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AFRICAN DEVELOPMENT BANK GROUP

Development of Wind Energy in Africa

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Office of the Chief Economist

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Abstract

This paper describes how Africa's wind energy markets have evolved over the years and the structural characteristics affecting the development of wind energy projects on the continent; providing what we believe is the first mapping of the continent's wind energy market. Results from our analysis of 94 projects on the continent suggest that wind energy markets remain small, concentrated and nascent in nature. While we observe an increasing trend in the number and size of projects being implemented, we show that wind energy contribution to the energy mix in Africa will remain unchanged over the long term. A key observation in the paper is that wind energy has limited potential to address the issue of access to electricity in Africa mainly due to the intermittent nature of electricity output from wind power plants. Wind energy is more likely to complement electricity generation from conventional sources, as has been observed in more mature markets. We estimate the cost of the 1.1 GW installed wind power capacity in Africa at USD 1.8 billion, out of which 59 percent was contributed by development finance institutions as non-concessional funding. We also notice a shift from the use of concessional funding on projects towards non-concessional funding from development finance institutions, an increasing participation of the private sector and greater use of specialized funds and Clean Development Mechanism funding. There is also emerging south-south cooperation with some experienced African firms seeking new markets across the continent. The paper finds that the public sector remains a key player in the wind energy sector, not only as a financier but also as a local partner that ensures smooth project implementation. The paper also discusses technical, environmental and financial considerations that African countries need to take into account when developing wind energy projects.

JEL Codes: O13, O55, Q01, Q42

Keywords: renewable energy, infrastructure financing, wind energy markets, Africa

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Abbreviations

ACF	Africa Carbon Facility
AFD	Agence Française de Développement
AfDB	African Development Bank
AGF	Africa Green Fund
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
CCC	Conventional Combined Cycle
CDM	Clean Development Mechanism
CED	Compagnie Eolienne du Détroit
CER	Carbon Emission Reduction
CIF	Clean Investment Fund
CTF	Clean Technology Fund
DANIDA	Danish International Development Agency
DFI	Development Finance Institutions
ECA	Export Credit Agency
EIB	European Investment Bank
EPC	Engineering Procurement and Construction
EUR	Euro
FAD	Development Assistance Financing (Spain)
FiT	Feed-in-Tariffs
GEF	Global Environment Facility
GHG	Green House Gas
GW	Giga Watt
IEA	International Energy Agency
IFC	International Financial Corporation
IPP	Independent Power Producer
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
KfW	Kreditanstalt für Wiederaufbau - German Development Bank
kWh	Kilowatt hour
LIC	Low Income Country
MDB	Multilateral Development Bank
MIC	Middle Income Country
MIGA	Multilateral Investment Guarantee Agency
Mtoe	Million tons of oil equivalent
MWh	Megawatt hours
NATO	North Atlantic Treaty Organization
NREA	New and Renewable Energy Authority (Egypt)
O&M	Operation and Maintenance
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
ONE	Office National de l'Électricité (Morocco)
PIDG	Private Infrastructure Development Group
PPA	Power Purchase Agreement
PPP	Public Private Partnership
REACT	Renewable Energy and Adaptation to Climate Technologies
REIPPP	Renewable Energy Independent Producers Procurement Programme
SAWEP	South Africa Wind Energy Programme
SEFA	Sustainable Energy Fund for Africa
STEG	Société Tunisienne de l'Electricité et du Gaz (Tunisia)
TZS	Tanzanian Shilling
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
ZAR	South African Rand

1.0 Introduction

With over half a billion people on the continent lacking access to electricity, Africa is faced with the challenge of generating more power to meet existing and future demand. For many countries, an opportunity exists to do so in a clean and sustainable manner. The continent is well endowed with renewable energy resources which constitute plausible solutions to address existing power shortages (Table 1.1). Indeed, Africa's reserves of renewable energy resources are the highest in the world, and the continent has enough renewable energy potential to meet its future energy needs (World Energy Council, 2010). It is estimated that 18 of the top 35 developing countries ranked highest in renewable energy reserves, normalized by annual domestic energy consumption, are located in Africa (Buys et al, 2007). Similarly, at least 8 African countries are among the developing world's most endowed in terms of wind energy potential.

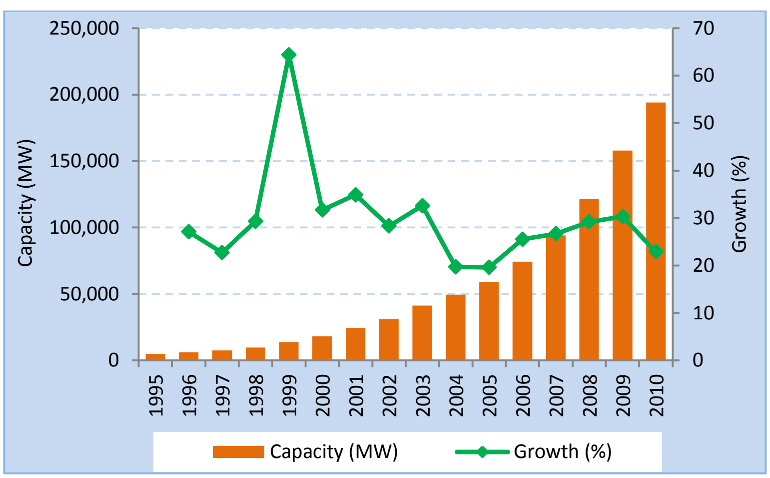
Table 1.1: Developing Regions with the Highest Potential for Solar, Wind, Hydro and Geothermal Energy

Region	Total Renewable Energy	Solar	Wind	Hydro	Geothermal
Africa	18	24	8	11	9
East Asia/Pacific	4	5	3	6	4
Europe/Central Asia	3	0	6	5	14
Latin America/ Caribbean	7	5	8	9	3
Middle East	1	0	1	0	0
South Asia	0	0	1	1	0
All World Bank Regions*	33	34	27	32	30

Source: Buys et al. (2007). *188 countries (close to world total of 193 countries per the World Almanac statistics 2012)

While global wind-based electricity generation is still underdeveloped relative to exploitation of other renewable fuels such as hydro, it has grown at an average annual rate of about 30 percent between 1996 and 2008; making wind one of the world's fastest-growing energy resources in terms of both coverage and technological innovations (Figure 1.1). The growth reflects mainly advances in technology and energy security concerns in a decade that saw some of the highest oil prices recorded in history. Climate change considerations have played a role as well.

Figure 1.1: Growth in Global Wind Generation Capacity



Source: World Wind Turbine and Wind Farms Database

However, despite these positive trends and Africa's potential supply of wind energy, installed capacity of wind-based electricity in Africa, of about 1.1 GW in 2010, does not exceed 0.5% of global capacity. The disparity between potential and extent of exploitation raises questions about constraints to development of wind energy on the continent. The absence of detailed information at individual project level further restricts developers' and policy makers' understanding of the market.

The goal of this paper is to improve understanding of how wind energy markets have been developing in Africa. There are two key objectives: provide a mapping of wind energy potential and projects developed on the continent so far; and identify impediments hindering further development of wind energy markets on the continent. We use a hand-collected sample of 94 wind projects in Africa to perform what we believe is the first continent-wide mapping for the markets.

The paper is structured as follows: Section 2 provides an overview of the continent's wind potential and installed capacity. Section 3 provides a micro picture of the sector by mapping wind energy projects, describing their main characteristics and financing sources, and identifying incentives that have been established to promote the sector. In section 4, physical, technical and economic peculiarities that prevent African countries from harnessing their wind energy potential are examined. Section 5 is a conclusion of the discussions in the paper and also provides policy recommendations.

2.0 Africa's Wind Energy Market: Setting the Stage

To contextualize the development of the wind market in Africa, it is important to set the backdrop against which projects are being developed. This includes mapping of locations with wind resources and the size of potential output, reviewing the electricity generation mix for currently installed capacity, as well as assessing the outlook of the industry. The mapping of potential is important to establish the upper limits of wind energy development on the continent. These limits are most meaningful when cast against existing technologies and other important considerations in wind energy development.

While multiple dimensions exist on which wind energy potential could be defined, we adopt for the purposes of this paper, a characterization based on the technical wind energy potential for African countries. This approach takes into consideration the physical upper limit given observed wind speeds, technological efficiency, and other structural and ecological restrictions[5]. We defer to section 4 the discussion on soft constraints to wind energy development such as legislative restrictions and limited competition in the energy markets.

Using a technical feasibility method based on technologies available in 2005, Buys et al. (2007)[6] find that eight African countries, namely; Somalia, Sudan, Libya, Mauritania, Egypt, Madagascar, Kenya and Chad have large on-shore wind energy potential (Figure 2.1). Mauritania's potential, for example, is about four times its annual energy consumption in tons of oil equivalent, while Sudan's is equivalent to 90% of its annual energy needs. Yet, there is variability in terms of geographic location of wind potential across countries. In particular, the study finds that five additional African countries – Mozambique, Tanzania, Angola, South Africa and Namibia – have potentially large off-shore wind energy resources (Figure 2.2).

[5] Wind potential could be (i) ***theoretic***: the physical upper limit of an energy resource, (ii) ***conversion***: theoretic capacity accounting for technology efficiency, (iii) ***technical***: conversion capacity accounting for other technological, structural and ecological restrictions (iv) ***economic***: technical capacity which is economically feasible (Teske et al 2011).

[6] Buys et al. (2007) estimate potential electricity generation from renewable energy resources based on a geo-referenced database of energy indicators from a variety of sources. A key merit of this database is that it adopts a standard unit of measurement – million tons of oil equivalent (mtoe) – which makes estimates ideal for comparison of potential across energy types.

Figure 2.1: On-shore Wind Potential (mtoe*)

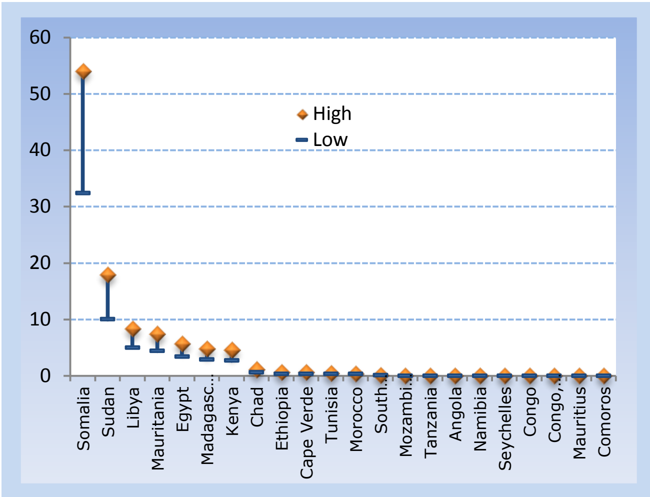
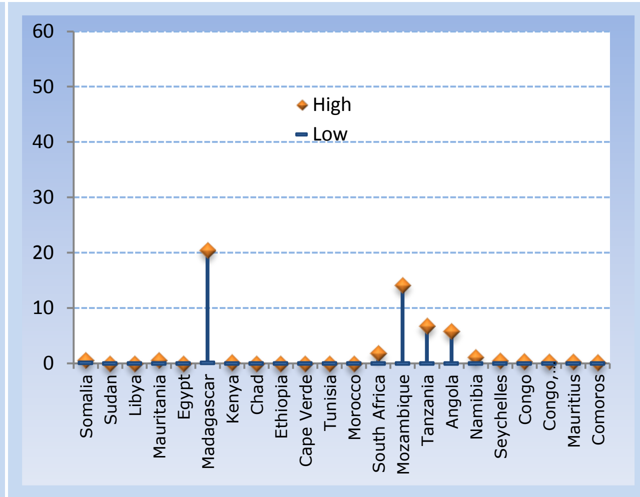
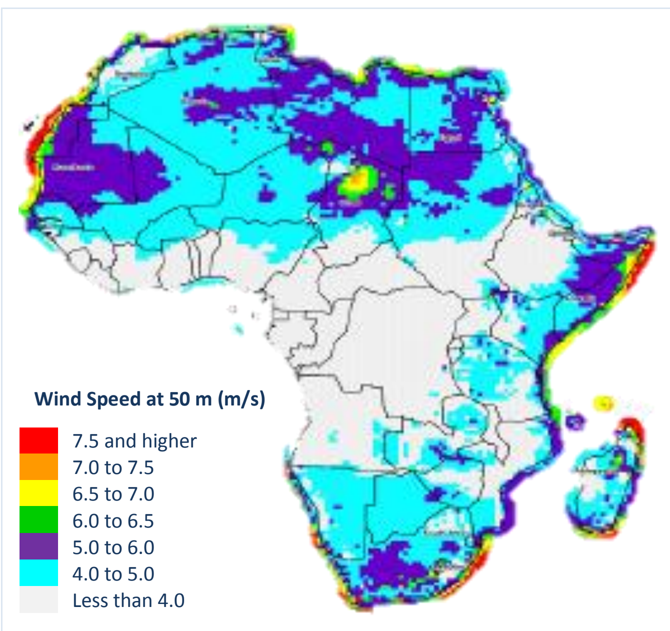


Figure 2.2: Off-shore Wind Potential (mtoe)



Source: Buys et al (2007). The 'high' scenario assumes technical feasibility at 2007 wind rotor density for Germany – world leader in 2005 – in terms of installed wind energy capacity; 'Low' scenario assumes 60 percent of Germany's density. * Mtoe: stands for million tons of oil equivalent.

