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# **Prospects for investment** in large-scale, grid-connected solar power in Africa

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# ABSTRACT

Solar power in Africa is on its way to becoming a market-based commodity, thus escaping the niche for individual electricity supply that is mainly supported by international donor organisations. Significant reductions in the cost of photovoltaic (PV) panels and a 400 percent increase in oil prices since the 1990s have changed the competiveness of solar PV in all markets, ranging from individual households via institutions to mini-grids and grid-connected installations. In volume and investment, the market for large-scale grid-connected solar power plants is by far the most important, and as production costs are today competitive with large-scale diesel, this market is rapidly emerging. Donor-influenced plans and visions for solar PV development have often been optimistic with regard to the diffusion of solar PV in Africa, but the last three years of development, in terms of a number of large-scale investments in grid-connected solar power plants and local assembly facilities for PV panels, have exceeded even optimistic scenarios. Finally, therefore, there seem to be bright prospects for investment in large-scale grid-connected solar power in Africa.

# 1 INTRODUCTION

We are currently observing a shift in the African PV sector away from mainly donor-driven projects towards market-driven investments in PV in all market segments. This transition is stimulated on the one hand by rising oil prices and a substantial reduction in the cost of PV panels during the last decade, which has significantly improved the competitiveness of PV, and on the other hand by conducive enabling frameworks comprising innovative financing schemes, exemptions from VAT and import taxes, standardised power-purchasing agreements and feed-in tariffs. In particular, the market for large-scale, grid-connected PV plants is rapidly emerging throughout Africa, as production costs are currently competitive with large-scale diesel. This development towards the market-based diffusion of PV therefore also marks a movement from mainly small-scale and off-grid PV installations to larger scale grid-connected PV with increased capital intensity (Hansen et al. 2014). In parallel with this movement, a market for another large scale solar power technology, concentrating solar power (CSP) has been developed especially in Spain, but also lately in South Africa and Morocco, with the effect that also the cost of CSP is being reduced, and currently competitive with PV under certain conditions.

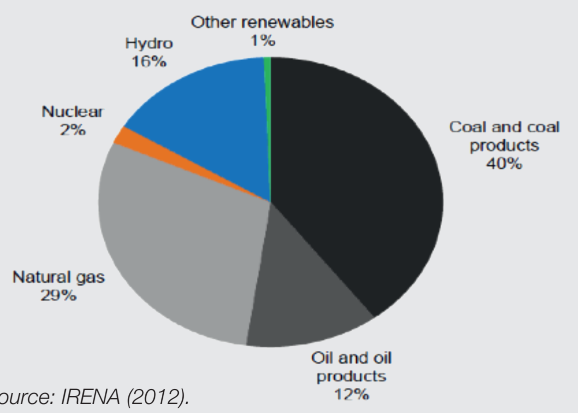
Hence although large-scale and market-driven investments in renewable energy and local industry development in a high-tech sector is not something one typically associates with Africa, this is nevertheless what we are seeing emerge in the case of solar power. While this situation is exciting from a policy and investment perspective, a coherent overview of the market for grid-connected solar power plants in Africa is currently not available. Therefore, in this paper we attempt to provide a systematic overview of the prospects for and recent investments in large-scale, grid-connected solar power in Africa, based on reports from governments, international finance institutions and research centres, and supplemented by the latest media reports from the internet.

The paper is structured as follows. Section 2 provides a background description of the power infrastructure in Africa. Section 3 explains developments in the markets and prices for PV modules, followed in Section 4 by examples of recent policies and government plans for supporting large-scale solar power in a number of African countries. Section 5 describes the investment models applied in projects that are currently underway, while Section 6 offers a conclusion.

# 2 POWER INFRASTRUCTURE

While there are large differences in both natural (energy) resource endowments and political and economic conditions, the compositions of power systems in African countries share a number of similarities. As shown in Figure 1 below, most African countries' power generating systems rely on a combination of coal, gas, diesel and hydropower. With increasing world market prices for coal and diesel, this puts significant pressure on state expenditures from importing (and subsidising) these resources.

**Figure 1.** African power generation by fuel.




*Source: IRENA (2012).*

The widespread privatisation of electricity systems in Africa due to structural reform programs in recent decades has not generated the level of foreign investment expected in expanding and improving the power infrastructure. The lack of investment in the sector has led African utilities and governments to expand capacity rapidly through the use of emergency solutions, such as diesel barges and temporary generators (Eberhard et al. 2010). As illustrated in Table 1, this has been a costly solution for utilities, thus further reducing the opportunities for long-term investments.

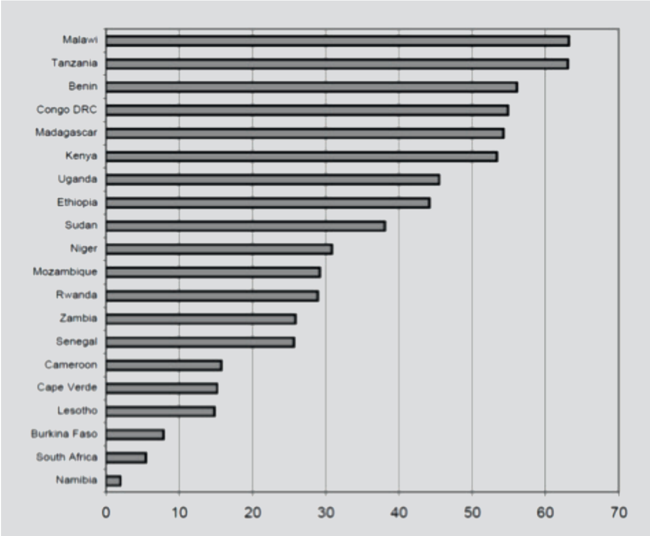
The investment deficit that has failed to replace aging infrastructures and created low levels of reserve capacity has further had the effect that power supply is highly unreliable, with frequent power cuts in most African countries, as shown in Figure 2 (Eberhard et al. 2008). This has been costly for industry and private consumers in terms of production losses and investment in individual back-up systems.

