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China in the African Solar Energy Sector: Kenya Case Study

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A 'China–Africa Toolkit' is being developed to serve African policymakers as an information database, a source of capacity building and a guide to policy formulation.

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ABSTRACT

Africa has immense energy challenges, characterised by low rates of access to electricity, and irregularities and a general shortage in electricity supply. Solar energy provides African governments with the opportunity to address these challenges. With an average quantity of 5–6 kilowatt-hours[1] of power from the sun falling on the earth per square metre per day, the continent has vast potential for producing energy from the sun. The moderate success that Kenya has achieved in its solar energy industry is commendable and provides a good platform for other countries aspiring to extend electrification to its population through solar energy. China's emerging capabilities in solar technology also offers the continent the opportunity to take decisive steps towards sustainable energy production. The proposed partnership between China's Tianpu Xianxing Enterprises and Kenya's Electrogen Technologies to build a solar panel factory in Kenya is a positive step towards addressing both the country's and the continent's energy challenges.

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INTRODUCTION

Access to reliable and affordable electricity is critical for poverty alleviation and the improvement of livelihoods the world over. However, a combination of factors, such as climate change, insufficient investments, slowness to adopt energy efficiency measures and renewable energy sources, and damage due to war and conflict, have contributed to very low rates of access to electricity, and to irregularities and shortages in electricity supply across many parts of sub-Saharan Africa (SSA). At present, only one in four inhabitants of this region is connected to the grid and as little as 10% of rural populations in SSA have access to grid electricity.[2]

The pattern of electricity deprivation is set to change, as 95% of the increase in population in the next 30 years is projected to occur in urban areas.[3] This trend will present considerable challenges to policymakers, especially in SSA. Consequently, in December 2005 African senior officials and policymakers met in Addis Ababa, Ethiopia to address the energy challenges facing them.[4] They recognised that only with greater access to modern energy could they achieve the poverty reduction goals of the United Nations (UN) Millennium Declaration.[5]

Solar energy provides African governments with the opportunity to address energy challenges without the need for expensive power generation projects, transmission and distribution networks. SSA has one of the highest levels of average annual solar radiation, with the continent receiving an estimated average quantity of 5–6 kilowatt-hours of power from the sun per square metre per day (kWh/m^2/day).[6]

However, unlike in other parts of the world, where the use of solar energy has gained impetus, few African countries have a coherent plan or strategy for tapping the sun's power. National governments do not have serious interest, except in places where rural electrification grids cannot reach. And, while grid-connected energy growth worldwide has outstripped off-grid photovoltaic (PV)[7] market growth, similar important and strategic niches for grid-connected PV panels in Africa have been ignored. Although PV solar home systems have been only fairly successful in markets such as Kenya, Morocco and Zimbabwe, among others, their promotion has been largely private sector-driven without any government support.[8] If on-grid PV makes sense in countries where there is excess power, then surely PV solar home systems make sense where grid power availability and fluctuations are a problem, e.g. in places like Nairobi, Kenya, as discussed below.

Although much of the potential impact of PV panels remains in small off-grid systems in SSA, there is considerable potential for use of PV panel in more highly structured off-grid systems such as irrigation pumping and cold storage. To tap this potential, a combination of both public and private sector involvement should be considered. Moreover, both provision of the necessary incentives and capacity building are necessary prerequisites to entice the private sector to invest in PV systems.

The aim of this study is to establish the potential in the China–Africa relationship to address chronic energy supply-side deficiencies in African economies. The paper focuses on solar energy in Kenya. The Kenyan market is important for three reasons. Firstly, it is the most dynamic and largest private sector-led PV panel market in Africa as measured in per capita solar home systems units in use. Secondly, the Kenyan market has now become a driver of East African regional PV solar home system sales.[9] Thirdly, the Kenyan market represents a promising policy and development model because of its private sector-led

development of clean energy technologies. It is therefore important to understand this market in order to evaluate the strengths and weaknesses of this market-based approach to environmentally sustainable development and for the provision of rural energy services in similar developing countries.