Figure 2.3: Wind Speeds in Africa at an Altitude of 50 m



Source: AfDB, 2004

A study undertaken by the African Development Bank to create a wind atlas for Africa also revealed significant potential on the continent (AfDB, 2004). This study produced a quantitative map of wind speeds on the continent (Figure 2.3) simulated using the Wind Energy Simulation Toolkit (WEST)[7] model at an altitude of 50 meters and a resolution of 50 km. Results demonstrated that the best wind in Africa is found in the coastal regions of the continent: in the North (Algeria, Egypt, Morocco Tunisia and Mauritania), the East (Djibouti, Eritrea, Seychelles and Somalia), West (Cape Verde) and South (South Africa and Lesotho). Notably, this study identifies wind potential in some countries not identified by Buys et al in 2007, highlighting the need for further work to establish accurate data on wind energy resources on the continent.

In general though, sources show that the highest wind potential exists in coastal areas, which tend also to have both on-shore and off-shore potential (Figure 2.3). With the exception of countries like Chad and Ethiopia, whose topographies give rise to high speed winds in certain high altitude areas, the rest of mainland (land-locked) Africa's wind intensity is too low to be harnessed for electric power generation.

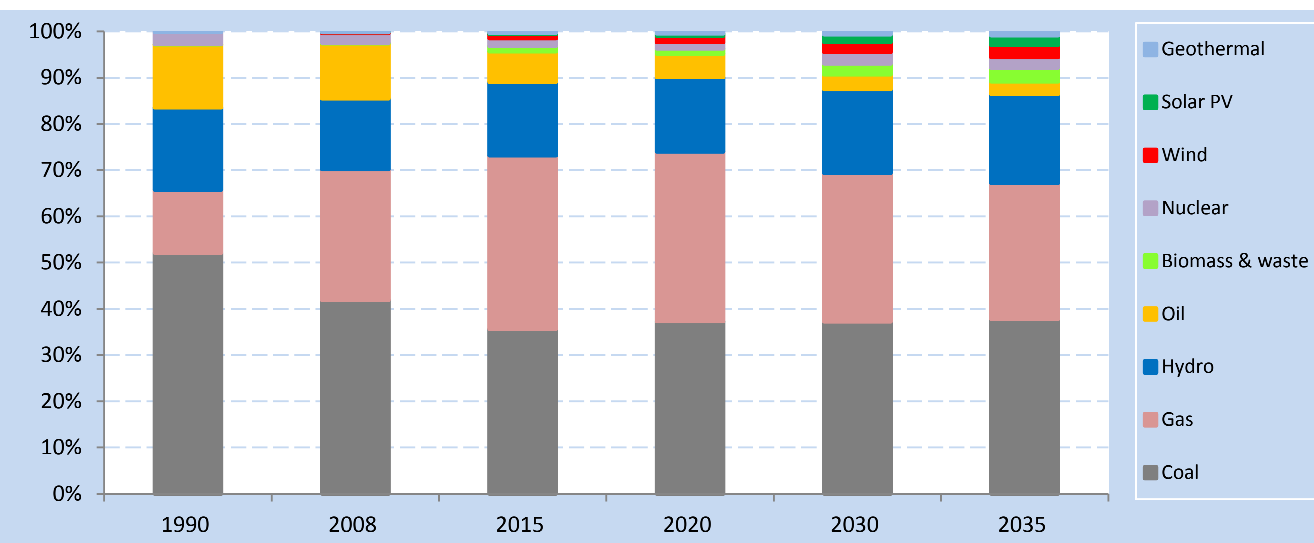
[7] The Wind Energy Simulation Toolkit (WEST) is a dynamic three-dimensional model of wind circulation on a horizontal plane which integrates physical phenomena such as radiation and condensation and parametric analyses of effects such as turbulence and convention (AfDB, 2004).

Despite the high wind energy potential in some African countries, wind powered electricity generation is still very limited, with an estimated 1.1 GW installed capacity in 2011. Notably, wind-based electricity contributes less than 1 percent to installed electricity generation capacity on the continent. This share falls below that for OECD countries (3.8 percent) and for non-OECD emerging markets (1.1 percent).

Among developing countries, Africa's wind energy potential is comparable to that of Latin America and the Caribbean. While the installed capacity for wind in Africa is expected to increase twelvefold over the next decade, in line with global trends in renewable energy development and technological innovations, the contribution of wind energy to Africa's electricity generation mix will remain very limited as illustrated by Figure 2.4. A similar trend is expected for Latin America whose current capacity falls below that observed in Africa. According to the International Energy Agency's projections (2010) wind energy is expected to contribute only 2% of generated electricity in Africa by 2030 under a business as usual scenario, as compared to other conventional energy sources like coal (37%), gas (32%) and hydro (18%); and relative to a global share of nearly 5% of total electricity generation capacity.

Wind installed capacity in Africa is not only small – both in absolute terms measured by installed capacity, and relative terms as measured by its contribution to the energy mix – but has also been highly concentrated with 3 countries (Egypt, Morocco and Tunisia) holding about 96% of total installed capacity as at end-2011. Further details about this market feature are provided in the next section.

Figure 2.4: Historic, Current and Projected Trend of Africa's Electricity Generation Mix



Source: International Energy Agency 2010

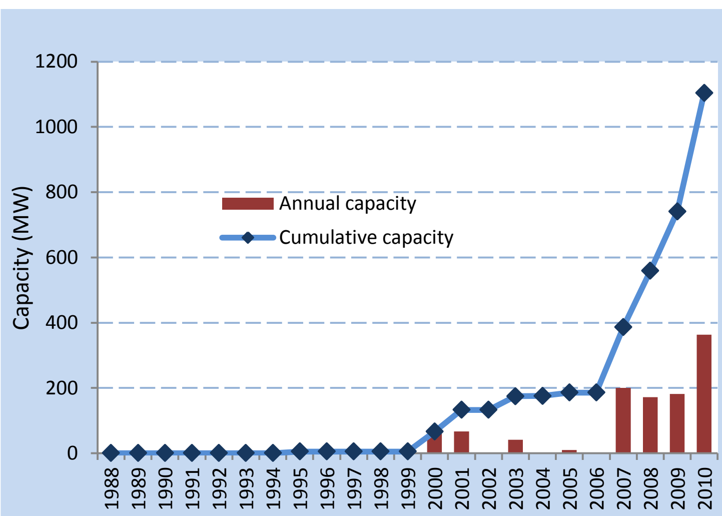
3.0 Mapping Wind Energy Projects in Africa

In this section we first take a historic perspective on wind energy development in Africa to provide stylized facts on the industry and its funding sources, then analyze the market's outlook. Inevitably, there is a strong focus on market leaders including analyses of specific policies, strategies and financing instruments adopted in these countries to develop the market. We use a hand collected sample of 94 wind energy projects, compiled from various data sources including the AfDB's project portfolio, Thomson One database, the Wind Power database, the Global Energy Observatory, research papers and various websites as detailed in the References section. Our sample is comprehensive with a near full list of completed projects in Africa between 1980 and 2010; and an extensive, though non-exhaustive, list of ongoing and planned projects[8].

3.1 The Profile of Wind Energy Projects

Based on the individual capacity of projects we identified, Africa's installed wind energy capacity increased twelvefold between 1995 and 2010 (Figure 3.1), with most of the growth taking place starting early 2000. Notably, between 2000 and 2010, Africa's installed wind capacity grew at a rate of 41%; much faster than the average global growth rate of 27%. Africa's great performance is a reflection of the embryonic nature of the African market characterized by limited initial capacity. Indeed, Africa's growth rate between 2000 and 2010 is very similar to the one reported for other regions during their early stages of market development (*i.e.* 35% over the period of 1995-2000).

Figure 3.1: Installed Wind Capacity in Africa



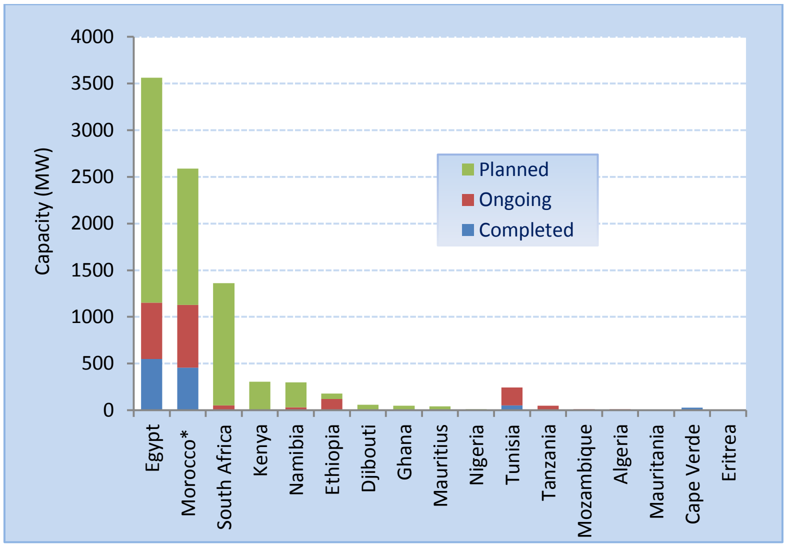
Source: Authors' analysis

A distribution of projects based on their location and stage of development is provided in Figure 3.2 and Figure 3.3. Out of the 94 projects identified, about a third (30) is completed. Of the completed projects, 93% came on stream after 2000, which is consistent with the nascent nature of this market on the continent. Our database also shows a high concentration of installed wind capacity, with 73% of completed projects located in 3 North African countries – Egypt, Morocco and Tunisia – which collectively account for 96% of total installed capacity at end-2010. Egypt leads this market, contributing 33% of total completed projects and 50% of total installed capacity on the continent. Egypt is followed by Morocco which accounts for 30% of total completed projects and 41% of total installed capacity. Tunisia has three completed projects, all located at Sidi Daoud, with a total installed capacity of 54 MW (about 5% of Africa's installed capacity). In southern Africa, Namibia, Mauritius, Mozambique and South Africa already have installed wind energy capacity. So far, South Africa has an installed capacity of only 9 MW. In East Africa, two small projects have been completed; one in Kenya

[8] '*Ongoing*' projects are defined as projects for which construction activities have commenced while '*planned*' projects are those in the pre-construction phase.

(Ngong Hills) and the second one in Eritrea (Assab Wind Park). No completed wind energy projects were identified in West and Central Africa.

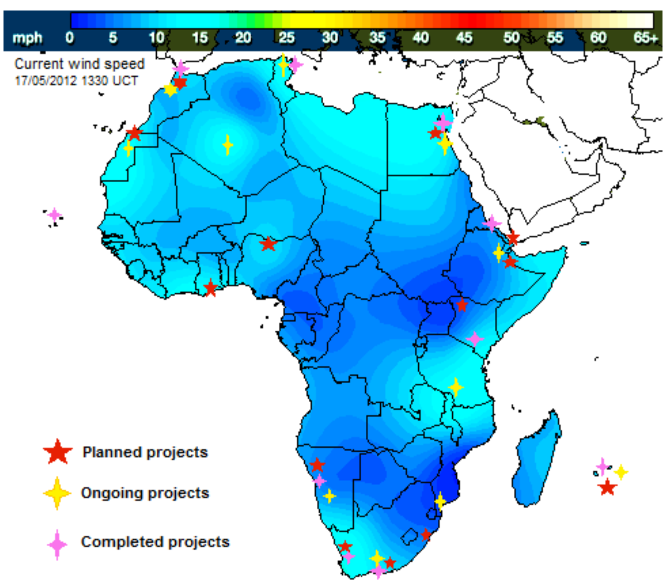
Figure 3.2: Installed Capacity by Country and Stage of Development



* Excluding the planned Sahara Wind Project (5000 MW)
Source: Authors' analysis

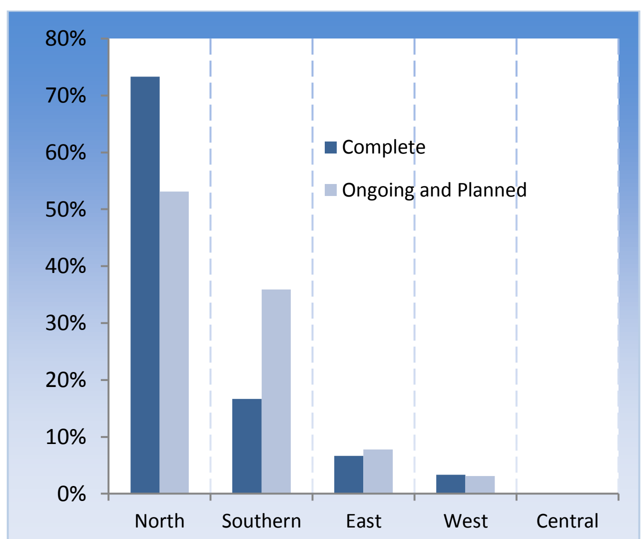
Although North Africa remains the leading region in wind energy markets in Africa, southern and eastern African countries are expected to reduce the gap, contributing 36% and 8% respectively of combined ongoing and planned projects (Figure 3.4). For instance, 35% of all planned projects are located in South Africa followed by Egypt (27%) and Morocco (21%). East Africa is also gaining ground with several projects in the region such as the two ongoing commercial scale projects in Ethiopia and Tanzania (Ashegoba and Njiapanda wind farms, respectively); and some planned projects in Kenya, Djibouti and Ethiopia. The latter include the Lake Turkana wind farm in Kenya, which is the largest wind energy projects planned in Sub Saharan Africa. No ongoing or planned projects were recorded for Central Africa.