**Table 1.** Economic cost of emergency power generation

| Country | Emergency generation capacity (megawatts) | Total generation capacity (megawatts) | Emergency generation capacity (% of total) | Cost of emergency generation (% of GDP) |
|---|---|---|---|---|
| Angola | 150 | 830 | 18.1 | 1.04 |
| Gabon | 14 | 414 | 3.4 | 0.45 |
| Ghana | 80 | 1,490 | 5.4 | 1.90 |
| Kenya | 100 | 1,211 | 8.3 | 1.45 |
| Madagascar | 50 | 140 | 35.7 | 2.79 |
| Rwanda | 15 | 31 | 48.4 | 1.84 |
| Senegal | 40 | 243 | 16.5 | 1.37 |
| Sierra Leone | 20 | 15 | 133.3 | 4.25 |
| Tanzania | 40 | 881 | 4.5 | 0.96 |
| Uganda | 100 | 140 | 41.7 | 3.29 |

*Source: Eberhard et al. (2010).*

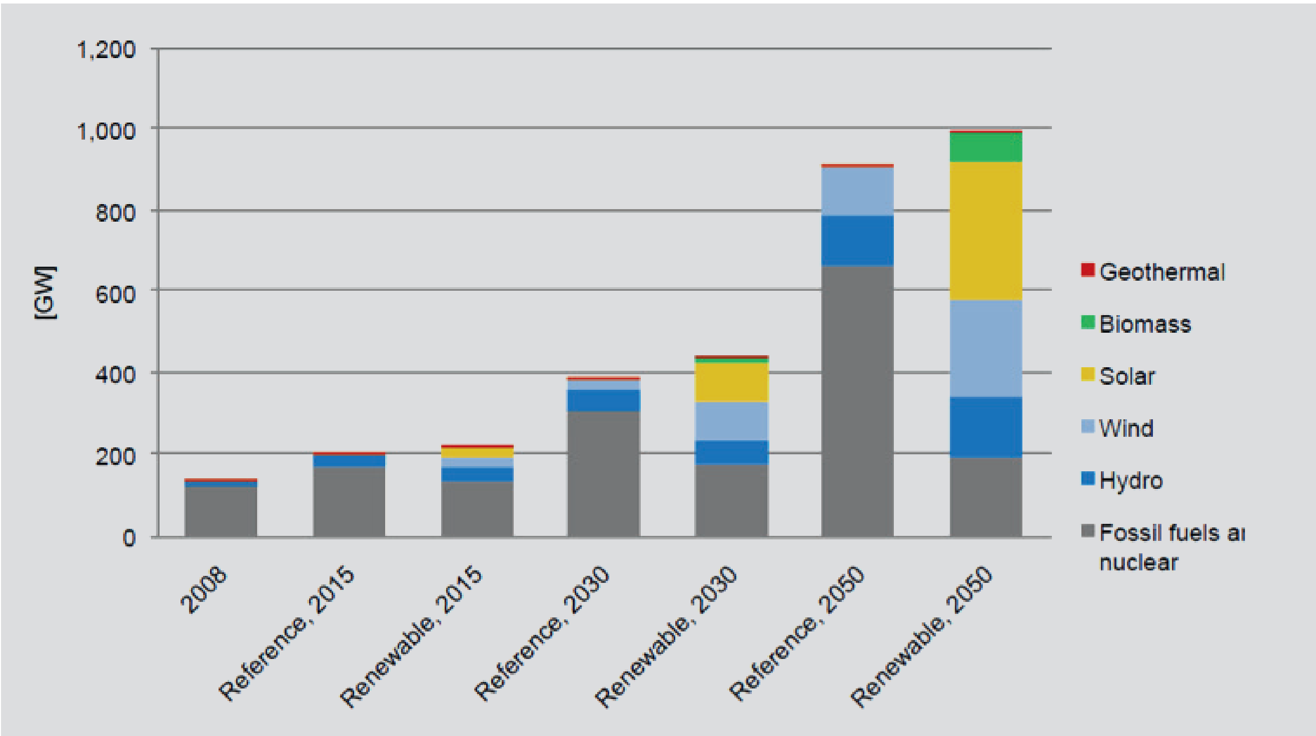
**Figure 2**. Black-out time in African grid infrastructure: Percentage of time in one year.




*Source: Eberhard et al. (2008).*

The current investment problems are being exacerbated by the rapid economic growth and concomitant increase in power demand in a number of African countries, leading to a situation in which demand is rapidly outstripping supply (Eberhard et al. 2010). In addition, around 70% of the population in Sub-Saharan Africa lack access to electricity, but rolling out additional electricity infrastructure to drive prices down and increase access is often being hindered by a lack of financial resources (IEA 2013). According to a recent study, *Prospects for the African Power Sector* (IRENA 2012), the African continent will need to add around 250 $GW_p$ of new capacity (in addition to the existing 147 $GW_p$) between now and 2030 to meet this growth in demand. The study operates with two scenarios, a reference scenario and a renewable energy scenario. Installed capacity by technology is shown in Figure 3. According to the renewable energy scenario, a large share of this,

**Figure 3.** Installed electricity generation capacity by fuel in the reference and renewable scenarios, 2008 to 2050.




*Source: IRENA (2012).*

## **Table 2:** Composition of power-sector funding gap.

| Country type | $ billions annually | | | Percentage of GDP | | |
|---|---|---|---|---|---|---|
| | Capital expenditure gap | Operation and maintenance gap | Total gap | Capital expenditure gap | Operation and maintenance gap | Total gap |
| Sub-Saharan Africa | 17.6 | 5.6 | 23.2 | 2.7 | 0.9 | 3.6 |
| Low-incom fragile countries | 2.6 | 0.1 | 2.8 | 6.9 | 0.2 | 7.1 |
| Low-income nonfragile countries | 4.5 | 0.1 | 2.8 | 6.9 | 0.2 | 7.1 |
| Middel-income countries | 5.5 | 5.2 | 10.7 | 2.0 | 1.9 | 3.9 |
| Resource-rich countries | 3.5 | 1.0 | 4.5 | 1.6 | 0.5 | 2.0 |

*Source: Eberhard et al. (2010).*

namely about 100 $GW_p$ capacity from solar power (PV and CSP), should be installed between 2012 and 2030.

The study estimates an annual investment of USD 133 billion per year until 2030 in the renewable energy scenario. This is about USD 32 billion more than in the reference scenario. These investment needs are up to three times the finance requirement referred to by Eberhard et al. (2010) and raise concerns because, even with the lower estimate of USD 40 billion, Eberhard et al. expected a funding gap of USD 23.2 billion, as shown in Table 2.

However, as we shall see below, some African utilities and governments have already started to consider the expansion of grid-connected PV. There are three main reasons for this. First, PV has the advantage of faster installation time (compared, for example, to a large-scale coal-fired power plant). Secondly, access to (green) financing for PV is easier than for environmentally questionable technologies such as coal and large-scale hydro. Thirdly and most importantly, PV has become competitive with diesel technologies, due to the falling price of modules, a topic we will turn to in the following.