The paper is organised as follows: a brief overview of China's investment trends in SSA is followed by discussion of solar energy industry trends globally and then by an analysis of Kenya's solar energy industry in particular. The challenges of, demand for and supply of solar energy and the regulatory framework governing the industry in Kenya are highlighted. The paper proceeds to give a picture of Chinese involvement in this sector in Kenya and a view from local companies on Chinese involvement. Finally, it concludes by recommending a way forward for other developing countries in SSA.

CHINESE INVESTMENT TRENDS IN AFRICA

The expansion of China's foreign direct investment (FDI) outflows is largely influenced by its 'Going Global' strategy. This strategy signalled a foreign and economic policy shift driven by that country's need for raw materials to feed its rapidly developing economy, the need for new markets in exploiting its developing comparative advantages, and the need to expend its growing foreign reserves, among other motives.

According to the UN Conference on Trade and Development[10] and Alden,[11] China's FDI stock in Africa stood at $1.6 billion in 2005, and the country had 800 firms in 48 African countries. Besada, Wang and Whalley[12] also show that China's FDI flows in Africa reached $520 million in 2006. However, Chinese FDI in Africa is still negligible compared to that in other regions.

A large percentage of Chinese FDI stock in Africa is concentrated in mineral sectors such as oil and mining. More recently, however, there has been greater diversification of Chinese FDI flows in clothing and textiles, construction services, power plants, and telecommunications, among other sectors. Table 1 shows the sectoral distribution of Chinese FDI flows to Africa between 1979 and 2000.

Table 1: Sectoral distribution of Chinese FDI flows to Africa, 1979–2000

Sector/industry	Number of projects	Investment value ($ millions)
Agriculture	22	48
Resource extraction	44	188
Manufacturing	230	315
Machinery	20	16
Home appliances	36	25
Light industry	82	87
Textiles	58	102
Other manufacturing	34	86
Services	200	125
Others	3	5
Total	**499**	**681**

Source: UNCTAD, *op. cit.*

Table 2 below shows that Chinese FDI stock in 2005 was concentrated in Sudan, Algeria, Zambia, South Africa and Nigeria. Some of China's largest investment packages include the Sudanese oil industry ($3 billion) between 1996 and 1999, Angolan oil and infrastructure ($7–9 billion) between 2004 and 2006, Democratic Republic of Congo (DRC) mining and infrastructure ($9 billion) in 2008, and the Industrial and Commercial Bank of China purchase of 20% of Standard Bank ($5.6 billion) in 2007, among other investments.[13]

Table 2: China's FDI stock in selected African countries, 2005 ($ millions)

Country	FDI stock
Algeria	171.2
Botswana	18.1
DRC	25.1
Congo, Republic of	13.3
Côte d'Ivoire	29.1
Equatorial Guinea	16.6
Egypt	39.8
Ethiopia	29.8
Gabon	35.4
Guinea	44.2
Kenya	58.3
Liberia	15.9
Libya	33.1
Madagascar	49.9
Mali	13.3
Mauritius	26.8
Mozambique	14.7
Morocco	20.6
Niger	20.4
Nigeria	94.1
Sierra Leone	18.4
South Africa	112.3
Sudan	351.5
Tanzania	62.0
Zambia	160.3
Zimbabwe	41.6

Source: UNCTAD (United Nations Conference on Trade and Development), *World Investment Report 2006: FDI from Developing and Transition Economies: Implications for Development*. New York & Geneva: UNCTAD, 2006.

China's FDI on the continent is undertaken by either partially or wholly state-owned enterprises (SOEs). However, private businesses have featured prominently in recent

years. The form of entry is usually a formation of joint ventures with local companies and, to a lesser extent, mergers and acquisitions. Most Chinese SOEs negotiate for long-term supply agreements in exchange for infrastructure (financing, construction) investment in the domestic market. They are assisted in part by access to low-cost capital seemingly financed by low-interest foreign exchange loans drawn from China's foreign reserves. Some of the key drivers for the globalisation of Chinese firms include their desire to become global players, build global brands, access technology and distribution channels, secure resources, and broaden markets, among other motives. Furthermore, more-intensive competition and sluggish demand at home for certain products encourage Chinese firms to expand their markets abroad.

