

PAVING THE WAY TO LARGE-SCALE WIND POWER DEVELOPMENTS: MOROCCO'S PRE-COP22 POLICIES

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In 2016, Morocco's 850 MW wind auction set a world record at 2.8 ¢cent/kWh with up to 70% of investments in local contents. A local rotor blade factory as part of industrial offsetting policies showed how ONEE, the country's utility leveraged its wind energy experience. Public and private wind developments backed by local banks enabled Morocco to tap into its significant wind potential. With an interconnected grid to neighboring markets opening the Atlantic Sahara trade winds to a regional power dispatch, Morocco's chairmanship of the Marrakech COP 22 conference makes inclusive renewable energy policies a matter of utmost importance.

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INTRODUCTION

A High-level impulse to wind energy

Before 1994, efforts to develop wind energy in Morocco were rather limited. Created in 1983 with the aim to promote the use of renewable energies, the Centre for Development of Renewable Energies (CDER) carried wind measurements on a few sites in the northern parts of the country. Distributed throughout the countryside, earlier mechanical wind pumping systems installed during French colonial times in the 1930's were turning decrepit. These were gradually replaced by diesel pumping. Hence, the first wind turbines introduced in the country under a US foreign assistance program were dedicated for that purpose. Under a partnership with CDER, USAID funded two 10 kW Bergey wind turbines connected to water pumps in the North-Eastern rural community of Naima..

The country's wind energy prospects remained rather bleak, that is until the significant Atlantic trade winds potential blowing over the Sahara desert coastline were brought to the attention of Morocco's Head of State. Submitted on February 19th 1994 through the express intercession of King Mohammed VI (then Crown Prince Mohammed) a High-level Report [1] on the Sahara wind energy potential was presented to late King Hassan II. In a matter of days, an entirely new team was nominated at the helm of Morocco's national electric utility ONE [2] with the firm intent to develop wind energy. Trained at the prestigious Ecole Polytechnique of France with experience in the private sector Driss Benhima was nominated as ONE's managing director, flanked by a deputy director with strong experience in renewable energies. Holding a PhD in energy management Ali Fassi Fihri [3], was the head of Morocco's Renewable Energy Development Center-CDER. He would concurrently hold this position with that of deputy director of ONE. Tasked with building a strong wind energy portfolio, he coordinated Morocco's first private energy concession schemes.

Under instruction of Morocco's Head of State, the country resolutely pursued a renewable energy deployment strategy. It

is important to mention that most alternative energy policies were at the time eluded by France's EDF, where many of Morocco's utility employees had accomplished training programs. Within such context, late King Hassan had personally funded the building of Africa's first wind-diesel system on the Sahara Atlantic trade windblown coastline, on one of his agricultural properties. The hybrid system that I had the privilege to conceive and install, took advantage of the significant trade winds that were reported upon initially. Built at cost of 500,000 US\$, the AOC 15/50 kW [4] wind turbine powered a small distribution grid connected to various electric loads such as water pumping and ice-making. Built at El Argoub, near the city of Dakhla, the Tiniguir wind-diesel demonstration system premiered wind technologies in many aspects. Powering an agricultural farm, the system was to be commercially viable and was built for that purpose. The very same spirit drove ONE's subsequent wind program on a much larger scale in trying to develop a wind power base relying on private sector involvement. Within a few months, the country's first Independent Power Purchase IPP agreement for a large coal-fired power plant had been attributed to a private operator. ONE looked therefore at similar options and attempted to launch an auction for a first wind park.

