number of years now. This is partly due to the fact that the electricity rates which have been kept artificially low by the government in recent decades have reduced ONEE's revenues. Prolonged periods of drought in recent years have furthermore resulted in a lower electricity yield from hydropower. In addition, the arrears of electricity customers have risen. Both effects have placed an additional strain on the ONEE's revenues. What is more, the state company has very high operating costs. The reasons for these high costs include the increased prices for primary energy and the additional cost burden on ONEE caused by the expansion of the electricity grid (rural electrification). The steady erosion of capital which has taken place due to significant losses has been offset in recent years by recapitalisation subsidies from the Moroccan state in the amount of several billion MAD (MAD 1 billion is the equivalent of approximately EUR 90 million). With the aim of restoring ONEE's economic sustainability, a framework agreement was signed between ONEE and several Moroccan ministries in 2014. The agreement settled inter alia cost-cutting measures, the strategic realignment of ONEE, as well as the steady increase of electricity rates in all voltage ranges up to the year 2017. Since ONEE is the only state power generation and transmission company and is thus of systemic importance, state support can be considered secured in the future. Overall, however, this incentive mechanism hinders the more efficient and economical realignment of ONEE, which could result in the state company's options for action being limited in the event of external changes and shocks. It can in principle be said that private companies – such as the operator of the El Haouma wind farm – operate on a more sustainable basis than ONEE.

Since, at 5.50 EUR cents/KWh, the dynamic production costs fall well below the average electricity tariff of 11 EUR cents/kWh, the Tangier II wind farm operates in an economically sustainable manner. The project area can be assessed as stable from a social, economic, political and environmental point of view, and therefore does not represent a risk for the sustainability of the project.

The wind farm was appropriately constructed and is operated and maintained in a professional manner and by well-qualified Moroccan personnel under an operating and maintenance contract agreed with the supplier of the wind turbines. This contract provides for all the necessary repairs that are required for safe and proper operation over the 12-year contract period. According to expert opinion, the WTs from this supplier are not as susceptible to failure as those of other renowned manufacturers thanks to a proven technology. It is assumed in principle that the typical WT lifetime of 20 years will be reached, however, two factors could jeopardise the sustainable operation of the wind farm over the long term: although the strong winds on the site produce very good energy yields, they also result in premature wear and tear and mechanical material fatigue. In addition, regular blade cleaning is not provided for in the operating and maintenance contract, yet dirty rotor blades can cause energy yield losses. It is therefore recommended that the blades are cleaned on an annual basis in the course of other maintenance works. This also makes it possible to detect damage to the rotor blades at an early stage and to deal with such cases in the proper manner, thus preventing potential total failure. The maintenance works in the El Haouma wind farm include regular blade cleaning. The operation and maintenance contract for the Tangier II wind farm

specifies a technical availability of at least 95 % for the entire wind farm. Despite the temporary failure of individual wind turbines in recent years, this target value was met at the level of the overall farm. Nevertheless, a defective WT always results in a loss of production. To be able to generate the highest possible electricity yield while at the same time providing the supplier with an incentive to repair or replace defective WTs promptly, the contract should also specify a technical availability per WT.

Overall, the positive effects and changes which resulted from the construction and operation of the Tangier II wind farm can be regarded as sustainable.

Sustainability rating: 3

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 overall developmental efficacy. 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 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 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 objective ("overarching developmental impact") and the sustainability are rated at least "satisfactory" (level 3).