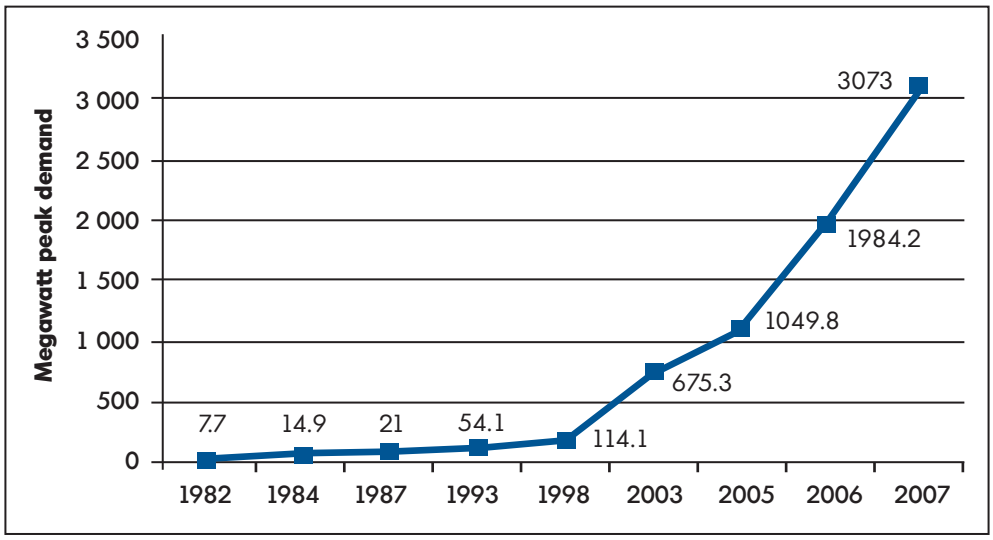
In spite of the current (2008/09) global financial crisis, it is unlikely that there will be a significant downturn in China's engagement with Africa in terms of trade, investment and aid in the short term. China's inelastic demand for natural resources, combined with a heavily infrastructure-focused domestic stimulus package, should maintain demand for key commodities such as oil, cotton and copper at a time of falling global demand and deteriorating trade conditions. In terms of investment, there is little reason to expect significant reductions in China's public and private investments in Africa, according to Chinese sources.[14] SOEs are taking advantage of opportunities created by the crisis to increase investments, especially in the energy sector. New deals are being made, and China is seeking investments in commodities that are important for its long-term food and energy security and growth. With regard to aid to the continent, China has reiterated commitments made at the Forum on China–Africa Co-operation. During his February 2009 visit to Africa, President Hu Jintao pledged increased economic aid, infrastructure investment and co-operation. China signed $90 million worth of loans and deals in Senegal, invested in infrastructure development in Mali and pledged $22 million in aid in Tanzania.[15] Elsewhere, it has been reported that China plans a 200% aid increase for 2009.[16]

GLOBAL TRENDS IN SOLAR ENERGY: AN OVERVIEW

As concerns around climate change continue to grow, the solar energy industry is attracting increasing interest as a reliable and cheap form of energy. While growing at a rapid pace, solar electric energy globally still only accounts for less than 1% of primary energy supplies.[17] However, this means that relatively small increases in market penetration by solar energy as costs decline can lead to very rapid growth rates in this industry.

Figure 1 shows industry demand/sales from 1982 through to 2007. Demand for solar grew by over 50% in 2007 and exponentially by 44% over the preceding five years from 2002 to 2007. According to Mints,[18] over 10.3 gigawatts (GW) of PV products have been installed globally since the 1970s, and half of this was installed between 2004–2007. Frost and Sullivan, a global growth consulting company, also attest that the global solar PV market earned revenues of $6.49 billion in 2005 and should reach more than $16 billion in 2012.[19] All this indicates the emancipation of the solar industry as a viable renewable energy alternative.