INITIATING PRIVATE WIND CONCESSIONS

Morocco's first Koudia/Abdelkhalek Torres wind farm

With wind measurements available from CDER for several years, the Koudia al Baida site on Morocco's northern tip, displayed one the best wind conditions available at the time. With a yearly average of 11 m/s, it was estimated that the site could generate wind energy on a competitive basis. Unfortunately, private sector interest into a Moroccan wind venture was limited at the time. Thriving on favorable feed-in-tariffs available in Europe, the industry considered Morocco's first-mover conditions not attractive enough. With limited options available, ONE ended-up working out a Power Purchase Agreement on a 50 MW wind farm with Jean Michel Germa, a French expert running a consulting cabinet. The latter brought EDF and the ParisBas bank in a wind farm venture, into which he would retain a 15% equity stake. At

5.5¢cent/kWh over a 20 year concession, the Power Purchase Agreement was about one-third more expensive than a coal-fired one. It represented nonetheless the country's first step into a major wind project. As the largest private wind farm on the African continent (as well as emerging economies) upon commissioning, it represented EDF's major wind investment for many years. On-line since the year 2000 with some 90 single 600 kW Vestas wind turbines, the Koudia wind farm was renamed after Abdelkhalek Torres, Morocco's iconic nationalist which led the region's independence from Spanish rule.

An inconclusive Tangier/Tarfaya joint wind farms bid

Subsequent to the aforementioned wind premiere, ONE sought to expand the country's wind capacities by launching a call for tender for two large wind farms, making it the world's largest wind auction at the time [5]. Introduced in 1999, the combined 140 MW Tangier wind tender north of the country coupled to 60 MW by Tarfaya in the south saw the participation of nine international consortiums. Due to significant price differences between both sites, ONE decided to drop the Tarfaya site, short-listing two consortiums for the Tangier wind farm. As ONE disposed of concessionary financing sources of its own -unavailable to the private sector- the Tangier wind tender ended-up too expensive to build [6]. The tender was therefore considered inconclusive and subsequently withdrawn. Having lost the opportunity to win this tender, Enercorp one of the two remaining qualified bidding companies was dissolved. Its director, Alexander "Andy" Karsner left for the United States and became U.S. Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) [7] during most of the Bush administrations' second term. Although anecdotal, his nomination made earlier applied research partnerships with the U.S. Department of Energy in support of the Sahara Wind project extremely difficult to implement [8].

PUBLIC UTILITY WIND DEVELOPMENTS

The Essaouira Amogdoul wind farm

At Cape Sim, Atlantic trade winds can be tapped on Morocco's northern latitudes. Favorable wind measurements confirmed the quality of a site, adjacent to the ocean. With the help of a 50 M€ (Million Euro) concessionary loan provided by the German KfW, ONE launched its first wind farm tender under an Engineering Procurement and Construction EPC scheme. The tender's result enabled the building of the 60 MW Amogdoul wind farm commissioned on April 13th 2007 with 71 G52-850 kW Gamesa wind turbines. Located near the city of Essaouira, reduced financing costs and a maintenance contract with Gamesa, enabled ONE to refine its experience in wind farm operation. An earlier 3.5 MW Enercon E-40 wind demonstration facility within the 50 MW Koudia wind farm had indeed proven to be challenging to maintain for ONE. The relocation of the Amogdoul wind farm's site a few kilometers away from the ocean's more corrosive environment where measurements were taken, affected its productivity negatively. As a consequence, wind-electricity costs turned out to be higher than expected. The lack of regulatory compensation mechanisms to support wind power deployments makes generation costs a critical issue to ONE. This would be particularly relevant in its merger with ONEP Morocco's water utility to form a joint state conglomerate designated as ONEE.

The Tanger I Dahr Saadane 140 MW wind farm

With a firm commitment to develop wind energy using concessionary finance, ONEE launched its second EPC tender on the site of Tangier's earlier private 140 MW wind farm tender. At the height of the wind turbine market crunch of 2008 with soaring prices, financing from the European Investment Bank-EIB (80 M€) and the German KfW (50 M€) had to be complemented with 100 M€ provided by the Spanish Instituto de Credito Oficial-ICO to support Gamesa's winning tender. Building upon earlier experiences with similar machines at the Amogdoul wind farm, the Tangier 140 MW wind farm's larger scale made the local integration of its components economically viable. Besides civil works and electrical equipment sourced locally, tubular towers for the 165 G52-850 kW Gamesa wind turbines were also rolled in Morocco. For that matter, upon the June 28th 2010 official commissioning of the "Dahr Saadane" Tangier wind farm, a 1000 MW Moroccan Integrated Wind Energy program was officially announced.