Figure 3.3: Geographic Location of Projects by Stage of Development



Source: Find Local Weather (wind map) plus authors' mapping of wind projects

Figure 3.4: Regional Coverage of Projects by Stage of Development (% of projects)



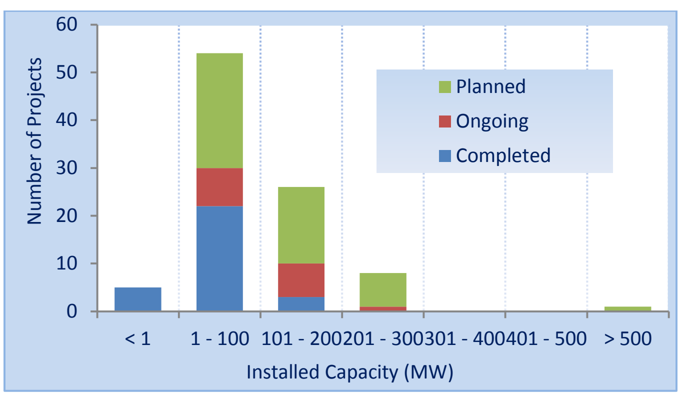
Source: Authors' Analysis

Interestingly, concentration is reported for ongoing and planned projects as well with three countries – Egypt, Morocco and South Africa – collectively contributing about 75% of the total number of projects either ongoing or planned (or 83% of total capacity) on the continent. This is due to, among other factors, a stronger political commitment to renewable energy from what are comparatively energy-intensive countries and the high electricity access rates that already exist in these countries (see section 4.2).

It is worth noting that the bulk of Africa's completed projects are located either in coastal areas, or sit on islands. The exception is Kenya, which has its largest potential inland around the Lake Turkana highlands whilst having significant coastal potential as well. Both its pilot facility and planned projects are located inland. The wind farms in Algeria, Nigeria and Tanzania are also located inland.

The small size of the African wind market documented earlier reflects not only the limited number of wind farms but also the small scale nature of the projects. The individual capacity of most projects in Africa, whether completed, ongoing or planned, remains small and broadly ranges between 1 MW and 100 MW (Figure 3.5). Only 3 completed projects have installed capacity exceeding 100 MW (Zafarana VI and VIII in Egypt and Tangier in Morocco). Notably, most of the larger wind farms have been implemented in phases whereby the individual project sizes generally fall within the abovementioned range. For example, the Zafarana and Gulf of Zayt wind farms in Egypt consist of 8 and 7 separate projects respectively, whereas the Touahar wind farm in Morocco is made up of 3 individual projects. Each individual project in the aforementioned examples may be unique in terms of project sponsors, sources of funding and sometimes the technology used. There is however an increasing trend in the size of projects being implemented. For instance, while only 3 completed projects have installed capacity exceeding 100 MW, half of ongoing and planned projects have capacity greater than 100 MW. No pilot projects were identified in our sample of ongoing and planned projects, which comprise only of commercial scale wind farms (Table 3.1). This suggests either progress toward maturity of the market, or transferability of technologies already tested on the continent.

Figure 3.5: Distribution of Projects by Installed Capacity



Source: Authors' analysis

Table 3.1: Projects' Capacity by Stage of Development (MW)

Installed Capacity	Completed	Ongoing	Planned[9]
Total	1,104	1,731	10,907
Range	0.2 – 140	5 – 300	10 – 5,000
Mean	37	108	227
Median	25	95	110
Standard Deviation	40	86	701

Source: Authors' analysis

[9] The sample includes the planned 5,000MW Sahara Wind Project, whose planned capacity is an outlier. Excluding this project, average capacity of planned project drops to 126 MW. The Sahara Wind Project is an ambitious project aimed at generating electricity to supply Europe and the Mediterranean region via high voltage Direct Current transmission lines that will run from North Africa to Europe as well as other targeted markets. The project has already attracted interest from the North Atlantic Treaty Organization (NATO) and the United Nations Industrial Development Organization (UNIDO), among other global leaders in the energy sector, but is still a long way from being realized.

The 16 ongoing projects we identified are expected to add a cumulative capacity of about 1.5 GW to the current installed wind capacity. The 48 planned projects would add at least another 10 GW inclusive of the Sahara Wind Project, also known as the Moroccan Wind Plan, which is expected to have an installed capacity of 5GW.

3.2 Models of Industry Development

The observed trends emerging from the profiling of projects can be traced back to how the wind energy industry has developed in Africa. Most African countries pursued a phased approach to develop wind energy projects. This often started with pilot and field testing wind projects followed by semi-commercial wind farms, and subsequently by large scale commercial projects (Figure 3.6). The phased approach at pilot stage reflects need to test available technology, insufficient geo-referenced resources and data sets to gauge feasibility and guide investments, and low public sector capacity to oversee the industry's development. Once technologies have been proven feasible in pilot projects, a phased approach towards commercialization is often adopted, mainly reflecting lack of sufficient resources to fund large scale operations initially.

Figure 3.6: A Phased Approach of Wind Energy Development

Source: Authors

The first wind farms in Africa were established during the 1980's. In Egypt, a pilot wind farm was developed at Ras Gharib, near the Gulf of Suez, in 1988 which laid the foundation for large scale projects that were later established. The project was co-sponsored by the then Egyptian Electricity Authority (now Egyptian Electricity Holding Company, or EEHC) and the state-owned General Petroleum Company, to partly meet the energy needs of General Petroleum Company (USAID, 1986). This was immediately followed by the establishment of the Wind Energy Technology Center at Hurghada, which was established initially as a measurement and turbine testing center. A small scale demonstration wind farm was later added at the location. Egypt's first commercial wind project was the first phase of the Zafarana wind farm (30 MW) commissioned in 2001. Seven subsequent phases of Zafarana have since been completed, bringing the farm's capacity to 545 MW as of 2010. There are currently three ongoing developments on the Gulfs of Suez and El Zayt which are expected to add another 200 MW capacity each, and the expansion of the Hurghada wind farm which is expected to have an installed capacity of 1,100 MW at completion.

A strong public sector and donor presence can be observed in projects implemented in Egypt. For example, the Ras Gharib pilot project was developed using USAID resources whereas the Hurghada wind farm was funded by Danish and German resources. Zafarana received support from several bilateral investment promotion agencies, mostly the Danish International Development Agency (DANIDA) and Germany's KfW. All completed projects in Egypt (and most ongoing and planned projects) were sponsored by the New and Renewable Energy Authority (NREA), the public entity created in 1986 with a mandate to plan and implement renewable energy programs. No private developers were active in Egypt on completed projects. The Italian energy generation firm, Italgen, is poised to become the first private developer with its planned 120 MW wind farm along the Gulf of El

Zayt. And among NREA's planned projects, one - the Gulf of Suez 200 MW facility - is structured as a public-private partnership (PPP)[10].

Tunisia is following a similar development path, though on a smaller scale and with concessional official development assistance (ODA). The first wind farm at Sidi Daoud was developed in three phases with financial support from Spain, including (i) concessional lending from the Spanish Development Assistance Financing (FAD) to the Tunisian government, and (ii) commercial debt from the Spanish Export Credit Agency in favor of the Spanish EPC (Engineering, Procurement and Construction) contractor, Gamesa. The state-owned utility Société Tunisienne de l'Electricité et du Gaz (STEG) sponsored these projects. The utility is also sponsoring the planned large scale operation (190 MW), Centrales Eoliennes de Bizerte 1 and 2, which too is expected to receive Spanish development aid. No significant private operations were identified in the pipeline projects for Tunisia.

In Morocco, the first pilot was a 3.5 MW project near Tetouan (the Al Koudia Al baida project), developed by the public utility Office National de l' Électricité (ONE) with KfW support. But unlike Egypt, Morocco immediately migrated in 2000 to private procurement of wind energy projects: the 50 MW expansion of Al Koudia Al baida was developed by a French consortium Compagnie Eolienne du Détroit (CED) under a 19-year build-own-operate-transfer (BOOT) concession. A third of the completed projects in Morocco were structured as public while the rest were developed as either public-private partnerships or independent power production.

Mauritius followed a path similar to Morocco's; first engaging with public entities for pilot phases before turning to private sponsors. A first attempt was made in the 1980s, but did not yield satisfactory results as cyclone-proof technology was not fully mastered. A 0.2 MW pilot project was later commissioned in 2004 at Rodrigues Island. This project is owned and operated by state-owned Central Electricity Board. A private French wind energy developer, Aerowatt, is expected to execute the first two commercial operations in the country under BOOT contracts: the 18 MW Eole (Plaine Des Roches) and the 22 MW Britannia wind farms. Similarly, Kenya's only pilot farm at Ngong Hills was developed by its public utility KenGen in 2009. After the successful operation of the pilot project, there are plans to expand this wind farm to a commercial scale. Also in the pipeline is the country's first full blown commercial operation of 300 MW Lake Turkana wind farm which is also privately sponsored.

Some African countries are moving directly to relatively large scale projects and with private participation. Cape Verde's first wind farm – also the first commercial operation outside of North Africa – was executed as a PPP. However it is interesting to note that the key private shareholders of the project company (Cabeólica S.A.) – Africa Finance Corporation, Finnfund and Infraco – are institutions with a development mandate. Similar developments are being observed in Algeria.

In South Africa, the wind energy market remains underdeveloped, with only two completed pilot projects sponsored; one by its public utility Eskom (Klipheuwel wind project); and another through a PPP arrangement with the financial backing of DANIDA (Darling Wind farm). The industry is however poised to grow exponentially, thanks to the private sector led developments expected following the recent conclusion of a concrete procurement framework for renewable energy Independent Power Producers (IPP) as discussed in section 4.4. The first set of grid connected wind

[10] PPPs encompass all forms of engagement involving a private party as part or full owner of the wind project, and including a power purchase agreement with the national utility.

power projects is currently under procurement and is expected to add 634 MW in installed capacity by 2013. New key players will emerge once these developments get under way, the largest being South Africa's Red Cap Investments and the Spanish firm Iberdrola (Table 3.2). Namibia is following suit: the quasi-public entity ErongoRED led wind energy development with its pilot farm at Walvis Bay, and a commercial project (Innowind project) is underway with financial support from DANIDA.

3.3 Key Players in Wind Markets

3.3.1 Developers, Sponsors and Operators

In order of installed capacity, NREA (Egypt) is the largest owner/operator of wind energy capacity on the continent. It is followed by other North African public utilities, ONE in Morocco and STEG in Tunisia. The profile of private players is heterogeneous in nature, and includes both established international operators, as well as recently established African based firms, some of which are joint ventures between African and international firms. Table 3.2 summarizes the key operators and developers of wind energy projects in Africa, including the top-ten prospective entrants. French, Spanish and Dutch investments are already present on the continent. With the exception of prospective IPP investments by the world's third largest wind energy developer, Iberdrola, foreign direct investments in Africa's wind energy market is driven by relatively small and emerging players.

Table 3.2: Key Operators in the Wind Energy Market in Africa

	Ownership	Domiciliation	Country Coverage in Africa	Installed Capacity (MW)	Pipeline Capacity (MW)
NREA†	Public	Egypt	Egypt	550.2	2690
ONE†	Public	Morocco	Morocco	304.3	650
STEG	Public	Tunisia	Tunisia	53.6	190
Chaâbi Group§	Private	Morocco	Morocco	70	-
Compagnie Eolienne du Détroit (CED)	Private	France	Morocco	50	-
La cimenterie de Tetouan§	Private	Morocco	Morocco	32.2	-
Cabeolica	PPP	Cape Verde	Cape Verde	28	-
Nareva Holding‡	Private	Morocco	Morocco	70	750.6
InnoVent	Private	France	Namibia	-	300
KP & P Holding B.V (Lake Turkana)	Private	Netherlands	Kenya	-	300
Red Cap Investments	Private	South Africa	South Africa	-	277.6
Masdar	Private	Abu Dhabi	Egypt	-	200
EEPCO	Public	Ethiopia	Ethiopia	-	180
Iberdrola	Private	Spain	South Africa	-	160
Exxaro§	Private	South Africa	South Africa	-	140
ACED, AIIM & AFPOC	Private	South Africa	South Africa	-	135
ITAL-GEN	Private	Italy	Egypt	-	120

†Includes capacity co-owned with private investors. ‡Includes a joint venture investment between Nareva and International Power §Auto-producer whose capacity is operated by specialized firms such as Nareva.