Figure 1: PV industry demand/sales, 1982–2007



Source: Mints P, *op. cit.*

Germany is the global leader in the PV industry. The country installed 1.1 GW of capacity in 2007, which is the equivalent of one large power station. Nearly 500 000 households are fitted with PV panels in Germany.[20] Suntech — a China-based company — is the world's biggest manufacturer of PV panels. Its 2008 production was panels capable of producing 540 megawatts (MW) and the company plans to double this to 1 GW in 2009.[21]

With regard to solar thermal,[22] there is currently 450 MW of installed capacity globally. However, this industry is experiencing a surge, with 100 MW of new capacity generated in 2007 globally, and this expected to reach a high of approximately 6 400 MW in 2012.[23] Research shows that global installed solar thermal capacity would exceed 200 000 MW in 2020 — equivalent to 135 coal-fired power plants — if the current annual growth rate is sustained.[24] According to Dorn, the United States (US) and Spain are the leading global players in solar thermal power development.[25] Dorn contends that both countries are expected to account for approximately 90% (i.e. 5 600 MW) of the projected new thermal power by 2012. The Solar Electricity Generating Station in California is the largest solar thermal power compound in the world. The compound produces approximately 350 MW, and has been powering approximately 100 000 local households for the past 10 years.[26] Other countries playing a significant role in solar thermal power development include China, France, Italy, Australia, Israel, Egypt, Morocco, South Africa and Mexico.

Scientists have further shown that solar thermal could be utilised to power electric vehicles, thus providing strategic environmental benefits by reducing carbon emissions and dependence on oil. According to Dorn,[27] Israel and Australia are already leading on this technology. Through solar thermal power, Project Better Place, a US company, is planning to build an electric transportation system (comprising 100 000 electric cars) in Israel — to be completed by 2010 — and a similar $667 million network project in Australia.[28] Other research by Ausra, a California solar energy-based company, shows that solar thermal power could reduce the dependence of the US on fossil fuel-generated electricity and oil usage for transportation by up to 90%.[29]

Against this positive development is a long-standing debate over the cost of solar energy in comparison with other sources. The principal disadvantage to solar energy has been its cost, especially the high price of polysilicon. The latter constitutes approximately 70% of the total cost of producing a solar panel. At the same time, Nanosolar — a solar panel-producing company — asserts that it could produce and sell solar panels for as little as 99c a watt (W), equivalent to the price of coal-generated electricity.[30]

SOLAR ENERGY IN KENYA

With an average of 5–6 kWh/m^2/day falling on the continent, Africa has vast potential for producing energy from the sun.[31] Yet Africa accounts for only a small percentage of global solar energy production. The continent, however, has a growing demand for and awareness of the potential benefits of solar power, especially as the conventional grid in many parts of the continent continues to be unreliable. Therefore, a substantial number of people have been looking for alternatives.

Beyond financial constraints, solar technologies suffer from an image problem in parts of Africa, because they usually operate on a small scale and in isolation. Some governments have initiated policies to promote the use of solar energy at village level. For example, Burkina Faso offers small micro loans with good repayment terms to rural households and Ghana is envisaging setting up a similar scheme.[32]

The continent is also making its first steps towards large-scale solar generators whereby some European and African countries have established a renewable energy network plan with the aim of transmitting power from the Sahara desert to Europe. The network aims to generate 100 GW of concentrated solar thermal power by 2050.[33]

The energy sector in Kenya is no different from other African countries. The sector is facing chronic challenges due to limited investments in power system upgrading. As a consequence, the economy has been experiencing high electrical power system losses estimated at 20% of net generation, extreme voltage fluctuations and intermittent power outages at a rate of 11 000 per month, which cause equipment and material damage, including losses in production. These power system weaknesses contribute to the high cost of doing business in Kenya. Other challenges include low per capita power consumption at 121 kWh and low countrywide electricity access at 15.3% of the total population, and 3.8% of the rural population.[34]

Furthermore, a study by the UN Economic Commission for Africa concludes that energy sector reforms in Kenya have led to significant increases in tariff levels, stagnation, and reductions in electricity supply levels.[35] The Kenyan drought has also strained the country's power supplies, forcing the government to resort to power rationing, which leaves many Kenyans without electricity for long stretches of each day.

Due to these challenges, a substantial number of institutions and people have turned toward alternative technologies in order to access electricity; solar energy constitutes one such alternative. Solar energy is the largest single energy commodity available in Kenya, has great potential and increasingly appears to be an attractive option, especially in remote and rural areas where the national electricity grid is not accessible.