# 3 MARKET DRIVERS FOR SOLAR POWER

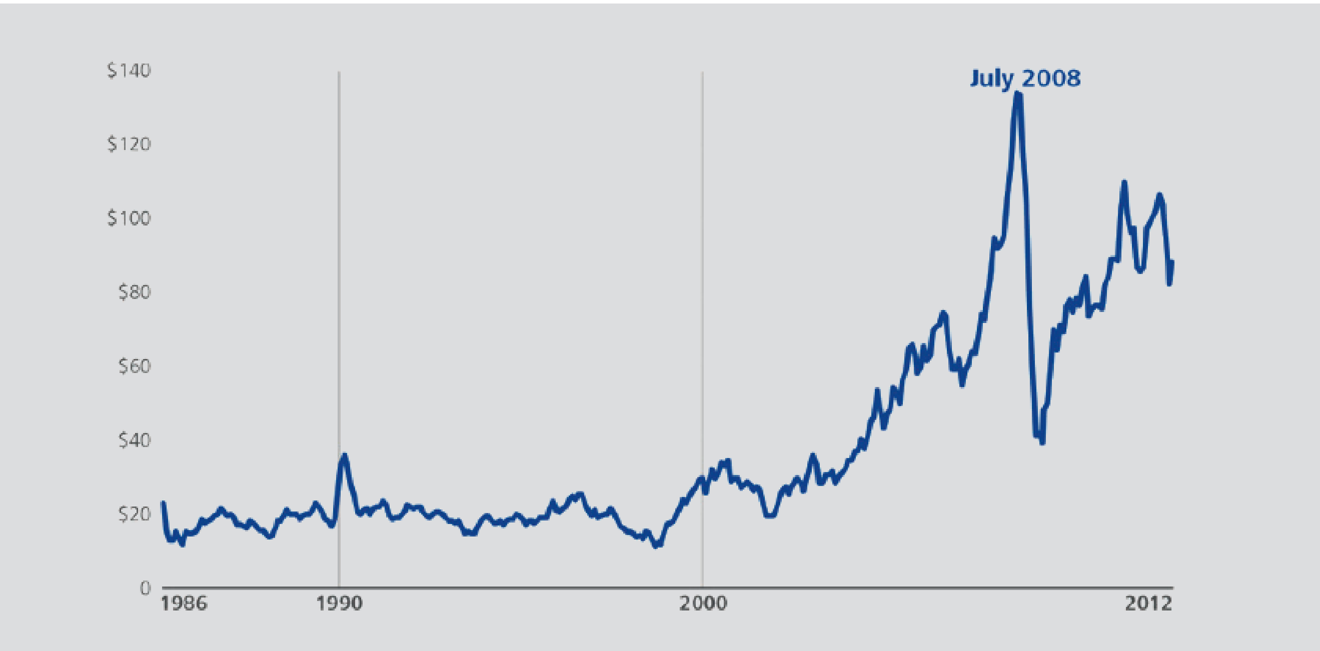
Among policy-makers, planning agencies and industry experts, there has for a long time been an expectation that solar power would become competitive with conventional electricity generating technologies, and there are plenty of examples of over-optimistic expectations of what could be achieved from interventions. However, while the potential of PV for power generation has long been acknowledged, it is only recently that the economics of PV have been improved to the extent that, under good conditions, it reaches grid parity (Bazilian et al. 2013). As we shall see in the following, this is mainly due to increases in oil prices and decreases in PV module prices.

As Figure 4 below shows, an almost stable oil price of around 20-30 USD per barrel from 1986 to 1999 in the last years fifteen years has gradually increased and reached a new stable level of around 100 USD per barrel, which represents an increase of about 400%.

At the same time, as shown in Figure 5, the price of PV modules has been reduced continuously since the 1990s, and after a period of relative stagnation and momentary price increase during 2003-2007, module prices dropped dramatically from 2008 onwards.

During the period from the early 1990s to the early 2000s, the price of PV modules was gradually reduced in line with the general increase in global PV production and installed capacity (see Figures 6, 7 and 8). These PV cost reductions resulted from continuous corporate R&D investment in process efficiency improvements and scale economies to reduce manufacturing costs in cell and module production plants located mainly in China and Taiwan (Jäger-Waldau 2013). From the early 2000s and until 2007/2008, PV module prices increased as a shortage of polycrystalline silicon hindered increases in production capacity and the ability to meet the growing

