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Ouarzazate - Morocco

Solar power from the desert

Morocco is a country on the upswing: a growing population, increasing prosperity, connection of rural areas to the power supply and economic growth are creating growing demand for energy. The Moroccan energy strategy is setting a clear course in a country that, to a large extent, has been dependent on importing fossil fuels until now.

Context

The Moroccan government is pursuing an active energy strategy: by 2020, the capacities for solar, wind, and hydropower are expected to be expanded to 2,000 MW respectively. The percentage of installed electricity generation capacity based on renewable energy sources will then reach 42 per cent. By 2030, the proportion is expected to further increase to 52 per cent. The country is thus also a pioneer in the use of renewable energy even outside the region. By converting to renewable energy, Morocco is reducing its dependency on imported energy sources. Moreover, the country is making a contribution to global climate protection and to the security of its own supply. Within the scope of Financial Cooperation with Morocco, KfW is supporting the execution of this plan on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). Financing the Ouarzazate solar complex and the next NOOR Midelt solar complex are the flagship projects in this respect.

Project approach

With rugged canyons and plenty of sunlight, Ouarzazate's surroundings have already served as the backdrop for films like "Lawrence of Arabia" and "The

Physician" as well as television shows like "Game of Thrones". The radiant intensity of the sun, with more than 2,500 kWh per m² and year, is more than twice as high as at the best locations in Germany: a favourable location for Africa's first large solar complex named "NOORo" (Arabic for "light" – the "o" at the end stands for the location in Ouarzazate). Once commissioned, NOORo will be the largest solar complex in the world with an output of 580 megawatts, consisting of four power plants on an area of 3,000 ha.

The projects are being implemented within the scope of Public Private Partnerships (PPP). Project risks can thus be efficiently divided between public and private project partners to realise the lowest possible electricity price. The public implementing organisation is the Moroccan Agency for Sustainable Energy (MASEN). The first NOORo I solar power plant is operational since early 2016. Construction on NOORo II, III and IV was finished in 2018. NOOR Midelt is currently in the competitive bidding phase.

Various solar technologies will be applied in the complex. NOORo I (160 MW) and NOORo II (200 MW) are parabolic trough power plants in which over 100 rows of parabolic mirrors focus the sunlight onto pipes in which a heat transfer fluid circulates. This heats a water-

Project name	NOORo I - IV
Commissioned by	Federal Ministry for Economic Cooperation and Development (BMZ), Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU)
Country/Region	Morocco
Lead executing agency	MASEN (Moroccan Agency for Sustainable Energy)



Africa's first large solar power plant: a look at NOORo III. Source: KfW Group, photographer: Florian Ziegler

steam cycle, which then powers a conventional turbine. In contrast, NOORo III is a 150 MW solar tower power plant. Over 7,000 individual mirrors focus the sunlight and reflect it onto a receiver module at the top of a tower which is over 240 metres high. The absorbed thermal energy is transferred using a heat exchanger to the connected steam cycle in the power plant unit. The highlight of the three solar thermal power plants is molten salt batteries that make it possible to provide power even after sunset. NOORo IV is a conventional photovoltaic power plant with a capacity of 70 MW. The NOOR Midelt solar complex will consist of two innovative hybrid power plants in the first phase, combining solar thermal energy and photovoltaics in one power plant.

The costs for NOORo are approximately EUR 2.2 billion. The German contribution – from the Federal Ministry for Economic Cooperation and Development, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, and KfW – is EUR 829 million. On behalf of the Federal Republic, KfW is providing EUR 15 million from the International Climate Initiative (IKI), EUR 324 million from the German Climate and Technology Initiative (DKTI) and EUR 490 million from the Initiative for Climate and Environmental Protection (IKLU). In addition, the European Commission, the European Investment Bank, the French Development Bank, the Clean Technology Fund, the African Development Bank, MASEN and a special-purpose vehicle identified through public and international competitive bidding are participating in the financing.

Impact

NOORo I already produces over 400 GWh of power a year, which corresponds to the average consumption of around 400,000 Moroccans. The installed battery technology allows the plant to feed power into the grid up to three hours after sunset. The storage capacity of NOORo II and III amounts to as many as seven hours. The solar power plants are an important element of Morocco's energy strategy, where flexible but environmentally damaging oil and gas power plants, in particular, are used to cover the evening peaks. In contrast, the NOORo IV photovoltaic power plant provides particularly affordable power, especially during the daytime peaks. In addition, NOORo IV is the first large photovoltaic power plant in Morocco and thus also has a strong signalling effect.

The entire solar complex will generate electrical energy for at least 1.3 million people. When compared to conventional power generation, over 800,000 metric tonnes of CO₂ emissions will thus be avoided per year. Furthermore, the country saves foreign currency in the long term by tapping into inexhaustible solar energy because Morocco was previously nearly completely dependent on imports of fossil fuels.

The solar complex is also groundbreaking in its use of water. While a conventional but fuel-efficient water cooling system is used at NOORo I, NOORo II and III use an advanced dry cooling system that also guarantees the environmentally friendly nature of the measure in the context of climate change.



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