There are three main types of solar modules used in Kenya, namely mono-crystalline, poly-crystalline, and amorphous silicon solar modules. The former two are characterised

by relatively high efficiencies and are available from a few watts to 100 W or more. Amorphous silicon solar modules (also known as a-Si modules) are generally only available in small sizes, with the most common used in Kenya being 14 W.[36] The systems typically consist of a 10–50 W peak PV module and a battery sometimes coupled to a charge controller, wiring, lights and small appliances (such as a radio, television or mobile phone charger).[37]

Other large-scale applications include water heating, crop drying, water pumping and cathodic protection for pipelines. For example, solar drying is widely used for coffee and other agricultural commodities. On-farm drying of mangos for sale is being done in several areas and has the potential to become a small-scale industry.

Kenyan demand for solar energy

There are an estimated 200 000–350 000 (representing approximately 10% of solar energy users) solar PV home systems currently in use in areas remote from the electricity grid.[38] These comprise an installed capacity of 4 MW and generate 9 gigawatt-hours (GWh) of electricity annually primarily for lighting and powering television sets. The rate of solar PV home systems adoption far outpaces the state's own efforts to electrify rural areas. For example, the 30-year-old government rural electrification programme has been responsible for a mere 70 000 connections since its inception.[39]

According to the Kenya Ministry of Energy, the demand for electricity generated from home-based PV systems is projected to reach 22 GWh annually in 2020, representing a growth rate of 20 000 solar home units annually.[40] The Ministry further estimates that with the projected growth in income-generating activities in rural areas such as tea and coffee growing and dairy farming, this number is likely to rise.

The number of solar water heating units currently in use in Kenya is estimated at over 140 000 units, translating to an estimated 19 000 tons of oil equivalent (TOE)[41] annually.[42] According to the Ministry of Energy, it is projected that the demand for solar water heating would grow to 400 000 units by 2020, equivalent to 150 000 TOE. This represents a growth rate of 10% per annum. The growth is expected to come from households, public institutions (e.g. hospitals and higher learning institutions) and commercial households such as hotels.

Supply of solar energy in Kenya

The estimated power from the sun that Kenya receives averages 300 million MW a day.[43] Ministry of Energy officials says if just 10% of this figure is converted to power on the national grid, the country would be oversupplied with electricity by over one fourth.[44] Furthermore, the amount of energy ranges from 700 kWh in mountainous regions to over 2 600 kWh in arid and semi-arid regions annually.

Given that there are at least four million households in rural Kenya alone, the potential for solar PV home systems is virtually untapped. This source of energy has not been fully utilised in Kenya due to a number of factors, including relative cost of systems and lack of standards, among other reasons. It is expected that with the diversification of the government's rural electrification programme, the number of installed solar PV home systems will grow substantially. Furthermore, it has been argued that with access to loans

and fee-for-service arrangements, it is estimated that the solar PV home system market could reach up to 50% or more of non-electrified rural homes.[45]

Kenyan domestic companies

There are over 40 leading, privately owned solar distributors and retailers in Kenya.[46] Initially, there were various small companies trying to tap into the solar market, but now bigger companies have taken over, resulting in fewer players in the industry. Among others players, Solarnet, BP Solar, Chloride Exide, Sollatek Electronics, Solagen and Electric Link are the major distributors in Kenya. The majority of the companies are located in Nairobi, with subsidiaries strategically located in arid and semi-arid areas to serve off-grid rural populations. Information on the production size and market share of the major distributors and retailers is non-existent.

Solar-powered borehole pumps, lighting kits, batteries, charge controllers and hot water systems are among many of the solar energy products distributed. With the exception of batteries, all the products are sourced from abroad, mainly from China, the United Kingdom and the US. The companies also tend to specialise more — either in exports to the regional market or consumer products to domestic industrial and residential clients.

Despite the global interest in solar power, Kenyan firms have seen profit decline due to the high cost of importing foreign products. 'This market is highly competitive. Changing fortunes have seen many firms shut down in the last few years', said Sailas Kitinya, sales representative of Kenital Solar Energy, a locally owned solar panel importer.[47]

Industry players say the introduction of the expanded government rural electrification programme is likely to threaten the livelihood and sustainability of smaller suppliers. For example, in 2007 the government spent Sh8 billion (approximately $124 million) on approximately 1 000 rural electrification projects countrywide, potentially displacing the solar accessories demand as consumers now have the option of accessing electricity by connecting to the grid.[48] However, one of the leading local solar distributors, Chloride Exide, is participating in this government electrification programme. The company has been awarded a contract to install solar electricity converters in secondary schools in selected areas in the country and has since installed converters in over 30 schools through the programme.[49]

For displaced smaller firms, solar water heating systems are an alternative. In this regard, the companies have seen increased sales of water heating implements to urban consumers, who enjoy savings of up to 60% on power bills. Diversification into this sub-market will potentially save these firms from perishing as a result of the threat posed by the government's expanded rural electrification programme.