Source: Authors' compilation

With regard to African firms, South Africa will soon have the fastest growing wind energy industry, as indicated by the number of prospective private operators in the market. Over 500 MW is expected to be installed by South African private operators though all operations will be concentrated in South Africa. The emerging south-south cooperation is also noteworthy: some well-established African firms are already seeking investments opportunities elsewhere on the continent, for example Egypt's El Sewedy which has plans to invest in the Ghanaian market.

Developments in the Moroccan market are unique in that they include some operators whose core business lies outside of the energy sector, for example, the Chaâbi Group and La cimenterie de Tetouan self-producers with mostly captive wind energy capacity. Nareva Holding, established in 2005 in Morocco, is set to have the largest market share among private operators.

3.3.2 Wind Turbine Manufacturers

The choice of wind turbine manufacturers on the continent is dominated by global leaders in the industry (Table 3.3). Data shows that the world leaders Gamesa and Vestas (fourth and largest wind turbine manufacturers respectively on the world market) dominate in terms of installed capacity and geographic reach.

Table 3.3: Wind Turbine Manufacturers with a Presence in Africa

Manufacturer	Domiciliation	Country Coverage	Installed Capacity	Pipeline Capacity
Gamesa†	Spain	Egypt, Morocco, Tunisia	630.8	590.0
Vestas	Denmark	Egypt, Kenya, Morocco, South Africa, Cape Verde, Algeria	136.3	55.0
Alstom Ecotècnia	Spain	Morocco	100.0	-
Nordex	Germany	Egypt	63.0	-
Fuhrländer	Germany	South Africa	5.5	-
Enercon	Germany	Morocco	3.5	-
Wincon	Denmark	Egypt	2.6	-
Vergnet	France	Eritrea, Mauritius, Ethiopia, Mauritania	1.0	125.0
Ventis	Denmark	Egypt	1.0	-
Jeumont	France	South Africa	0.8	-
Wind World	Denmark	Namibia	0.2	-
Vensys	Denmark	Algeria	-	14.0
Siemens	Germany	Morocco	-	50.6
Alstom	France	Morocco	-	200.0
El Sewedy Electric	Egypt	-	-	-

†Includes MADE and Eólica turbines
Source: Authors' compilation

Production of wind turbine components on the continent has been limited to small scale system producers mainly in South Africa and Egypt. In South Africa, manufacturers such as Kestrel Renewable Energy, African Wind Power and Palmtree Power produce low capacity turbines (less than 300 kW) that are not adequate for large-scale commercial power production and connection to national grids. At the higher capacity level of localised production in South Africa, Isivunguvungu Wind Energy Converters (I-WEC) produces wind turbine systems with a capacity of up to 2.5MW. In Egypt, the wind turbine manufacturing industry is dominated by El Sewedy through its two subsidiaries: El Sewedy for Wind Energy Generation (SWEG) with a plant that produces wind turbines of 1.65 MW capacity; and SET SIAG El Sewedy Towers - a joint venture with Germany's SIAG Schaaf Industrie AG that manufactures towers and rotor blades.

The manufacturing landscape is poised to change as more global players increase their presence on the continent. In South Africa such developments have been encouraged through the Renewable Energy Independent Producers Procurement Programme (REIPPP) that is targeting installation of 1,850 MW of on shore wind power with at least 35% local content requirements. Both South Africa and Egypt owe their success in the manufacturing industry to the existence of adequate regulatory and policy frameworks, well established research and development institutions and a relatively low cost of doing business in the two countries. However, more needs to be done to boost the industry. Policy makers not only need to focus on ways in which international technology providers could be attracted to the continent but also focus on taking advantage of regional and intra-continental economies of scale and encourage skills and technology transfer through partnerships between local firms and established global manufacturers (IRENA, 2013).

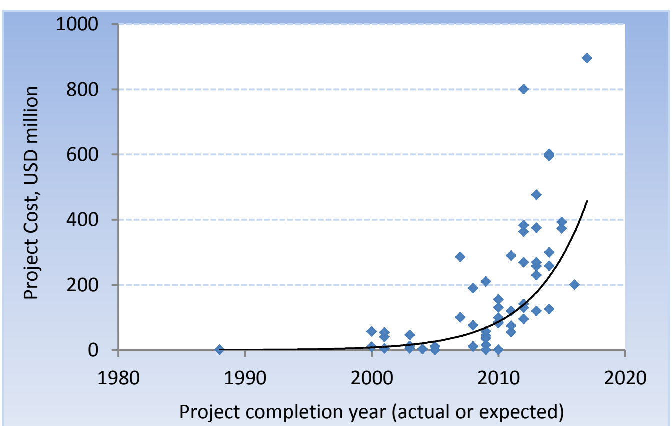
Local content in a wind turbine manufacturing industry that is well integrated with the local supply chain creates jobs and enhances capacity for local companies to become more innovative and competitive. Studies have demonstrated that local production of wind energy components could reduce system costs by 25% in the long term (Razavi, 2012).

3.4 Financing of Wind Energy Projects in Africa

In this section we discuss trends in project costs and funding sources. Project costs are interesting in understanding industry development because they give an indication of both the resource needs per unit of installed capacity, and signal affordability of wind technologies in Africa as well as the level of maturity of the market. Project costs do not solely depend on installed capacity, but also on the project's location, the requisite off-take infrastructure and general costs of doing business. Therefore for meaningful conclusions to be drawn from the cost analyses one needs to look at disaggregated cost data at individual project level. This information was not available to us on a large enough sample size to conduct this assessment.

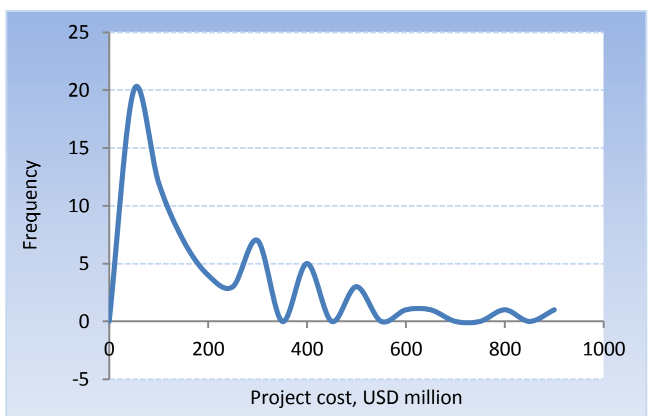
From the aggregated cost data[11] some broad observations can be made. Total project costs range from as low as USD 0.5 million (the cost of the small pilot at Rodrigues Island in Mauritius), to USD 900 million – the cost of Morocco's largest planned wind farm, the 300MW Al Koudia Al baida II Wind Farm. As expected, the cost of projects has increased over time (Figure 3.7). About a third of the projects, both completed and planned, for which cost statistics were available, are small, costing less than USD 50 million (Figure 3.8).

Figure 3.7: Trend in Total Project Costs



Source: Authors' analysis

Figure 3.8: Distribution of Total Project Costs



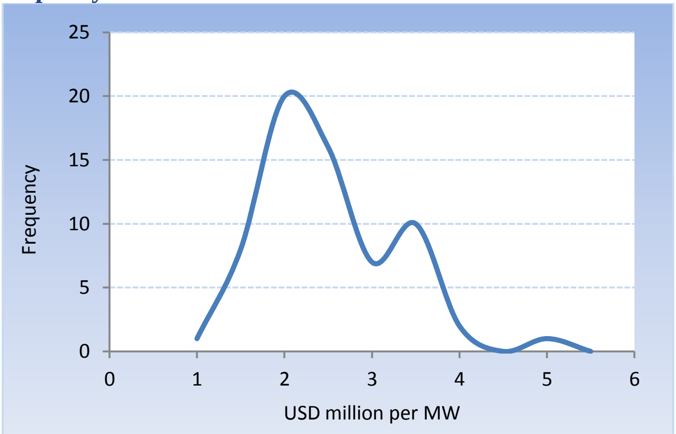
Source: Authors' analysis

[11] From the list of compiled projects, aggregated data on project cost was available for 65 projects (29 completed, 14 ongoing and 22 planned).

On the basis of the restricted sample for which cost data was available, on average, between USD 1.25 and 3 million is spent per MW of installed capacity (Figure 3.9). 72% of projects fall in this cost range. This is consistent with the expected high upfront costs associated with wind energy technology, and the range of costs observed on global markets of between EUR 1.1 million and EUR 2.25 million per MW (International Energy Agency, 2009). Exceptionally high per unit capital costs are observed in smaller scale operations, for example, the 0.3 MW pilot Inhambane in Mozambique which cost the equivalent of about USD 5 million per MW. We observe a negative correlation of -0.27 between per unit capital cost and installed capacity (Figure 3.10).

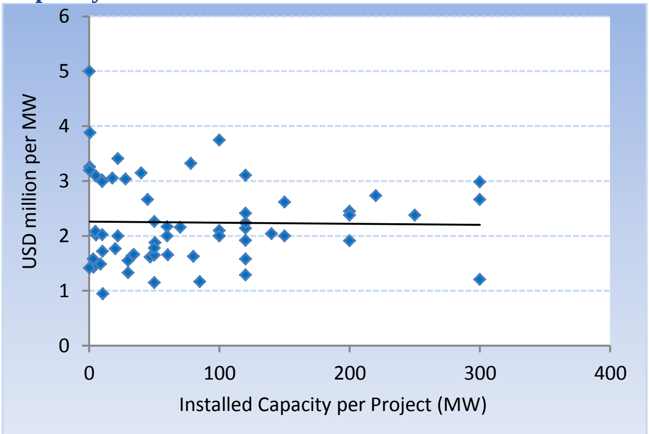
At the aggregate cost level, no clear global trend over time in costs per unit of installed capacity can be deduced from a statistical analysis which does not control for operation size and the costs of ancillary infrastructure such as transmission lines and access roads. Yet, there are few markets where trends can be deduced – Egypt, South Africa and Morocco – where wind farms are located in similar geographic areas, and there is a large enough sample. We find that costs per unit are on marginally decreasing trend only in Egypt. In South Africa, the cost per unit MW for planned projects appears to be higher than the unit cost for completed pilots; while in Morocco the trend is similar but not strong (Figure 3.11).

Figure 3.9: Distribution of Costs per Unit of Installed Capacity



Source: Authors' analysis

Figure 3.10: Capital Costs per Unit of Installed Capacity

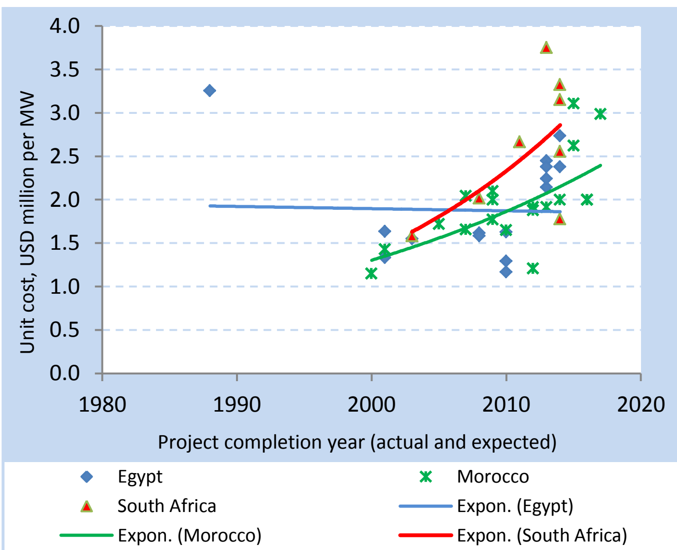


Source: Authors' analysis

There are several possible explanations: different levels of maturity of the markets especially when comparing Egypt to South Africa, and an economies-of-scale advantage for Egypt (a typical pipeline project in Egypt is about 2.5 times as large as a typical planned project in South Africa). In Egypt, several projects have been planned or implemented in close proximity (for example, the 8 and 6 individual projects at Zafarana and the Gulf of Zayt wind farms respectively); such occurrences significantly reduce the need for new ancillary infrastructure. Meanwhile, South Africa's projects are located in different coastal areas of the country, hence the need to integrate new ancillary infrastructure in the projects. It is also important to note that there could be mispricing in the current bids for IPP procured wind energy projects (especially in South Africa), given that most projects were at the first bidding stage which focuses on technical aspects, and had not yet competed on price. Unit costs can therefore be expected to stabilize in the medium term.

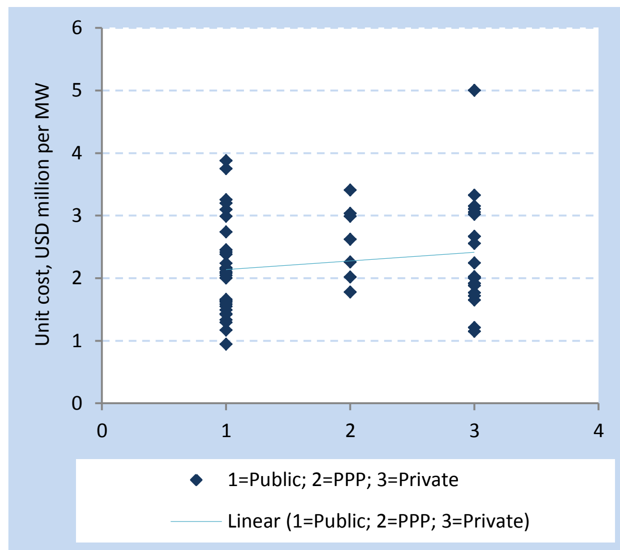
These cost trends are also closely linked to the profile of project developers in the three countries: government-sponsored projects being least expensive on average, followed by PPPs, then private sponsored projects. This conclusion seems to hold on the full sample as well (Figure 3.12). This observation is partly a reflection of the terms at which governments mobilize funding for the projects as compared to private sponsors. Whereas governments may have access to cheaper financing through grants and concessional loans from development agencies, private sponsors mobilize financing at commercial terms which are relatively more expensive. In addition, it is likely that private promoters of pipeline projects adopt equipment which is more costly, but more productive in the long term in order to maximize returns over the life of the project. However, the standard deviation of unit costs for government sponsored projects is noteworthy; some projects (mostly the pilot projects) also have higher unit costs.