PRIVATE SECTOR WIND DEVELOPMENTS

Morocco's Renewable Energy Law 13-09 and Nareva's Akhfennir, Fom El Oued, Haouma wind farms

Concurrent to ONEE's wind developments, the Moroccan legislation evolved under a cogeneration law 13-09 on renewable energies [9]. This law enables private operators to supply industrial end-users with renewable electricity under a long-term contract. By wheeling this electricity through ONEE's grid at a fixed rate, and without providing any support scheme, the law saw the emergence of several wind farms on the country's windiest sites. Among these are the Akhfennir (100 MW) and Fom El Oued (50 MW) wind farms located on the Sahara trade windblown coastline, as well as the Haouma (50 MW) wind farm near Tangier. Developed by Nareva, a local private energy developer and equity investor, these came online in 2013 [10]. Moroccan banks mostly from the private sector carried the financing for these wind developments. ONEE's 300 MW concurrent wind tender by Tarfaya -Africa's largest- paved the way to similar funding schemes.

Tarfaya 300 MW: Africa's largest operational wind farm

Launched in 2007 the selection procedure for ONEE Tarfaya 300 MW IPP concession tender stretched over 4 years. During this time, developers found it challenging to mobilize significant amounts of investments needed in equity and project debt financing. After a lengthy process, the tender collected only two offers that pitched ENGIE (formally Suez-Gaz de France) on its own or in a partnership with Nareva through its recently acquired International Power subsidiary. With access to local finance facilitated by Nareva, the latter ended-up winning the tender in 2011. As a result, an Independent Power Purchase agreement for 0.64 DH/kWh (6.0¢cent/kWh) over 20 years was signed with ONEE under a BOOT (Build, Own, Operate and Transfer) contract. On-line since December 2014 with a capacity of 301 MW, the Tarfaya wind farm is the largest in operation on the African continent. Its size associated to subsequent financial exposure, represented both a challenge as well as an opportunity for local banks to get involved. As a first step into the wind sector, the effect of scale on electricity prices expected from a 300 MW single wind farm was rather limited. It remains indeed, the country's highest.

PUBLIC-PRIVATE PARTNERSHIPS

1000 MW Moroccan Integrated Wind Energy Program

While scale makes a sound economic justification for transferring a wind industry, the learning curve provided by the Tarfaya wind farm enabled ONEE to assess the best possible configurations for individual wind farms and project size. That combination will prove to be critical in the conception of its 1000 MW integrated wind energy program. Consisting of five separate wind projects listed within a single tender stretching over several years, ONEE's integrated wind program is capable of providing visibility to wind turbine manufacturers. It enabled them to identify manufacturing capacity deployments as well as key technology integrations over an extended period of time. This can enhance wind turbine efficiency and lower generating costs. In order to address financial exposure on each of the five wind farms within this large tender, ONEE provided co-financing possibilities of its own available under Public Private Partnership agreements. With concessionary sources of funds provided on most favorable terms by financial institutions, ONEE was in a position to help leverage financial deals for each bidding consortium. Following an international pre-qualification round, the open process during which every bidder was allowed to review its offer stretched over a timeframe ranging from its initial technical offer submission to its reviewed offer until the ultimate commercial offer. As time went on, wind measurements were collected over the five sites and continuously provided to each prequalified bidder. This added certainty and helped fine-tune respective offers being prepared.