Kenya's policy and regulatory framework

While the potential for solar energy to meet some of Kenya's most pressing development needs is evident, the existing legal and regulatory frameworks governing the energy sector are inadequate and there is no specific law to regulate the management of the renewable energy subsector.

However, to encourage wider adoption and use of renewable energy technologies and to enhance their role in the country's energy supply matrix, the government has designed

incentive packages to promote private sector investments in renewable energy and other off-grid generation. For example, value added tax on solar panels and accessories was removed in 2007.[50] These incentives are targeted at solar home systems consumers only and are not sufficiently attractive to induce the investment needed to ensure sustainable renewable energy generation and transmission. The phenomenal growth of the use of PV panels in Japan, Germany and elsewhere is almost entirely due to incentive support from governments. For example, the incentives in the US include a 30% federal investment tax credit for solar power systems.

In order to encourage private sector participation in harnessing solar energy, the Kenyan government has promised to do the following over the next five years:[51]

- formulate and enforce standards and codes of practice on renewable technologies in order to safeguard consumer interests;
- package and disseminate information on renewable energy systems to create investor and consumer awareness of the economic potential offered by alternative sources of energy;
- promote research and development, and the manufacture of cost-effective renewable energy products;
- promote the development and widespread utilisation of renewable energy technologies;
- allow the duty-free importation of renewable energy hardware to promote widespread usage;
- provide tax incentives to producers of renewable energy technologies and related accessories to promote their widespread use; and
- provide fiscal incentives to financial institutions to provide credit facilities for periods of seven years to consumers and entrepreneurs.

By 2024 the government envisages developing local manufacturing capability for advanced renewable energy technologies both for the domestic and export market and reviewing the fiscal regime for renewable energy technologies to promote their widespread utilisation.[52] With respect to the former, the proposed joint venture between China's Tianpu Xianxing Enterprises and Kenya's Electrogen Technologies (see *Chinese Involvement in Kenya's Solar Energy Subsector* on page 13) provides a good foundation for achieving this goal.

Future challenges

In Kenya currently the percentage of solar energy harnessed for commercial and domestic applications is insignificant relative to the available potential (i.e. an insolation[53] of 4–6 kWh/m^2/day). The constraints to accelerated market penetration include:

- the lack of a legal and regulatory framework and institutional support to promote widespread use and investment in solar energy. In this regard, the framework needs to include, among other objectives:

    - a vision for developing the power sector and increasing access to modern forms of energy for Kenyans; and

  - realistic, but ambitious targets to aim for in terms of percentage increases in sustainable energy generation in Kenya;

- the high initial capital costs of the systems relative to consumer incomes;
- the erosion of consumer confidence because of inappropriate system standards, faulty installations, the importation of substandard systems and poor after-sales service;
- the lack of awareness of the potential opportunities and economic benefits offered by solar technologies; and
- the lack of appropriate credit and financing mechanisms to facilitate the acquisition of solar technology by the rural population and urban poor. Electrification with solar PV panels brings certain quality of life improvements by providing lighting; power for TV, radio, and perhaps a mobile phone charger; and a limited range of income-generating opportunities. In the absence of credit or subsidies, however, PV systems are too costly to supply sufficient power for more energy-intensive income-generating applications such as shaft power or cold storage.

CHINESE INVOLVEMENT IN KENYA'S SOLAR ENERGY SUBSECTOR

Chinese companies

China's Tianpu Xianxing Enterprises and Kenya's Electrogen Technologies have entered into a Sh9 billion ($140 million) partnership to build a solar panel factory in Nairobi — considered to be the first in the Horn of Africa.[54] The move is expected to position solar power as a key source of energy in Kenya by making it more affordable to millions of consumers who do not have access to the national grid and also to those who depend on the unreliable national electricity grid for their energy needs.