Figure 3.11: Distribution of Costs per Unit of Installed or Planned Capacity



Source: Authors' analysis

Figure 3.12: Per Unit Cost by Type of Sponsor



Source: Authors' analysis

Further conclusions can also be drawn on the trends in sponsorship of projects. The public sector emerges as the main sponsor of completed wind projects in Africa for the reasons already outlined in section 3.2. Government sponsorship has been either through domestic utilities or special agencies established to promote clean energy projects like the NREA in Egypt. We find that 78% of all completed projects were government sponsored, relative to 14% private sponsored and 7% public-private sponsored projects. The private sponsored projects include Morocco's industries self-generation projects (for example, the La Farge Wind Farm developed by the cement manufacturer La cimenterie de Tetouan)[12], and the wind energy project sponsored by South Africa's Eskom in Mozambique (Inhambane Wind Project).

The landscape of sponsors is expected to significantly evolve in the coming years. Most countries will seek private (e.g. South Africa) or public-private (e.g. Morocco) sponsorship of wind energy projects. Egypt is expected to increase private sponsorship of projects to about two thirds of its planned projects portfolio, although at present, NREA is still the primary promoter of pipeline projects. Only 37% of the

[12] This was facilitated by the 2008 electricity self-production law and Morocco's EnergiPro initiative.

pipeline projects are expected to be government sponsored, relative to 52% private and 11% public-private sponsored projects.

We also review the mode of procurement, in particular of private sponsored projects, to assess the evolution of roles played by public and private partners in the wind energy industry. Results show that concessions – where the government passes the responsibility and risks of building, operating and maintaining the projects to private operators – are becoming more common. The most common PPP model observed in completed projects is the build-own-operate (BOO) scheme on projects fully owned and managed by the private sponsor. Morocco's auto-producers tip the scale in favor of this model. BOOT contracts are more common in non-captive completed wind projects, as already discussed under section 3.2. Concession periods generally range between 20 and 30 years. PPPs are attractive from both a resources and risk-allocation perspective, as depicted by the Cabeolica wind farm (Box 3.1).

Box 3.1: Funding Cabeolica Wind Farm, Cape Verde

Project description: Cabeolica Wind Power project was to construct, operate and maintain four wind farms, with a combined capacity of 25.5 MW, on four islands (Santiago, São Vicente, Sal, and Boa Vista) of Cape Verde.

Developers: Cabeolica was jointly developed by the Government of Cape Verde, Electra (the state-owned power utility company) and an infrastructure development company, InfraCo. InfraCo, which is privately managed but publicly funded by DFIs, was heavily involved in upstream activities to design and structure the project. The early stage development risks of the project were borne by the developers which paved the way for other investors to participate in the project.

Project structure: The project was based on a PPP structure involving the Government of Cape Verde, Electra, a private equity fund (FinFund), the Africa Finance Corporation (AFC) and InfraCo. The project was developed using a Build Own Operate (BOO) procurement model implying that the operators would bear the risk of building, operating and maintaining the project.

Financing: The total cost of the project was EUR 64 million of which the sponsors (The Africa Finance Corporation, InfraCo, FinFund, Electra and the Government of Cape Verde) mobilized equity financing worth Euro 19 million. Apart from indirectly providing equity funding to the project through InfraCo, DFIs further contributed all the debt financing. The AfDB and EIB provided Euro 15 and 30 million respectively in senior loans with a tenor period of 15 years and a grace period of 2 years.

Risk management: To enhance the bankability of the project, several risk mitigation measures were adopted as demonstrated below:

- The private sponsors of the project were insured against political risk through the World Bank's Multilateral Investment Guarantee Agency (MIGA) facility.
- A 20-year 'take or pay' Power Purchase Agreement was signed between the project company (Cabeolica SA) and the national power utility company (Electra) to purchase all the electricity produced by the project.
- A Support Agreement was signed by the Government and Cabeólica SA to guarantee that any payment deficiency on the part of Electra would be covered by the Government.
- A turnkey Engineering Procurement and Construction (EPC) contract and a service agreement, in form of an Operation and Maintenance (O&M) contract, were signed with a leading company in wind energy technology to reduce the sponsor's exposure to risks during construction and operation of the project.
- Due to the volatility of the local currency, the price for electricity purchased from the project in accordance with the PPA was expressed in Euros.

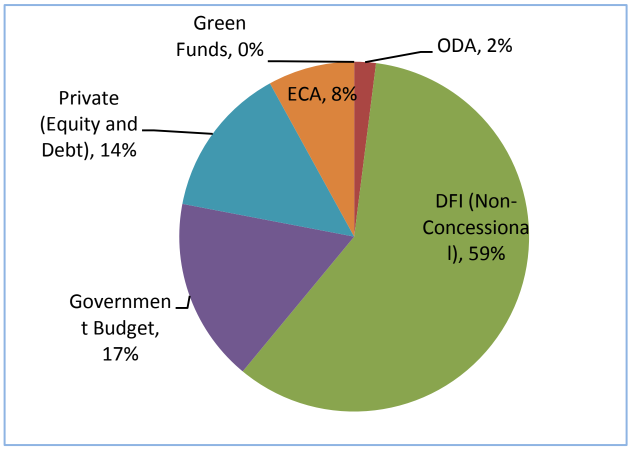
Source: AfDB, 2010

About USD 1.8 billion has been invested to develop the 1.1GW of installed wind generation capacity on the continent. Of the USD 1.8 billion, 59% was contributed by Development Finance Institutions (DFI) through non-concessional funding; mostly bilateral development agencies which account for

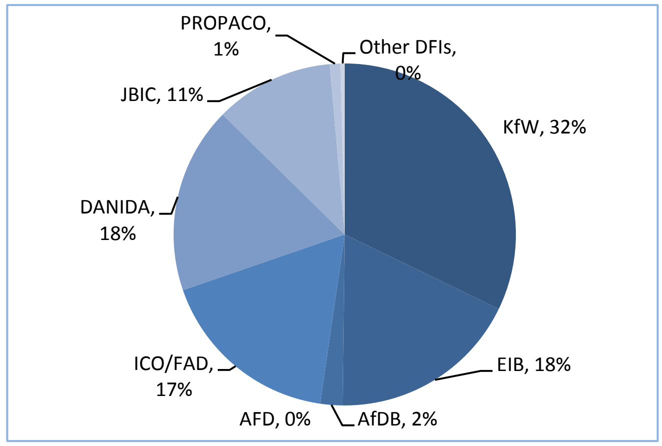
47% of total financing (Figure 3.13; a and b). Figure 3.14 suggests a shift in funding channels used to support wind energy projects in Africa, with ODA[13] funding decreasing progressively while non-concessional contributions from bilateral and multilateral development agencies, and commercial sources, are increasing.

Figure 3.13: Financing of Projects

a: Financing for Completed Projects, % of value



b: Profile of Participating DFIs, % of Non-Concessional Funding in Completed Projects



Source: Authors' analysis

We find limited use of specialized Funds, such as the Global Environment Facility (GEF), in financing completed pilot or commercial wind energy projects. This trend is changing as larger pools of funds earmarked for clean technologies become available. For example, six of the pipeline projects located in Egypt, Morocco and South Africa are set to receive a total of about USD 400 million from the Clean Technology Fund (CTF)[14]. GEF is supporting the ongoing South Africa Wind Energy Programme (SAWEP), and was present in Eritrea's pilot project at Assab.

Half of the pipeline projects had equity financing from private investors, relative to less than a third of completed projects**.** Data on exact amounts contributed by project financiers was not available for a large enough sample to ascertain larger volumes of private funding toward wind energy projects. However some trends are emerging, for example, the growing presence of international wind energy developers as equity providers in pipeline projects. Among the 32 projects expected to receive private equity financing, 41% will likely be financed by firms with a global footprint. Emerging African firms are expected to finance about 26% of the projects – half through joint ventures with foreign international firms; while equity in 20% of the project is expected to come from auto-producers.

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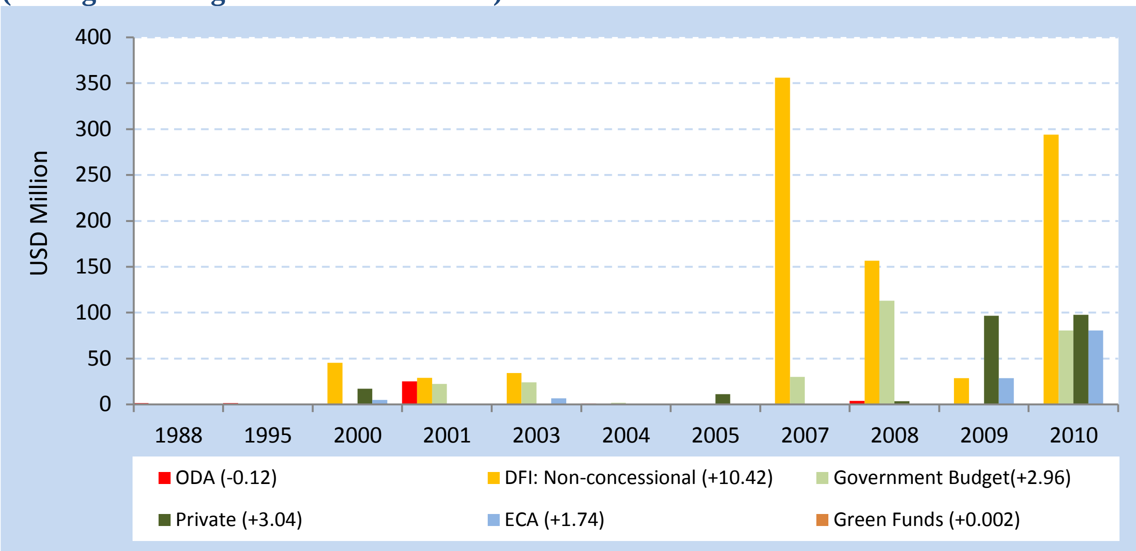
[13] Official Development Assistance is defined by OECD as those flows to countries and territories on the Development Assistance Committee List of ODA Recipients and to multilateral development institutions which are: (i) provided by official agencies, including state and local governments, or by their executive agencies; and (ii) each transaction of which: (a) is administered with the promotion of the economic development and welfare of developing countries as its main objective; and (b) is concessional in character and conveys a grant element of at least 25 per cent.

[14] The Clean Technology Fund (CTF) is a multi-donor pool established to provide grants, highly concessional loans or risk mitigation instruments to projects that improve the environmental footprint of key emerging market economies.

Figure 3.14: Financing for Completed Projects, Value of Total Project Financing by Source (average annual growth in USD million)



Source: Authors' analysis

Another hypothesis tested is whether access to carbon finance markets through the Clean Development Mechanism (CDM) has affected technology choices in favor of wind energy developments in Africa. We find that less than a quarter (23%) of completed projects benefited from CDM. These projects range in capacity from 22 to 120 MW, with an average plant size of 84 MW. Average sales amount to 188,400 tons of CO_2 tons-equivalent per year, equivalent to about USD 2.7 million per year per project, over a modal crediting period of 7 years. At these rates, beneficiary projects generate up to 20% of total project costs over the crediting period. CDM funding has been useful in improving the commercial viability of beneficiary projects. For instance, in Zafarana 4, CDM financing helped improve the project's internal rate of return by approximately 2% through an emission reduction purchase agreement spearheaded by KfW covering the 2007-2012 period (Sünnen, 2010). CDM projects include some of the Zafarana wind farm projects in Egypt, as well as some auto-production projects in Morocco. European countries – including Germany, Japan, the UK, Denmark, France, and Switzerland – are the most active CDM partners for wind projects in Africa. A list of projects, both completed and in the pipeline, that have benefited from CDM financing is presented in Annex 2.

4.0 Explaining Market Development Trends

The patterns identified in Section 3 could possibly be explained by external forces such as conventional foreign direct investment drivers, internal macroeconomic and social considerations, or global considerations such as climate change. In this section, we explore the extent to which these factors have affected the adoption of wind-based electricity generation, starting from the assumption that adequate wind energy potential exists. First, we ran the following hypothesis tests non-parametrically[15] to test the extent to which the wind sector has been influenced by the pursuit of new markets for a growing wind technology manufacturing sector in OECD countries:

i. The correlation between the origin of the ODA and of the wind turbines used in pilot projects.
ii. The correlation between the origin of ODA in pilot project and that of private investments in the sector through project sponsorship, development or operation of commercial scale projects.