**Figure 4.** Crude oil price (US$ per barrel) 1990-2013.



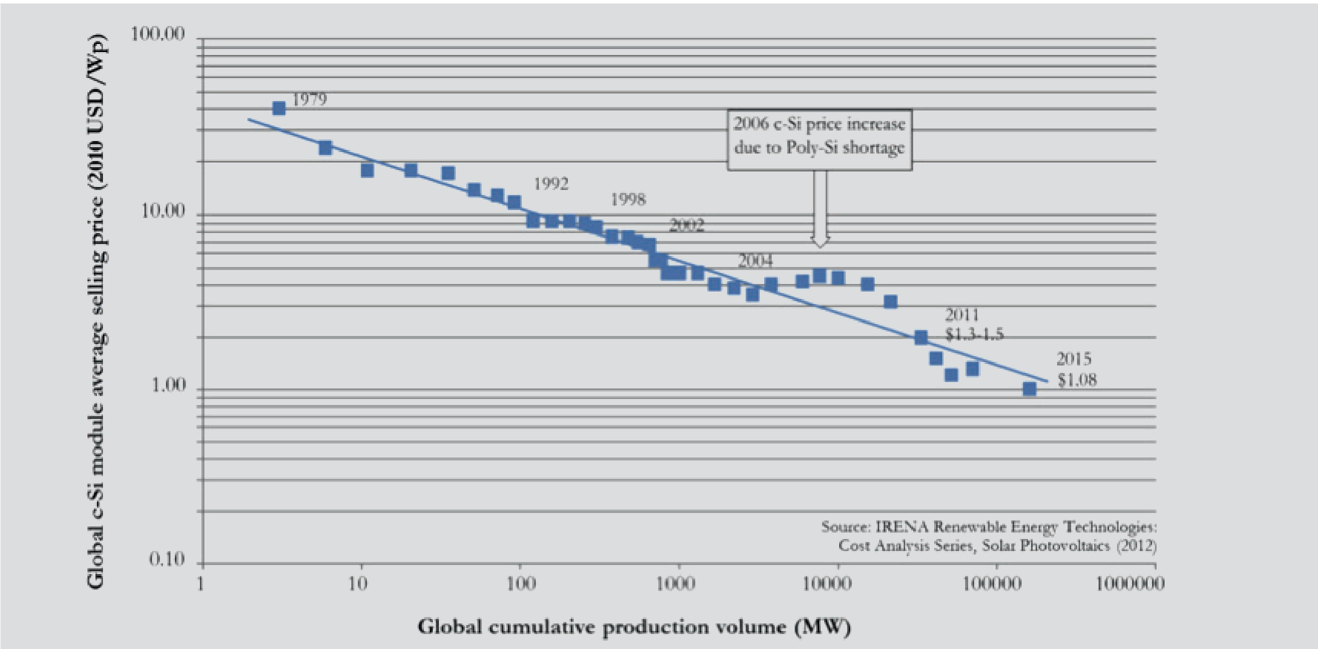

*Source: Terzic (2012).*

**Figure 5.** PV module prices 1992-2013.


*Source: Mints (2013).*

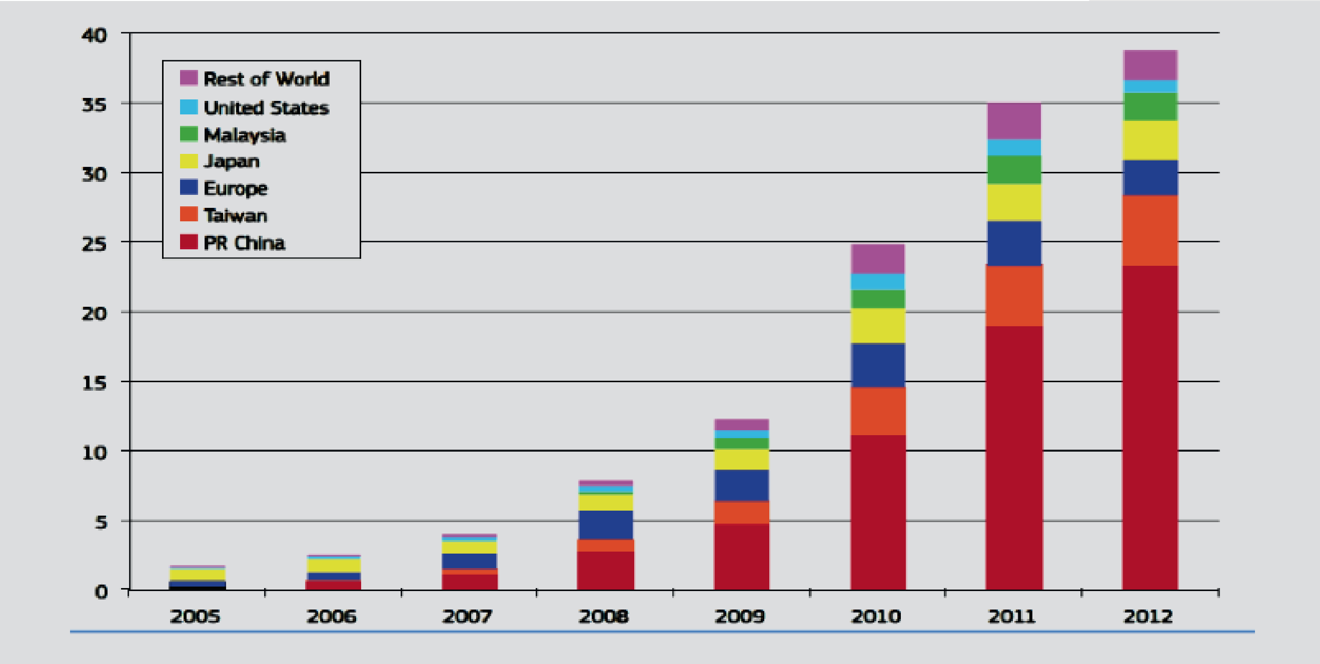
market demand. This spurred large-scale investments in increasing production capacity in the polycrystalline silicon and PV production supply chain, mainly in China. However, following the closure of the Spanish PV program in September 2008, these investments in expanding production facilities led to a substantial global overcapacity in PV cell and module production, as Spain had led much of the market demand for PV (Bazilian et al. 2013). This overcapacity is a key element in explaining the rapid drop in PV module prices from 2008 onwards, since it led to significant price pressures along the entire PV value chain as a result of cut-throat competition among module suppliers and further improvements in economies of scale (REN21 2013). Nevertheless, as illustrated in the learning curve in Figure 6, prices are expected to continue to fall, although at a slower rate in the near future.