Phase I: the Taza wind farm

As wind data for the 150 MW wind farm by Taza were readily available before the 1000 MW initiative started, the site would be used to stage a phase I/pilot project for the remaining 850 MW wind tender [12]. The Taza wind farm involved for the first time a Public Private Partnership on its financing. As a result, a 50 Million Euro reduced-interest loan was provided by the German KfW to ONEE for this project. Closed in 2012, the 150 MW Taza wind tender ended-up being won by a consortium led by French electric power provider EDF Energies Nouvelles along with the Japanese investment firm Mitsui & Co. Ltd at an electricity price of 0.52 DH/kWh (4.7¢cent/kWh) [11].

The 850 MW Moroccan Integrated Wind Energy Initiative

The expected lower electricity prices achieved on Taza's wind site, comforted ONEE in its approach to blend public and private funding for its remaining 850MW of wind capacity to be carried out in five different projects. Designated under the Integrated Wind Energy Program the Tanger II (100 MW), Boujdour (100 MW), Tiskrad (300 MW), Midelt (150 MW) and Jbel Lahdid (200 MW) wind farms are spread throughout ONEE's national grid over a distance exceeding 1500 kilometers. They range from the Atlantic Sahara trade windblown coastline at Boujdour (100 MW) in the South, to the Tanger II (100 MW) wind farm by the strait of Gibraltar on Africa's Northern tip.

Table 1. 850 MW Integrated Wind Energy Program wind farms

Name	Wind Quality	Size MW	Year
Midelt	Good	150	2017
Tiskrad	Excellent	300	2018
Tanger II	Very Good	100	2018
Jbel Lahdid	Good	200	2019
Boujdour	Excellent	100	2020
Total		850	2020

Although extended in time due to its size, the preparation of Morocco's Integrated Wind Energy Program spearheaded by ONEE involved contributions of major financial institutions. The program benefited from respective loans amounting to 15 M€ from the European Commission [13], 130 M€ from the KfW Development Bank of Germany [14], 200 M€ from the European Investment Bank (EIB) [15], 359 M\$ from the African Development Bank [16] and a further 125 M\$ from the World Bank Group's administered Climate Investment Fund [17]. Under the last two, the Integrated Wind Energy Program helped leverage funding for rural electrification and pump-storage facilities for excess wind-electricity generation to help shave-off peak-load demand curves. Hence, the cumulative financing collected from international institutions around the 850 MW Integrated Wind Program amounted to approximately 775 M€.

The auction process which lasted from June 2010 until March 2016 aligned five final qualified international bidding consortiums. As a result, the winning Nareva/Siemens/Enel-led consortium managed to submit an offer which consecrated one of the world's cheapest wind-electricity at 0.31MAD/kWh or 2.8¢cent/kWh obtained through project finance (without feed-in tariffs, tax breaks or other support mechanisms) [18]. The offer included the launching of a 600-Rotor-blades/year factory unveiled by Siemens near the Tanger-Med harbor [19]. The major part of its production is destined to regional export markets. Considering such project-tied industrial investments, Morocco's Integrated Wind Energy Program can reach up to 70% in local contents of its total value. In the light of a rather limited 850 MW auction volume, the learning curve of Morocco's earlier wind deployments led to a high-impact successful economic model.

CONCLUSION

After the Paris Global Climate Agreement, the 22nd Conference of the Parties COP22 taking place in Marrakech, Morocco from November 07-18th 2016 will gather major players to help establish effective global climate adaptation and emission mitigation policies. As a host country which will carry the COP21 Chairmanship from France, Morocco's wind deployment frameworks set the tone to sound, more inclusive wind-energy driven policies. Dubbed the "COP of projects" or the "Paris Agreement-Implementation COP", the Marrakech COP22 conference will provide further economic evidence on the benefits of a global renewable energy transition. The Multi-GigaWatt scale of the Sahara Wind project is for that matter set to open a new chapter in high-economic impact regional trans-border renewable energy collaborations.

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