Results show that the origin of ODA and that of wind turbines adopted in pilot projects is weakly correlated. A weak correlation is also observed between the origin of ODA for pilot and that of wind turbines adopted in commercial operations. There is almost no correlation between the origin of development assistance for pilot projects and the origin of private investment flows into commercial operations. This outcome is consistent with the post-2011 adoption of 'untied aid' frameworks in OECD countries predominant as donors, lenders and investors in this industry.

Other considerations appear to be stronger drivers of the observed trends in developing the wind energy potential in Africa. These include the physical attributes of wind energy, economic, environmental and climate change considerations, as well as aspects related to the regulatory environment in the host country.

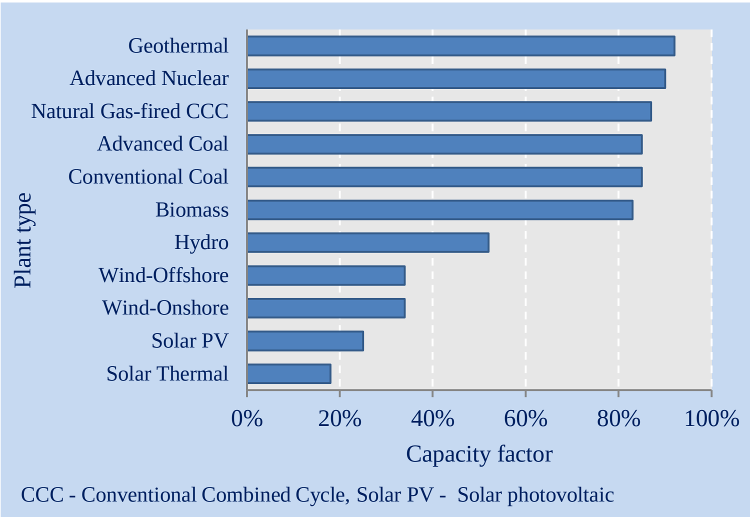
4.1 Technical Considerations

Wind energy is intermittent, which means that it is not continuously available due to exogenous factors. The result is irregular electricity output from wind power plants. In addition, wind is non-storable, in contrast to other renewables such as water which can be stored and dispatched in response to demand. These two features imply that wind energy does not make good base load capacity – the capacity which must be continually available to meet the minimum demand of all users connected to an electricity grid. This capacity dictates volume of new grid connections.

The issue of base load capacity is important in the context of most national grids which are "demand-driven", thus require stable base load capacity to meet the continuous electricity needs of users connected to the grid. Failure to fully meet these needs at any moment would trigger a system failure. Moreover, integrating large wind-based electricity flows into the grid may require a grid overhaul. This pertains to both grid planning (power plant dispatch systems) and resilience of the network to peaks and troughs in electricity flows from the wind farms. Again, conventional "demand-driven" grids make this integration particularly complex. Grid integration also requires efficient back-up plants to regulate volatility in electricity flows. Given the state of African national grids, these considerations present a major barrier to the development of wind energy on the continent.

[15] Non-parametric tests are based on sample data without imposing assumptions on statistical form of the full population. This is appropriate given that there are not enough degrees of freedom to support generalizable parametric results.

Figure 4.1: Capacity Factors for Selected Technologies



Source: United States Energy Information Administration, Annual Energy Outlook 2011

Studies have also shown that on average, wind turbines perform far below their capacity mainly due to the intermittent nature of wind. Typically, a wind turbine will produce electricity at its rated or maximum capacity in wind speeds between 30 and 55 miles per hour (mph). At lower wind speeds, the production falls drastically. Although industry projections estimate capacity factors[16] of 30 to 40%, field experience has shown that it is not uncommon to have annual outputs of just 15 to 30% of the maximum turbine capacity[17]. Compared to capacity factors of other technologies in power generation such as coal (85%), natural gas (87%), and hydro (52%), the average capacity factor of wind energy (34%) further lowers its competitiveness (Figure 4.1).

But the conversation should not stop there. Science and innovation is moving the frontier of renewable energy technologies, including the field of hybrid and "smart" grids. In the African context, these cutting edge technology options are suited mostly for the Middle Income Countries that have reached their energy access goals. It has been shown that the negative effects of intermittency can be managed if many different and complementary energy sources are connected to a fairly large grid which is also robust and 'smart'; i.e. has high self-adjustment capacity. Few examples exist of countries that have advanced their national grids to this level. Europe is leading the way, through its Smart Grid European Technology Platform. To our knowledge, no African country has yet seriously explored the option of smart grids. In South Africa, the conversation around adoption of smart mini grids has started, with the state utility Eskom announcing in March 2012 its plans to start deploying the hybrid smart grid model (EREC and Greenpeace, 2011).

Power systems based on conventional grid can also adapt to increasing proportions of renewable energy in the energy mix. At the time of writing (May 2012), Kenya's grid was undergoing fortification in preparation for the 300 MW input from the Lake Turkana wind farm. This process included among other things, strengthening the Nairobi ring (transmission infrastructure) as well as developing thermal power plants to act as back-up facilities. Associated investment costs figure into the value for money assessment of the wind option, and may reduce its attractiveness.

Another innovation that has been tested in practice to tackle the intermittence of wind power and enhance its adequacy for base load capacity suggests interconnecting wind farms through transmission grids. When farms are interconnected in an array the probability that all sites experience the same wind

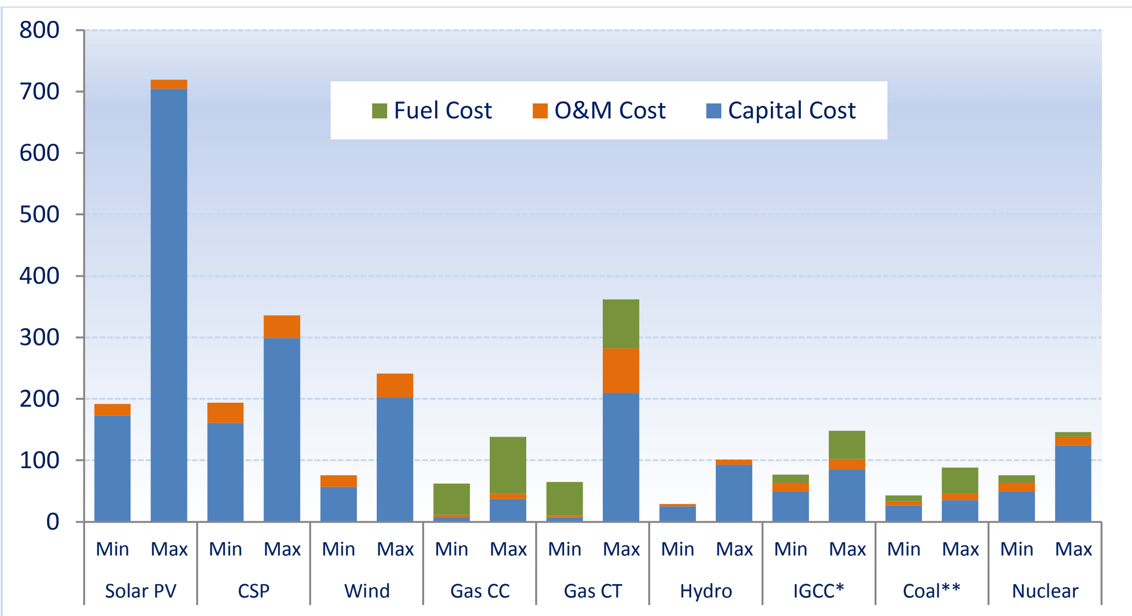
[16] Capacity factor is the actual power output over a period of time, as a fraction of the theoretical output if the plant was operated at rated or maximum capacity. The capacity factor takes into account among other aspects, times when wind speeds are not adequate for electricity production, unavailability of the plant during maintenance and equipment failure.
[17] According to the United States Energy Information Agency, the average capacity factor for European countries in 2007 was 13% while that of 137 wind projects in the US was 26.9% in 2003.

regime at the same time reduces and the array consequently behaves like a single farm with steady wind speed and thus steady deliverable wind power (Archer and Jacobson, 2007).

4.2 Economic Considerations

There are other reasons why African countries may not opt for the wind energy solution. One relates to the attractiveness of wind based electricity generation from a commercial viability perspective. This is because value-for-money assessments of project options often do not take into consideration the valuation of negative externalities, nor do they correct for undervaluation of tradable energy resources. Emissions from polluting power generation activities are not always assigned a cost, nor are benefits from renewable energy reflected in prices. In the presence of capital cost disadvantages for emerging technologies such as wind (Figure 4.2), this implies an implicit bias in financial return comparisons in favor of conventional energy resources.

Figure 4.2: Levelized Cost of Electricity Generation by Technology (2008 USD/MWh)



* IGCC with carbon capture and storage, ** Supercritical coal. Solar PV- Solar Photovoltaic, CSP - concentrated solar power, Gas CT - Gas combustion turbine, Gas CC - Gas combined cycle, IGCC - Integrated gasification combined cycle, O&M – Operation and Maintenance

Source: World Bank, 2011

Indeed, there is substantial competition between wind and other well established renewable energy sources such as hydro, which have the capital cost advantage and favorable physical attributes such as storability (Figure 4.3).

Competition also arises from fossil fuel resources (Figure 4.4). About half of the wind energy endowed African countries are also rich in conventional thermal resources, *i.e*., coal, gas and oil. The generation mix in these countries is predominantly thermal. Closely linked to the issue of endowments, are the existing rules regulating pricing of fossil fuels. Underpricing of fossil fuels especially in net exporting countries is creating an uneven playing field for renewables such as wind energy. Moreover, the higher upfront costs for wind technology, in the absence of favorable tariff regulation, can make capital expenses restrictive. For instance, import duties on renewable energy technologies coupled with subsidies on fossil-fuels in Nigeria make renewable energies, in particular wind and solar, uncompetitive (Kennedy-Darling J. et al, 2008).

Figure 4.3: Potential from Other Renewable Energy Source, mtoe

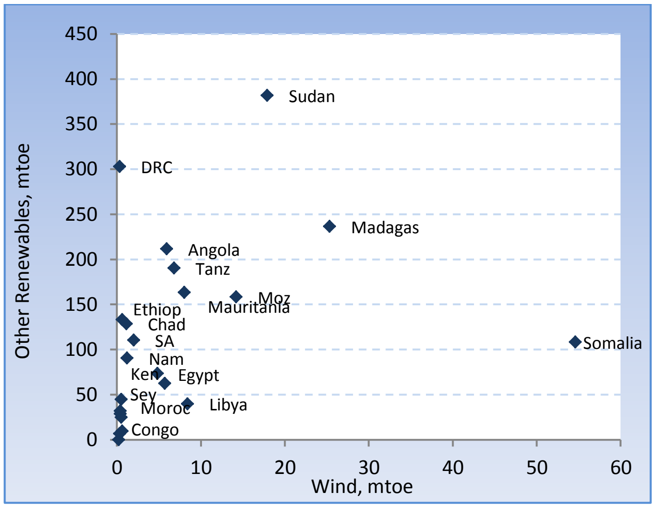
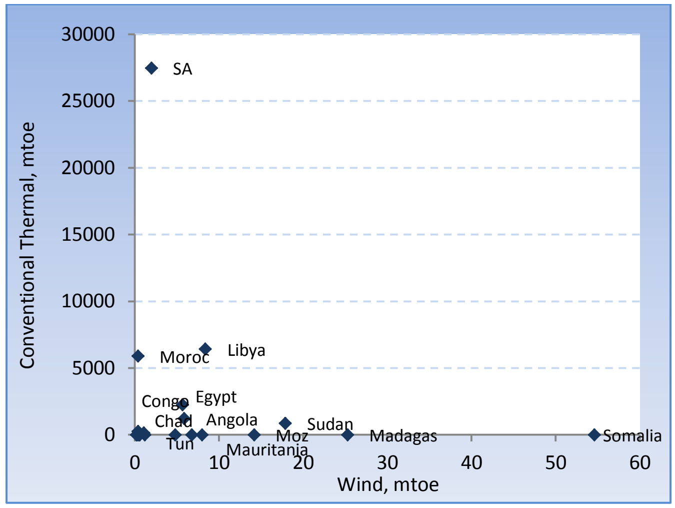


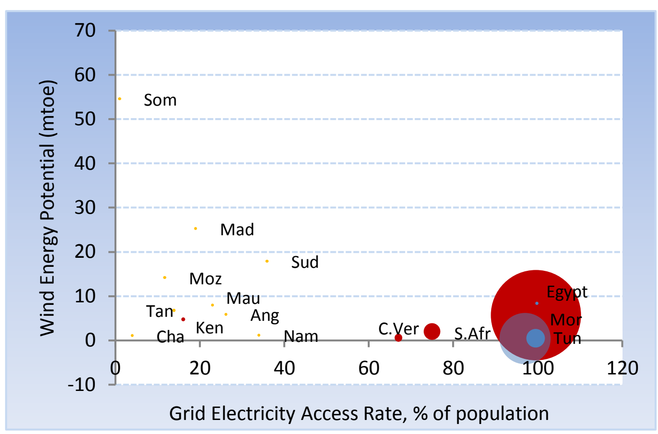
Figure 4.4: Potential from Conventional Thermal Energy Source, mtoe



Source: Authors' adaptation using Buys et al 2007 (data)[18]

The continued growth and sustenance of wind energy, just like several other renewable energies, has come at a significant cost for governments and the public. Many countries, including some African countries, have introduced public policies to make wind energy more affordable for the end user through direct subsidies or other mechanisms such as Feed-in-Tariffs (Section 4.4 and Annex 3). For instance, the World Nuclear Association estimates that the cost to the German government and consumers to make wind and solar energy accessible and affordable is EUR 5 billion per year in subsidies. Such a cost is obviously beyond what most African countries can afford. Renewable energy subsidies have come under intense pressure especially in light of the economic crisis and public spending cuts forcing several countries including Spain, Germany, Japan, USA and South Africa, among others, to revise such subsidies in order to reduce the fiscal burden on government budgets.