**Figure 6.** The global PV module price learning curve for crystalline silicon modules.



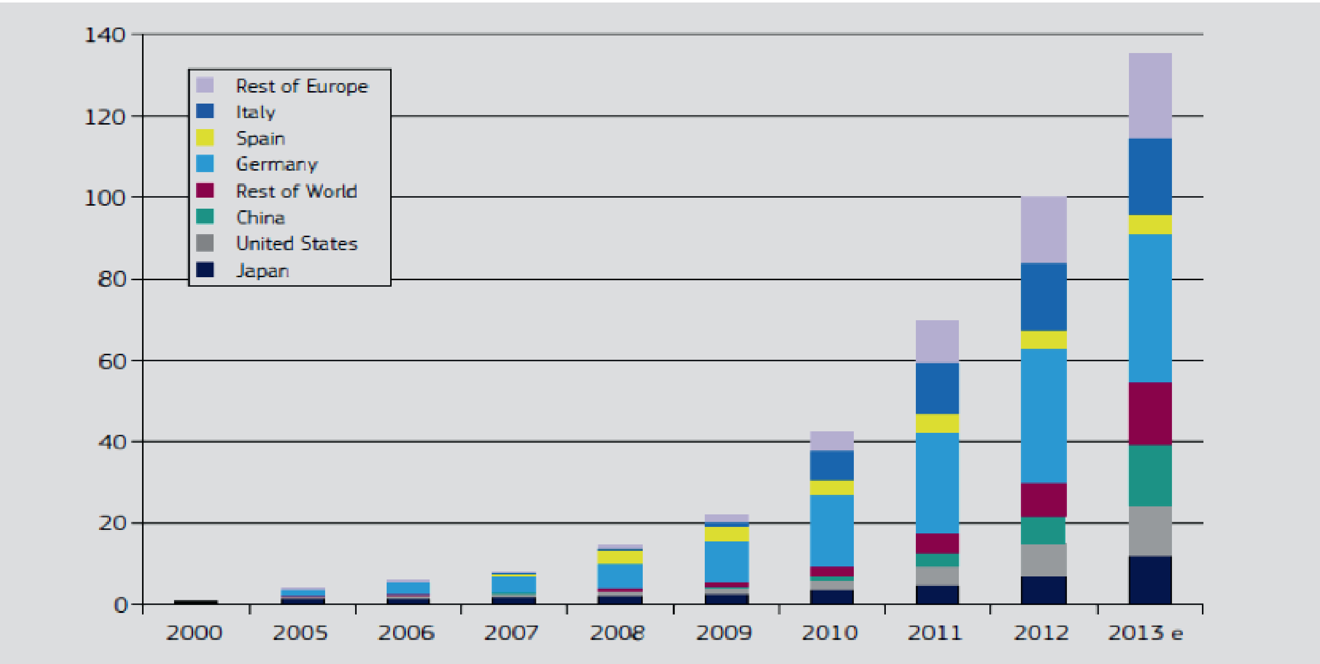

*Source: Bazilian et al. (2013).*

**Figure 7.** Global PV production (GWp) by country and region 2005-2012.




*Source: Jäger-Waldau (2013).*

**Figure 8.** Installed PV capacity (GWp) by country and region 2000-2013.




*Source: Jäger-Waldau (2013).*

The cost reductions for PV cells, the increases in oil prices and strong international competition has led to a situation where electricity produced by large-scale solar PV has reached grid parity in a number of markets, as we shall see in the following examples.

The results from three successive bidding rounds for large-scale grid-connected PV projects totalling 1400 MWp in South Africa provides a good up-to-date estimate of the current price level 'on the ground'. As illustrated in Table 3 below, the average power purchase agreement price for PV tenders was gradually reduced from 22.44 EUR cent/kWh in December 2011 to 13.39 EUR cent/kWh in March 2012 and finally to 7.17 EUR cent/kWh in October 2012 (PVInsider 2014). This shows the effects of successive bidding rounds in a national market, but it also indicates the cost levels we can expect for large-scale investments in developed markets in Africa.[1]

Similar price reductions and price levels have been observed in the German feed-in tariff (FiT) system, where the tariff for PV plants above 1 $MW_p$ changed from 13.4 EUR cent/kWh in April 2012 to 11.8 in January 2013 and to 9.5 in January 2014 (Lang and Mutschler 2013). As plants are still being constructed in Germany with this tariff level, we must expect the FiT to reflect the level of production costs in Europe. The current global price level of PV-produced electricity may therefore be estimated at around 7-9 EUR cent/kWh or 9.5-12.3 USD cent/kWh,[2] with the cost of CSP being a little higher.

This cost is still high compared to coal or large-scale hydro, but it is competitive with electricity from large-scale diesel where diesel is not subsidized (Bazilian et al. 2013). As shown in a recent study by Nygaard et al. (2012), the marginal electricity production costs of a newly installed (45 MW) diesel-fired power plant in Mali (at diesel costs reflecting a crude oil price of 100 US$/barrel) is about 16 EUR cent/kWh (103 XOF/kWh).

Since this case reflects the lowest costs of diesel-based electricity production, PV is indeed competitive with non-subsidized diesel-based electricity production. However, as elaborated in Bazilian et al. (2013), it seems that African policy-makers and planners are only slowly waking up to this new situation.

Referring back to Section 2 and the scenarios developed by IRENA, the renewable energy scenario would require installation of about 6000 $MW_p$ per year, equivalent to an annual investment of US$ 9-12 billion (assuming a total system cost of 1.5-2 $US\$/W_p$) to reach the goal of 100 $GW_p$ additional solar capacity (PV and CSP) in 2030. With such prospects for a future market for solar power in mind, the following will address how policies supporting grid-connected solar power have been implemented in a number of African countries, thereby preparing the ground for both small-scale and large-scale solar power.

**Table 3.** Average PPA price for PV in three bidding rounds in South Africa.

| | Window 1 Average PPA price (EUR cent/kWh[1]) | Window 2 Average PPA price (EUR cent/kWh[1]) | Window 3 Average PPA price (EUR cent/kWh[1]) |
|---|---|---|---|
| PV | 22.44 | 13.39 | 7.17 |
| CSP | 21.86 | 20.44 | 11.88[2] (18.95 if adjusted by the peak-base hours payment schedule) |

1 ZAR price base: April 2013. Assuming a exchange rate of 1 ZAR=0.07244 EUR as per 11/11/2013
2 Bid Window 3 base price payable for 12 hours every day and 270% of base price payable for 5 peak" hours every day. This pricing basis is not comparable with Bid Windows 1 and 2

*Source: PVInsider (2014).*

1 That said, it should be noted that the average price will increase if some of the lowest bids do not materialise due to, for example, problems in raising finance.
2 Exchange rate as of 04.06.2014.

# 4 EXAMPLES OF NATIONAL POLICIES

In the following we will present the main policies on solar power in four African countries – Kenya, Morocco, Rwanda and South Africa – which show very different development trajectories. These examples have been chosen to illustrate how different initial development paths may led to the development of large-scale, grid-connected solar power.

## KENYA

The Kenyan PV supply sector has been led by a commercial market for small-scale solar home systems (SHS) for private households, which in 2013 accounted for around 80% of the approximately 18-20 MWp installed PV capacity (Ramboll 2012; Meza 2013; Ondraczek 2013). The remaining 20% of capacity has mainly been installed in institutions, such as schools, public buildings and health clinics located in rural areas (Hankins et al. 2009), while only recently, as part of rural electrification programs, the government and donors have taken steps to support PV-based mini-grids, mainly in the form of hybrids with existing diesel-fired generators.

Also recently, the government's focus has turned towards supporting the construction of large-scale, grid-connected PV plants. In 2008, the Kenyan government introduced a feed-in tariff (FiT) policy to support grid-connected renewable energy, which was later revised in 2010 to include solar PV and again in 2012 to adjust tariff prices (ME 2012). The current FiT price for solar PV is 0.12 USD/kWh. Given the increasing demand for energy in Kenya, which is being fuelled mainly by rapid economic growth, a main objective of the FiT policy is to contribute to expand the capacity in the existing grid in order to maintain an adequate reserve margin to ensure security of electricity supply. According to Willis (2014), 25 projects with a total installed capacity of 750 MWp are in the process of the initial feasibility stage. Although some observers have stressed that PV tariff rates are currently too low to attract domestic and foreign investors (Meza 2013a; Ramboll 2012), the current range of PV production costs of 9.5-12.3 USD cent/kWh, estimated in the section above, indicates that the 25 projects above may be feasible within the current FiT. If so, the expectations of installed PV capacity of 100 MWp by 2016, 200 MWp by 2022 and 500 MWp by 2030, outlined in the National Energy plan from 2012, although impressive two years ago, may be fulfilled far ahead of schedule.