Figure 4.5: Correlation of wind energy potential to installed capacity



Source: US Energy information Administration 2008, AfDB Infrastructure Database 2011, Buys et al 2007

Another important consideration from commercial perspective has to do with the use of wind-based electricity in the generation mix. Wind can best be viewed as supplementary energy resource, given its unsteady output and

[18] Depicts 'High' scenario for renewable energy resources (wind, solar and geothermal). Wind energy potential refers to the sum of on-shore and off-shore wind potentials.

the need for back-up capacity.

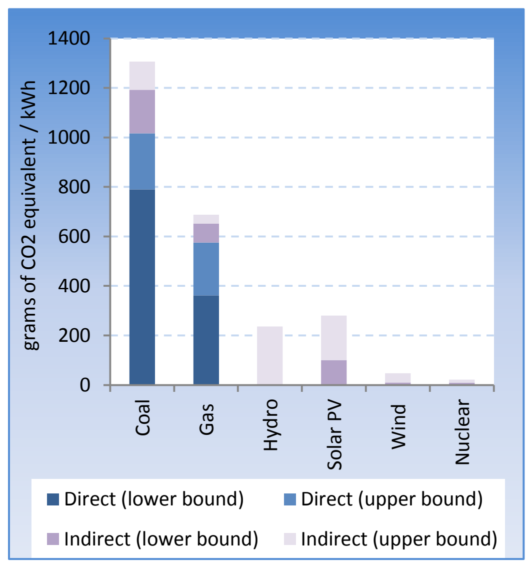
The main use for wind energy is to replace output from fossil fuels and other storable energy resources. In principle, this serves the dual purpose of lowering operation costs of the electricity grid, and enhancing availability of other sources such as hydro power plants. Because wind power plants, in essence, do not contribute base load capacity, they cannot be the primary basis for electrification programs targeting to add more users to the grid. Therefore countries trying to increase access rates are unlikely to choose wind. Indeed, the development of wind energy capacity in Africa has been following electricity consumption trends more than resource endowment levels. Figure 4.5 shows that those countries with higher access rates are leading the way in wind energy development. This is translated into stronger political commitments from energy-intensive countries to renewable energies. For instance, Egypt committed to produce 20% of its electricity from renewable sources by 2020, with South Africa and Morocco having announced similar goals.

4.3 Climate Change Considerations

From an environmental perspective, wind energy is of interest because it is both renewable and clean.

Here we explore the extent of the incentive for African countries to achieve the latter objective. The first test is determining the expected environmental benefits of wind energy. As shown in Figure 4.6, wind based power plants produce almost no greenhouse gas emissions directly. However, in evaluating the climate change effects of wind energy, one needs to take a holistic approach that looks at both the direct and indirect effects. We already discussed the physical features of wind energy and their implications in terms of back-up plants. The variability and intermittency of wind energy implies carbon emissions that are commensurate with the frequency at which back-up power plants are activated to stabilize the grid. Back-up measures require plants which can be dispatched quickly and run on a stable fuel resource. For these reasons heavy fuel oil and gas make the best back-up energy resources for wind. We show in Figure 4.6 that accounting for the indirect emissions from these back-up plants, wind based power generation remains attractive from a 'clean' energy perspective.[19]

Figure 4.6: Greenhouse Gas Emission from Electricity Generation



Source: World Nuclear Association

[19] We already mentioned that wind based electricity generation in the context of conventional electricity grids requires base load capacity supplied by a more stable energy resource. Aside from fossil fuels which are the largest polluters in the electricity generation mix, base load capacity could be provided by nuclear or hydro power plants which are overall less polluting. For African countries, fossil fuels and hydro make up most of the base load capacity, with nuclear based power generation almost non-existent (the exception is South Africa with installed nuclear electricity generation capacity of 1.8 GW). Base load capacity emissions are often not reflected in indirect emission for wind power plants, but it is important to bear them in mind.

The second important question to answer with regard to the potential use of renewable energy to curb carbon emissions is how much African countries value this consideration. This question can be answered by looking first at the marginal contribution of Africa's electricity sector to greenhouse gas emissions. As indicated in Table 4.1, this contribution remains rather small. On an aggregate scale, Africa contributed less than 3% of the world's greenhouse gas emissions in 2008.

The electricity sector contributes an even lower proportion of about 1%. The outlook shows a trend that is only slightly different, with Africa's aggregate emissions expected to reach 3.15% of global emission by 2030 under a business as usual scenario (source: International Energy Agency). Adopting clean energy solutions is expected to decrease this proportion to 2.74%. In a nutshell, the impact on global scale is small. But African economies are highly heterogeneous when it comes to climate change effects. For instance, South Africa, the largest CO_2 emitter on the continent, is also the 12th largest contributor on a global scale by measure of stock of annual emissions; 10th largest by measure of emissions per capita (UNFCC, 2000). And the bulk of the country's emissions come from the coal-based electricity generation system. Coal-based plants contributed over 90% of the country's electricity output in 2011; and the ongoing addition of two of the world's largest coal power plants will increase this share. In the context of a country like South Africa, renewable energy can make a significant contribution to improving the continent's carbon footprint. But overall, climate change considerations are generally not as high a priority as access, cost and energy security considerations in determining the adoption of wind energy.

Table 4.1: Greenhouse Gas Emission from Power Generation

	2008	2020 (e)	2030 (e)
World CO_2 Emissions, mt	29,259	35,436	40,008
World CO_2 Emission for Power Generation, mt	11,918	14,903	17,416
Africa CO_2 Emissions, % of total emissions	3%	3.12%	3.15%
Africa Emissions from Power Generation, % of total emissions	1.3%	1.39%	1.41%
Africa CO_2 Emissions from Power Generation, % of total power emissions	3.2%	3.31%	3.23%

Source: International Energy Outlook 2010

4.4 Business Environment Considerations

A legal framework defining investment parameters is a perquisite to the development of the clean energy sector. To our knowledge, 12 African countries have set up regulations and laws of reasonable scope on renewable energy, such as the 2009 *Renewable Energy Development Law N. 13.09* passed in Morocco which set the pace for greater off-grid capacity and allowed a stronger presence of independent power producers in the wind and solar energy industries. Morocco has also established a framework to enhance self-production of renewables by energy intensive industries, including increasing the production limit from 10 MW to 50 MW in 2007. Table 4.2 outlines the main regulatory measures that were used by African countries to promote renewable energy.

Analyzing the array of wind projects in Africa against the regulatory framework in respective countries puts into perspective the importance of establishing clear frameworks to promote the development of renewable energy. We find that about 88% of the completed and pipeline projects are located in countries with a market and existing regulatory frameworks for renewables. Yet, the assessment also shows that regulation is not a condition *sine qua non* for the development of wind farms, as 11 projects have been undertaken in countries without clear renewable energy frameworks. Interestingly however, out of the 11 projects that were developed in countries without policies, only 2 projects (Cabeolica and Njiapanda wind farms) received private funding. These projects also had strong DFI support, which possibly explains their success in mobilization of private investors. This suggests that private investors remain reluctant to engage in countries that lack frameworks regulating the industry.

Table 4.2: Renewable Energy Promotion Policies in Africa

Country	Feed-in tariff (FiT)	Capital subsidies, grants, rebates	Investment or other tax credits	Sales tax, energy tax, excise tax or VAT reduction	Public investment, loans or financing	Public competitive bidding
Algeria	x		x	x		
Egypt				x		x
Ethiopia				x		
Ghana		x		x	x	
Kenya	x		x			
Mauritius		x				
Morocco			x	x		
Rwanda	x				x	
South Africa	x	x		x	x	x
Tunisia		x		x	x	
Uganda	x	x		x	x	
Zambia				x		

Source: Author's compilation based on data from REN 21 and IEA/OECD 2010 Renewable Database

The existence of legal frameworks does not however guarantee sector development. While the presence of legislation is crucial, its quality is decisive. In this respect, Tunisia presents an interesting case. Prior to 2009, wind projects had been developed through the government which used the national power agency (Société Tunisienne de l'Electricité et du Gaz – STEG) as the sole entry point into the market. Projects were promoted as public-private-partnerships under an existing legal framework that did not allow private sponsors to implement projects on their own. In 2009, a law allowing for captive production or the so-called *auto-production* by private entities was passed. In theory, this law put the premises for the private sector to develop projects. In spite of this law, projects have not taken off for a core reason: there were few or no private firms that could afford to build wind farms for their own consumption, or had the knowhow to engage into such investments. At the same time, industry groupings could not get together to build wind farms either as they were faced with a billing issue: creating an ad-hoc company to manage the farm and billing the grouping's members for consumption would violate the National Electricity's company monopoly on power distribution.

Given the cost disadvantage still faced by wind energy relative to conventional energy resources, we take a closer look at the pricing mechanisms adopted to promote private investments in wind energy in Africa. As indicated in Annex 3, five countries have adopted the feed-in tariff (FiT) mechanism to promote clean energy. This sets a guaranteed off-take price for power producers selling to utility companies, and is designed to reflect costs and benefits of particular technologies. The main advantage of the FiT mechanism is predictability. However, it eliminates price competition, which is necessary to eventually bring down the cost to utilities of procuring renewables.

Experiences have however shown that alternative pricing methods can work just as well. For example, neither Egypt nor Morocco has adopted the FiT, choosing instead to apply a two-stage process including competitive bidding as a pre-FiT stage, and direct negotiation, respectively. The latter often entails a public transfer to the private developer, in the form of payments in kind or tax relief, to keep the off-take tariff affordable for the utility. South Africa has revised its framework twice since 2009, first lowering the FiT initially announced; then migrating to a new procurement system altogether, whereby developers bid on a technical basis first before bidding on price (Box 4.1).

Box 4.1: Feed-in-Tariffs and competitive bidding in South Africa

In 2006, the South African government introduced regulation for a "licensee to recover the full cost of its licensed activities, including a reasonable margin or return" (art. 16, Electricity Regulation Act 2006). As a follow-up move, the South-African Renewable Energy Feed-In Tariff (REFIT) was introduced in 2009, guaranteeing electricity purchase prices from independent power producers (IPP). Yet the program never really became active as two years later, no power-purchase agreements were negotiated with IPPs: stringent licensing conditions and difficulties in negotiating purchasing power agreements were at the heart of the problem (Edkins 2012).

In 2011, in an effort to stimulate IPPs, tariff reductions of up to 40% were proposed though this did not turn out to have any positive effects: the tariffs set were only guidelines and were not framed in the Department of Energy's regulation. This implied that the department was not obliged to comply with them creating difficulties in purchase power agreement negotiations (Bloomberg, 2011). As a consequence, the REFIT program was abandoned mid-2011 to give way to a competitive bidding process, referred to as "REBID". This move is intended to invite investors to submit bids for new capacity generation totaling 3,725 MW, of which 1,850 MW are from wind and 1,450 MW from solar. New projects will benefit from power purchase agreements as determined by the national utility's Multi-year Price Determination plan at prices capped for each technology. For wind projects, the price ceiling was set at USD 115c/Kwh.

The main change from REFIT is that power producers will be required to tender on the pricing for the off-take agreement. In other words, their bids will, not only be evaluated based on the technical proposals, but also in terms of the power purchase agreement to be concluded. In addition to pricing, other items included in the bidding process comprise localization, black economic empowerment, community development, and job creation amongst others.

This move introduces an important competitiveness element into the pricing for renewable energy, ensuring that the South African government gets a fair deal. Yet, all the above-mentioned changes and the lack of investments in that period highlight the importance of a stable and well calibrated policy. In light of the insecurity in the renewable energy policy illustrated by the changes which occurred in the past years, project developers took on a "wait and see" approach which affected their planned investments as well as their ability to secure new financing (Edkins 2012, and Pegel 2011). To date, it is difficult to assess the new policy in place: reports claim that the first bidding round was a success and that many firms applied for licenses. However, concerns have been raised that such a system will incentivize firms to cut costs to make projects work, raising the risks that projects never materialize.