## MOROCCO

From 1996 to 2010 the PV market in Morocco was dominated by SHS as part of a rural electrification scheme led by the Moroccan utility, Office National de l'Electricité (ONE). However, under the so-called Moroccan Solar Plan (MSP) adopted in 2009, the government's focus changed towards promoting large-scale solar power plants as a mean to i) diversify energy supply; ii) preserve the environment; iii) exploit domestic renewable energy resources; and iv) reduce energy dependency (Richts 2012). The MSP set a target of 2 GWp grid-connected solar-based power to be achieved by 2020, corresponding roughly to a share of 18% of total installed capacity in Morocco and a total investment of around US$ 9 billion. If realised, this will involve a significant increase from the total grid-connected PV capacity of 200 KWp in 2012 that was constructed under the so-called Promasol program. The plan is being implemented by the newly established Moroccan agency for solar energy (MASEN), which has selected five construction sites to be developed as CSP or PV projects. The first project is a CSP plant with a total installed capacity of 500 MWp, which is currently being constructed in the city of Ouarzazate in the south of the country. The plant will be built, owned and operated by ONE.

## RWANDA

The demand for PV in Rwanda has until recently been driven mainly by donor programs aiming to electrify rural institutions, such as schools and health centres,

through PV installations. In 2000 an influential report entitled ‘Rwanda Vision 2020' was launched, which had a strong focus on renewable energy, although without including targets for PV. However, following the so-called Energy Sector Overview Report that was launched in 2012 a political paradigm shift occurred in the government, as large-scale, grid-connected PV was incorporated into electricity generation targets (Jacobsson 2013). According to Willis (2014), the Rwandan government is expecting to have an extra 40 MWp of solar generating capacity in place by 2017, which will be achieved by means of a feed-in tariff for PV that is expected to be implemented by June 2014. Since Rwanda has one of fastest growing economies in Africa and only limited power generating capacity, the government is aiming to increase the country’s capacity from the current 110 MWp to 560 MWp by 2017, and PV has increasingly come to be seen as part of achieving this target. Interestingly, in 2008 Rwanda already installed the largest grid-connected PV plant in the region, with an installed capacity of 250 Kwp (Hankins et al. 2009).

## SOUTH AFRICA

Solar home systems for poor and remote rural areas were promoted by the government through the National Electrification programme as a substitute for grid electricity (Prasad 2007). An ambitious program to supply 300,000 households was initiated in 1999, but due to a number of difficulties in setting up and administering the fee for service concessions, only about 30,000 households were ultimately equipped with solar PV (Lemaire 2011). This segment has been important in establishing the local PV supply and maintenance infrastructure, but it remains minuscule compared to the large-scale project development initiatives that result from South Africa's ambitious vision for integrating renewable energy in the country's energy mix.

In March 2011, South Africa’s Department of Energy (DOE) finalised the Integrated Resource Plan (IRP), a twenty-year blueprint setting out the government’s commitment to energy from renewable sources (Government of South Africa 2011). A stated goal of the IRP is that renewable energy will make up 42% of all new electricity generation, totalling 17,800 MWp by 2030, with 8400 MWp coming from PV, 8400 MWp from wind and 1000 MWp from concentrating solar power. Through the IRP, DOE has initiated a Renewable Energy Independent Power Producer Programme (REIPPPP). South Africa's current PV market is mainly based on large-scale solar parks realized under this programme. The REIPPPP 2010-2013 consisted of three bidding rounds in which the government awarded a total of 33 PV projects with a total capacity of 1483 MWp. The first round awarded 18 PV projects with a total capacity of 632 MWp ranging from 5 MWp-75 MWp. The second round awarded 9 PV projects with a total capacity of 417 MWp in the range of 9-75 MWp, the third round 6 PV projects with a total capacity of 435 MWp in the range of 60-75 MWp (PV Insider 2014). Further details of the projects that have been implemented and their financing will be presented in the next section.

# 5 EXAMPLES OF LARGE-SCALE SOLAR POWER PROJECTS BUILT OR IN AN ADVANCED STAGE OF PLANNING

This section describes in more details large solar power projects in Kenya, Morocco, Rwanda and South Africa dealt with above, and further includes information on projects in Ghana and Burkina Faso. This section is to the extent possible based on research papers and official government documents, but to include the most recent development, it does also rely on information from the web based news magazines, such as PV insider, PV tech and PV Magazine.

## KENYA

In Kenya, only a few grid-connected PV plants have been installed so far: one plant in the UN compound in Nairobi with an installed capacity of 575 kWp, another at the SOS Children's village in Nairobi with an installed capacity of 60 kWp (Hille and Franz 2011; Ondraczek 2011), a third, 72 kWp system installed at a flower farm in central Kenya in early 2013 (Meza 2013a), and a fourth, 1MWp plant at a tea-processing facility, also installed in 2013. While the first two plants were financed mainly by international donors, the other two plants were financed by the industrial users and delivered by the Kenyan-based company East African Solar Ltd. under turnkey contracts (Mbogo 20133).

Foreign investors are now entering the PV sector in Kenya, which is reflected in the recently announced 50 MWp grid-connected PV plant to be constructed by a Chinese contractor. The plant is being developed by the China Jiangxi Corporation for International Economic & Technical Co, Ltd. which has liaised with the Chinese PV manufacturing company JinkoSolar Holding Co., Ltd to provide the necessary modules and technical support (Finkelstein 2012). While detailed information about this project is scarce, media coverage seem to indicate that a power purchase agreement and government approval have been obtained (African Building 2012).

Another 50 MWp PV plant is scheduled for completion by the end of 2014. This is being developed by a consortium of companies consisting among others of Canadian Solar, the Africa Energy Development Corporation and Eaton Cooper Solar (Woods 2013). A memorandum of understanding has been signed with the government of Homa Bay County and the Kenya Power Company specifying a total investment of US$145 million for the project.

## MOROCCO

In Morocco, only two smaller grid-connected PV systems of 200 kWp have been constructed under the Promasol programme, but unlike most other African countries, Morocco has shown great interest in concentrating solar power (CSP). The Mathar thermo-solar combined-cycle power plant, with a total capacity of 470 MW, was inaugurated in 2010, being built, owned and operated by ONE. The plant is mainly supplied by natural gas, but 20 MW of its power could be attributed to CSP (Cîrlig 2013). The total cost of the project is US$ 544 million, which includes US$ 43.2 million in grant financing from the GEF, two loans from the African Development Bank totalling US$ 371.8 million and a loan of US$ 129 million from the Instituto de Credito Official, a state-owned bank in Spain (African Development Bank 2014).

A second initiative under the Moroccan Solar Plan (MSP) with a target of 2000 MWp by 2020 is the 500 MWp Ouarzazate project. The first phase of the project comprises a 160 MWp CSP plant, which is expected to be in operation by 2015. The total project cost is around 1 billion EUR, which is mainly financed by loans (with average size of around 100 EUR million) provided by the African Development Bank and international donors, such as the World Bank, the European Investment Bank and the German Development Agency (Konate and Arfaoui 2012). The government's MASEN agency will cover the main part of the construction costs (Fal-

3 See also http://www.eastafricansolar.com/.

coner and Frisari 2010). The bidding process for the development of the remaining 350 MWp capacity is planned to be finalised in 2014.

To improve the prospects for fulfilling the 2000 MW target, the government plans to initiate a bidding round for new tenders to develop additional projects under the MSP. These include a 400 MWp plant next to the Ain Beni Mathar plant (to be commissioned in 2016), a 500 MWp plant in Foum Al Ouad (to be commissioned in 2017), a 500 MWp plant in Boujdour (to be commissioned in 2018) and a 100 MWp in Sebkhat Tah (to be commissioned in 2019).The investment set up is likely to be similar to the two mentioned above, comprising a combination of finance from government and international development donors.

## RWANDA

In Rwanda, an 8.5 MWp solar project is being developed at the Agahozo Shalom Youth Village in Rwamagana district. The project is the result of a global consortium of solar companies, funding institutions and national governments, which have raised US$ 23.7 million in financing for the plant. Leading the development of the project is Scatec Solar of Norway and Gigawatt Global Cooperatief, a solar project developer from the Netherlands. These two companies are partnering with Norfund, the Norwegian Investment Fund for Developing Countries, FMO, the Dutch Development Bank, and the Emerging Africa Infrastructure Fund (EAIF). All three entities have provided funding for the project, with additional investment from government-led initiatives from the UK, US, Finland and Austria (Clover 2014b).

According to Reuters (2014), in May 2014 the government of Rwanda also signed an agreement with a consortium consisting of South Africa-based renewable energy company TMM Renewables, Malta-based Gesto Energy Africa and Rwanda-based solar company 3E Power Solar for the construction of a 10 MWp PV power plant in the Kayonza district of Rwanda's Eastern Province.

## SOUTH AFRICA

In South Africa, international (PV) project developers from the US and Europe, such as SunEdison, Juwi, Scatec Solar, Mainstream Renewable Power and Enel Green Power, have been heavily involved in bidding rounds under the REIPPPP. These developers have been involved both as technology suppliers and constructors and as project investors, and they typically enter the market through joint ventures and consortiums with South African companies and financing institutions (Papadopoulos and Schmidt-Haupt 2013).

Scatec Solar, for example, was responsible for constructing, and was the main investor in, the first 75 MWp project under the REIPPPP, which became operational in September 2013. Finance was assured through Standard Bank by a consortium consisting of Scatec Solar, Norfund, Simacel, Stanlib/Standard Bank and the Old Mutual Life Assurance Company (Clover 2013d). Mainstream Renewable Power is leading a consortium implementing two projects each with a capacity of 50 MWp, and it has launched a new business venture called Mainstream Capital that is being targeted specifically at pension funds and insurance companies in order to gain access to capital at more favourable rates (Power 2013). Further, SunEdison is in partnership with a Chinese and South African trust that is developing two solar projects (Wiktop (30 MWp), as well as with Soutpan (28 MWp), with a US$314 million investment consisting of long-term debt and equity.

Compared to rounds one and two of the REIPPP, the results of the third round (completed ultimo October 2013) are pointing to an increasing concentration of projects submitted by large international companies (Von Aichberger 2014). In the third round, Enel Green Power won four of the six projects totalling 285 MWp

(PV Insider 2014), while the international South African-based financial services group Old Mutual won 9 out of the 27 solar projects in rounds one and two of the REIPPPP (Mulder 2014).

The majority of finance to date has been sourced from within South Africa, since international lenders are reluctant to take on the currency risks that rand-denominated power contracts would expose them to (Papadopoulos and Schmidt-Haupt, 2013). In terms of debt, the three largest financing parties, the Development Bank of South Africa, the Rand Merchant Bank and Standard Bank, are responsible for 23%, 22% and 18% respectively of all the financial closures within the REIPPP programme (Jansen, 2014).

According to Papadopoulos and Schmidt-Haupt (2013), the future ability of domestic lenders to provide loans may be constrained by a lack of liquidity in the market. The issue of whether enough liquidity will be available in South Africa to finance additional large solar projects in the future is also raised by Jansen (2014). In April 2013 the Standard Bank Group, which provided approximately R15 billion of debt finance in rounds one and two, addressed this issue by signing a R20-billion funding support agreement for renewable energy projects in South Africa with the Industrial and Commercial Bank of China (ICBC) (Standard Bank, 2013). The funding agreement is supposed to provide debt financing on a project finance basis to companies that have been awarded preferred bidder status under the REIPPPP. Besides liquidity, another constraint in attracting investors is that current interest rates on equity in the REIPPPP range from 12% to 14%, which according to Papadopoulos and Schmidt-Haupt (2013) is slightly lower than what would normally be expected.

## GHANA

In Ghana, a technology differentiated feed-in-tariff for electricity from renewables was published in 2013, by the Public Utilities Regulatory Commission. The tariff for solar is 40.21 GHp/kWh (9.79 EUR cent/kWh), significantly higher than for biomass, landfill gas and sewage gas (7.66 EURc/kWh), wind (7.82 EURc/kWh) or small hydro (6.47 EURc/kWh) (PURC 2013). In parallel, IPPs have begun the process of acquiring licences to generate electricity from renewables, with solar being at the forefront of the available technologies. The licensing requirement has three stages: 1) provisional licence (meaning no s to preparing the project); 2) siting and construction permit (to clear the site and construct plant); and 3) operational permit (to begin operations and sell power to the grid).

According to a source close to the Ghana Energy Commission, as of May 2014, 29 companies have been issued with provisional licences for different capacities of mainly solar projects. Four companies are now working towards acquiring siting and construction permits. None of them has reached the operational stage as yet. For reasons of confidentiality, the source could not provide any details of companies.