Sources: *Bloomberg 2011, van Dyke and Pollastrini 2011, Edkins 2012, Electricity regulation act 2006, Pegels 2011*

5.0 Conclusion and Policy Implications

5.1 Conclusion

The paper draws several conclusions based on discussions of the structural characteristics, development trends and challenges faced by the wind energy market in Africa. Using a hand-collected comprehensive sample of 94 wind energy projects over the period 1980 and 2010, it is observed that Africa's wind energy capacity increased twelvefold over the last two decades to stand at 1.1 GW in 2011. While the annual growth rate of Africa's installed capacity was almost twice as much as that reported for global capacity over the period 2000-2010, it remains similar to the growth rate reported for global capacity at the early stages of development for the global market. This growth was achieved mainly through a phased approach, reflecting countries' lack of familiarity with the technology and insufficient geo-referenced resources at early stages of market development and limited public resources to undertake large scale projects in more mature markets. North Africa is currently leading in terms of installed capacity while South Africa is poised to be the fastest growing market based on the number of prospective investors in the sector. Interestingly, North African countries followed different paths to develop their markets. While Egypt and Tunisia had a public sector-led model, Morocco relied more on private sector initiatives.

The paper shows that wind markets in Africa are small both in absolute terms- measured by installed capacity – and in relative terms – measured by their contribution to the energy generation mix. While significant growth in installed capacity is expected, driven by the increasing number of ongoing and planned projects as well as increasing capacity of individual projects, we show that wind-energy contribution to energy consumption is expected to remain unchanged. In other words, growth in wind energy production in Africa is not expected to outpace growth in total generation capacity.

Another interesting feature of African markets documented in the paper is the high level of concentration with 3 African countries, namely Egypt, Morocco and Tunisia capturing 73% of completed projects and 96% of total installed capacity at end-2010. Concentration is also observed for ongoing and planned projects whereby Egypt, Morocco and South Africa collectively account for 83% of total expected capacity. The paper also shows that public utilities such as NREA (Egypt), ONE (Morocco) and STEG (Tunisia) are the dominant players in the sector while private players remain heterogeneous and include both international companies, mainly from France, Spain and Netherlands, and local players whose core business lies sometimes outside of the energy sector.

Cost and financing data available in our database show that non-concessional resources from DFIs accounted for about 59% of the cost of installed capacity on the continent. The amount spent per MW of installed capacity is consistent with levels observed in global markets. The paper also shows that concessional funding is being phased out and replaced by non-concessional investments from bilateral and multilateral DFIs, as well as commercial investments. What's more, the paper reports the absence of a correlation between sources of ODA for pilot projects and sources of private investment into commercial operations implemented at later stages, suggesting that ODA is not particularly used to pursue new markets.

The second part of the paper explains why African countries have been lagging behind despite the continent's important wind potential. It shows that intermittency and output variability are two physically driven states that can make simple economic and financial comparisons between wind projects versus non-renewable energy projects difficult. In addition, pricing that does not take into account all externalities related to renewable energy investments presents an inherent bias against wind projects. Lack of regulatory frameworks and experience in the field constitute additional impediments. Ultimately, this introduces an important dilemma for African countries: whether to invest in what appears in the short-term to be reliable and more cost-efficient power generation based on fossil fuels, or to invest in wind energy that is unstable, capital intensive and requires development of regulations and schemes to cater for what is still a relatively nascent field. Considering the urgency with which African governments must address electricity deficits and Africa's limited global carbon footprint, the former solution will most likely be adopted.

Overall, the analysis provided in the paper shows that wind-based electricity has limited potential to address the issue of electricity access in Africa on its own. Only countries which could develop large, robust and 'smart' grids, *i.e.* with high self-adjustment capacity, are poised to fully capture the benefits of wind-based electricity.

5.2 Policy Implications

The following policy recommendations emerge from the discussions included in the paper:

The designation of a national entity dedicated to the promotion of renewable energy should be encouraged. Country experience shows that having national champions helps develop the sector by offering a single focal point for regulation, financing and oversight. In some instances, local agencies could be created but this is not the only route to promote the sector since well-established utilities or divisions within them could play that role ensuring policy continuity. While designating local champions should be the responsibility of local governments, DFIs could assist by making sure government agencies have the right capacity to oversee the industry's development. This calls for DFI's greater involvement in capacity building programs.

Experience shows that private investors are willing to invest in the sector as long as a clear regulatory framework is in place and wind resources are geo-referenced to gauge feasibility. The public sector therefore has a vital role to play in creating a conducive environment to attract private investors while at the same time investing in upstream operations such as feasibility studies that would pave the way for further sectorial development. DFIs should leverage their global experience to help countries design clear procurement frameworks, adopt best practice in the sector and undertake reforms aimed at facilitating private sector engagement.

Countries with sizeable wind energy markets such as Egypt, Morocco and South Africa, should design and implement robust policies to encourage local manufacturing of wind turbine components. Local manufacturers should be supported by governments and development partners to make them more competitive and able to bid for large scale projects. It has been shown in the paper that African manufactures of wind turbines are still few in number with almost no footprint on the market as all the technology that has been used on the projects is imported. Experience from emerging markets in the industry has shown that government intervention, as policy makers or even financiers, is key for a sustainable manufacturing industry.

Interventions to develop the sector should be adapted to country contexts. Country experiences show that wind energy markets face different constraints and could be developed using different paths. While

Tunisia and Egypt had a public sector-led development strategy, Morocco relied more on private procurement of wind energy projects. Kenya adopted the feed-in tariff mechanism, while Egypt and Morocco used a process involving competitive bidding and direct negotiation. For instance, the issue of carbon emissions could be more relevant for South Africa than for Chad. Hence, governments should adopt solutions that best fit to their existing challenges instead of seeking to adopt best industry standards. In this context, development partners should avoid the one size fits all approach when designing their interventions and should allow countries to use different approaches depending on their priorities and local constraints.

In order to address the issue of small scale projects, stakeholders should engage in implementing a regional approach whereby countries with greater potential develop large scale wind farms to address their needs and possibly the needs of their neighboring countries. The regional approach could also help solve the intermittency problem in wind electricity generation through interconnection of wind farms as proposed in section 4.1. This calls for greater involvement in regional projects that would enhance interconnections between national grids.

Annex 1: Sources of Financing for Wind Projects in Africa

Public funding comes in the form of budget contributions and direct or indirect subsidies. Most sustainable of the sources of public funding is taxation buttressed by sustainable tax policies and robust tax administration. Countries have strengthened domestic resource mobilization for infrastructure financing given the subdued flow of aid from traditional development partners in the wake of the global economic crisis and its aftermath. Public sponsorship of wind and solar energy projects is also increasing.	***Official Development Assistance (ODA)*** towards infrastructure grew to reach its peak of USD 3.3 billion per year in 2004 (African Economic Outlook, 2009). Since then, commitments have increased; however, actual financial flows have declined as donors continue to adopt austerity measures to curb the effects of the financial crisis which left them with enormous national debts. For renewable energy projects, ODA contributions through 'Climate Funds' have continued on a positive growth trend over the past decade.
Funds dedicated to the development of clean energy are often concessionary for example, the Global Environment Facility (GEF), Clean Investment Funds (CIF), Africa Green Fund (AGF), Sustainable Energy Fund for Africa (SEFA) and the Renewable Energy and Adaptation to Climate Technologies (REACT), among others. These funds provide grants and contingent financing to offset upfront project preparation costs, with potentially substantial crowding-in effect on private investment. They also provide direct project financing and support for pilot programs. GEF's USD 2 billion portfolio for Africa (1991-2009) includes renewable energy mini-grids for rural electrification in West Africa, covering 18 countries in the region.	***Multilateral development banks*** have played a central role in promoting wind and solar energy sectors in Africa. In addition to financing, MDBs also support policy and regulatory reforms in African countries to facilitate adoption of clean energy options. They also provide risk management instruments, financial market development in countries, and support activities to create an enabling environment for the preparation and implementation of clean energy projects. MDBs have participated in almost all large scale wind and solar energy projects in Africa, both completed and ongoing. They also support countries in accessing carbon finance, through instruments such as the Africa Carbon Facility (ACF) launched by the AfDB to promote Africa's carbon markets.
Most of the ***private investment*** in renewable energy in Africa is concentrated in North Africa and South Africa. Financial instruments such as risk guarantees and credit guarantees, export credit and incentives increase the bankability of projects hence catalyzing additional private sector flows. Private sector operations are hugely driven by the expected return on investment and portfolio diversification. From 2005 to 2010, a total of USD 4.5 billion was invested in SSA by the private sector in the renewable energy.	To raise funding on the carbon market, three ***carbon finance mechanisms*** are commonly employed: auctioning of assigned amount units, auctioning under emission trading systems and offset levies like the Clean Development Mechanism (CDM). Of the available mechanisms, Africa has mostly benefited from the CDM system. Income from CDM offsets is generally used to recover capital investment costs incurred in the implementation of renewable energy projects. Most carbon offset projects had been registered in Nigeria (4 million CERs) and South Africa (3 million CERs) by end-2009. In South Africa, the minerals and energy department estimates that the country could generate ZAR 618m in carbon trade by 2012.
Export credit agencies function to take risks or cover others against political and/or commercial risks resulting from the export of goods or services. ECA support usually takes the form of i) export credit guarantees or insurance ii) investment insurance (political risk insurance only); or iii) direct loans. Export credit guarantees can insure projects involving trade of green technologies against risks such as non-payment, bank loans or risk insurance to investors in overseas markets.	Clean technology financing can also take the form of ***private equity and debt funds***. The private equity fund InfraCo sponsored the Cabeolica wind farm in Cape Verde; while Evolution One is set to support a wind farm and a 10-year roll-out program for solar water heaters in South Africa.

Source: Mutambatsere and Mukasa (2011)

Annex 2: Projects Benefitting from CDM Financing

Project	Country	CDM Partner	GHG reduction (metric tonnes CO2 equivalent per annum)	Crediting period (years)	Capacity (MW)	Status
Zafarana IV	Egypt	Germany (KfW)	171,500	7	47	completed
Zafarana VI	Egypt	Japan (Japan Bank for International Cooperation, Japan Carbon Finance Ltd	248,609	7	120	completed
Zafarana VIII	Egypt	Denmark (Danish Ministry of Climate and Energy, Danish Energy Agency (DEA), Ministry of Foreign Affairs of Denmark (DANIDA))	209,714	7	120	completed
Cam Sim (Essaouira/Am Ogdoul) Wind Farm	Morocco	France, Switzerland (European Carbon Fund)	156,026	10	60	completed
Tanger wind farm (Dahr Saadane & Beni Mejmel)	Morocco	UK (Orbeo, Post 2012 Carbon Credit Fund CV)	334,073	10	140	completed
La Farge Wind Farm	Morocco	France	28,651	7	22	completed
Zafarana V	Egypt	UK (European Carbon Fund)	170,364	7	85	completed
Haouma	Morocco	Not Available	134,496	7	50	ongoing
Akhfenir (tan tan)	Morocco	Not Available	264,789	7	200	ongoing
Lake Turkana Wind Farm	Kenya	Not Available	736,615	7	300	planned
Eole (Plaine Des Roches) Wind Farm	Mauritius	Sweden (Swedish Energy Agency)	32,039	7	18	planned

Source: Authors' research and United Nations Framework Convention on Climate Change (UNFCCC), 2012.

Annex 3: Feed-in Tariffs for Wind Energy Projects

Country	Rate and year	Comment	Reference
South Africa	2009: 1.25 ZAR/kWh (0.14 USD/kWh) 2011: 0.938 ZAR/kWh ($0.14 USD/kWh) 2011: ceiling price (REBID reforms) (115c/Kwh)	South Africa's wind energy tariff started off greater than that offered in Germany (€0.092/kWh) and more than that proposed in Ontario, Canada ($0.135 CAD/kWh). In 2011 it was proposed that the FiT should be reduced to 0.938 ZAR/kWh, and at the same time, revised the procurement process from direct procurement to a two-stage bidding process known as ReBid. These changes caused discontent in the industry, but the 2011 bidding process has been rated as successful.	Renewable Energy World: www.renewableenergyworld.com/rea/news/article/2009/04/south-africa-introduces-aggressive-feed-in-tariffs Edkins, M. T. (2012), Local, National and Regional Policy, barriers and incentives – Renewing Wind Policy Risk in South Africa, World Wind Energy Conference 2012, Bonn Germany.
Kenya	2008: 0.09 USD/kWh		Ministry of Energy report
Algeria	2004 to date: 300% of the of the average electricity price	Tariff payment under the Algerian feed-in tariff scheme is expressed as a percentage of the average electricity price which is set annually by the power market operator, so there is not a specific contract term. Even though the tariff level can vary every year (due to the connection to the electricity price), tariff payment is guaranteed for the full lifetime of a project.	World future council: www.futurepolicy.org/2689.html
Tanzania	2009: 86.50 TZS/kWh (0.054 USD/kWh – wet season) 115.33 TZS/kWh (0.072 USD/kWh – dry season) For off-grid small power projects 334.83 TZS/kWh (0.21 USD/kWh)	The standardized tariff is above the market rate to cover cost of generation plus a reasonable profit. Tariffs are calculated differently for dry season and wet season. The amount of tariff for off-grid SPP is higher and is calculated on the basis of avoided cost of replacing diesel generators.	Tanzania electricity supply company limited: www.geothermie.de/fileadmin/useruploads/aktuelles/Geothermiekongress/vortraege/EA_Kabaka.pdf
Morocco	No FiT.	Auto-producers may sell extra energy from wind farms to the national utility, ONE for a price of 70 % of ONE-tariffs.	

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