According to the press, however, the following projects may be under way. A 155 MW Nzema project is expected to be built by a subsidiary of the British renewable energy investor and operator, Blue Sky. According to the company's webpage, ‘The project is fully permitted with a signed PPA and construction is currently due to commence in early 2014 with full operation achieved by 2015’.4 Furthermore, according to a description on the company webpage from 2012,5 ‘The Nzema plant will be built by a subsidiary of Blue Energy, Mere Power Nzema Ltd on a 183- hectare site close to the village of Aiwiaso in Western Ghana. It has secured a 100-year lease on the site, planning permission and permission to connect to the grid’. This information also appears in an article in PV Magazine (Clover 2014a), based on an interview with the management of Mere Power Nzema Ltd in March 2014. The sources of finance are not known, but according to the webpage in 2012, ‘Blue Energy will now conclude discussions with a number of international financial institutions and global equity and infrastructure funds which have expressed interest in providing debt financing or investing in the project. It expects to reach financial closure in the first half of 2013’. Another project of 55 MWp is expected to be built by a national subsidiary of the Norwegian PV manufacturer, Scatec. According to an article in PV Magazine (Clover 2013), the plant is ‘to be located in an as-yet-undecided location in the north of the country, and is scheduled to come online by 2015’. Furthermore, according to PV

4 http://www.blue-energyco.com/our-projects/.

5 http://www.blue-energyco.com/africas-largest-solar-pv-power-plant.

Magazine, 'in December 2013 DCH-Solargiga signed an agreement to form a joint venture to build 200 MWp of solar PV in the country' (Clover 2014a), but no more details were revealed.

## BURKINA FASO

In Burkina Faso, a number of initiatives are being developed to different stages in the project cycle, from studies to financial closure. Given that large-scale projects are often delayed,6 the four initiatives further described below may contribute 95-115 MWp PV to the national grid in Burkina Faso by the end of 2015. An inter-ministerial committee is in charge of a bidding round for four grid-connected plants of 10-15 MWp each to be built, owned and operated by IPPs. In November 2013, 18 out of 26 expressions of interests were prequalified for a tender, which, according to the Ministry of Mines and Energy (MME), will be carried out in 2014, with assistance from the International Finance Cooperation (IFC). While the MME expects the plants to be in operation by September 2015, no details are available regarding the prequalified companies and their potential sources of finance (MME 2014).

A study financed by the EU for a PV plant at Zagtouli in the outskirts of Ouagadougou is currently in the phase of technical studies and elaboration of tender documents (MME 2014). The first technical study was presented to the government and donors in November 2012 (Hall 2012) and, based on comments, the project has now been upgraded from the 22 MWp originally envisaged to 33 MWp (MME 2014). Finance for the project to a total of EUR 63 million has been agreed by the EU, (EUR 25 million), the European Investment Bank (EIB) and the French Development Agency, Agence Français de Development (AFD) (EUR 38 million). The agreement between the EU, the Ministry of Economy and Finance and the Ministry of Mines and Energy was signed in April 2013 (MME 2014). The Ministry of Mines and Energy does not provide information on the ownership and power purchase agreement, but it is most likely that the plant will be owned and operated by the national utility, SONABEL.7

Furthermore, SONABEL has received finance amounting to EUR 4.5 million from AFD for the construction of two smaller demonstration plants. So far five potential sites have been selected: Ouga 2000 (600 kWp), Kaya (1200 kWp), Gaoua (500 kWc), Dédougou (500 kWp) and Diapaga (350 kWp), and the tender documents are currently being elaborated. The project, however, may be postponed or cancelled, as it is embedded in a larger agreement for the financing of a transmission line from Ouagadougou to Ouahigouya, which may be suspended due to SONABEL's financial situation (MME 2014).

Furthermore, SONABEL in September 2013 signed the terms and conditions for a PPA for a 20 MWp solar installation with the Canadian mining company, Windiga SA, and a contract proposal presented by the company is currently being evaluated (MME 2014). The project started with a feasibility study for a 20 MWp installation conducted under the company's social corporate responsibility (SCR) program in 2009 in cooperation with the Burkina government (Cheyney 2009).

While we have only included some African countries in this section, it should be mentioned that similar activities are unfolding in other African countries as well. For example, a 15 MWp PV project is planned in Mauritania (Olson 2012), the Ugandan government has signed an MoU to build a 500 MWp utility-scale solar power plant (Parnell 2013) and, according to IRENA (2012), Egypt is planning a 140 MWp CSP plant, and Tunisia is planning 40 solar power projects to be developed between 2010 and 2016. Finally, despite high uncertainty about its future, the Desertec project in north Africa aims to install 100 $GW_p$ of solar power (IRENA 2012).

6 The EU project that is now expected to be finalised in 2015 was, for example, first announced as being online in late 2013 (Hall 2012).

7 This assumption is in accordance with the project fact sheet presented on the WEB: http://www.ecowrex.org/project/champ-solaire-de-20-mw-ouagadougou

# 6 CONCLUSION

Many African countries are struggling to meet the rapid growth in power demand, increasing rural electrification and improving existing generation facilities and transmission infrastructure in order to provide a sufficient and reliable supply of electricity. The widespread privatisation of electricity systems has not led to the level of foreign investment expected, and there is currently an important investment backlog in the sector. Moreover, a significant funding gap in electricity infrastructure has been identified for the large electricity infrastructure investments that will be necessary in the years to come. In response to these structural challenges, utilities and governments have often resorted to short-term and expensive solutions allowing them to expand capacity rapidly, such as diesel barges and temporary diesel-fired generators.

Recently, however, solar power has increasingly come to be seen by many African governments and utilities as part of the solution to solving some of these power system challenges. This is due to the advantages of PV, such as faster installation times and greater opportunities to mobilise (green) financing, but most importantly to the rapid and substantial price reductions in PV modules (and CSP plants) during the past decade, particularly since 2008. As shown in the paper, the price of large-scale solar power has now reached a level where it is competitive with diesel-generated electricity. This cost reduction has encouraged a number of African countries to include large-scale, grid-connected solar power plants in their recent energy policies and development plans. But most importantly, the updated overview of recently planned and commissioned large-scale, grid-connected solar power projects in Africa documents the existence of the blossoming solar industry in the continent that has emerged in the past three to four years, with strong involvement from international investors and technology contractors. Finally, therefore, there seem to be good prospects for investments in large-scale grid-connected solar power plants in Africa.

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