Tianpu Xianxing Enterprises is a Chinese company specialising in research, development, design, manufacturing and marketing of solar energy products such as water heaters, semi-finished pipes, vacuum pipes, heat pipes and air heat pumps. The company is strong in technology and advanced in its manufacturing methods. Its products have been awarded the Certificate of Operating High Technology and ISO9001–2000 certification. The company's annual production capability, for example, equals 300 000 luxury solar energy water heaters; three million glass vacuum pipes, super-conducting heat pipes and double vacuum-glass super-conducting heat pipes; 100 000 m^2 super-absorbing platmodules; and 200 000 million vacuum pipes and super-conducting heat pipes modules. The company enjoys a good reputation in the manufacturing of solar energy swimming pool, solar energy light-heat, photo-electricity, air heat pump and ecological architecture products. Furthermore, it has been constantly improving its production technology and is researching new products. Its products have been sold to countries such as the US, Japan, Germany, Holland and South Africa.[55]

These attributes reflect China's growing investment and capabilities in solar power technologies. This is driven by China's legendary pollution — so much in evidence during the 2008 Beijing Olympics — and intense international pressure for China to take on major carbon emission reduction commitments as the world prepares for a

post-Kyoto Protocol world in 2012. *Business Week* notes that by 2010 China hopes to be generating and consuming about 300 MW of solar energy, roughly equivalent to what Japan, the world's second-largest consumer of solar energy, used in 2006.[56] This is part of a broader target to generate 10% of its total energy requirement from renewables by 2010.[57] Nevertheless, the industry still has a long way to go: while Chinese companies account for a third of the world's solar cell production, the industry is heavily reliant on overseas supplies of polycrystalline silicon, or polysilicon, a key material used in solar cell production, an industry dominated by seven companies that guard their technologies closely. Furthermore, up until 2006, Chinese solar cell makers exported 90% of their products to Germany, Japan, the US and other countries.

Yet as the *Financial Times* notes, just as the focal point of global TV and personal computer manufacturing has shifted to China, solar panel and cell production could be next.[58] There are large-scale Chinese plans to invest in the production of polysilicon, with their target being to produce 25 of world supplies by 2010.[59] However, domestic regulations in China currently are not favourable to inducing the large coal-based energy suppliers to invest in renewable technologies — a fact that the government is aware of and wishes to change. Consequently, most of the current and projected domestic demand comes from rural electrification projects — a fact of great relevance to this case study.

The project will be implemented through Pan African Technologies, a jointly owned company in which Tianpu Xianxing has a 70% interest, and will raise $100 million (Sh7 billion) from its internal resources. The company's local partner, Electrogen, is expected to take up the remaining fraction of the financing plan in cash and kind, including $40 million (Sh2.8 billion) in cash and three acres of land along Nairobi's Mombasa Road. The factory will source the materials required locally and reportedly create at least 200 jobs locally and see the inclusion of a number of Chinese technicians to assist in training of the locals. It is projected that a typical solar PV home system will retail for Sh5,000 ($77) rather than the current Sh20,000 ($310). In the longer run, the joint venture is eyeing East Africa as a key market and wants to interest the government in a partnership to provide solar panelling for its rural electrification programme.

Initially, the construction of the factory was supposed to have commenced in October 2007 and be completed in February 2008. However, following the outbreak of countrywide violence in 2007 over disputed presidential election results, the project has missed these deadlines. In this regard, the investors set a new completion date of December 2008. According to Michael Munyao, executive director of Electrogen Technologies, although the project was suspended, it is still on.[60]

Despite all the positives surrounding the envisaged solar panel factory, product quality will be an important concern among distributors and end users. A study conducted by Jacobson and Kammen showed that brands of a-Si module (i.e. eSolar and SunLink) imported from China performed well below their nameplate power ratings as compared to similar brands from countries in Europe.[61] This confirms the need for a vigilant quality monitoring institution once the factory is operational. The result will be a stronger solar market and a better-served public. The Kenya Bureau of Standards has initiated product testing for batteries as a first step in the right direction. Important next steps along these lines include establishing ongoing testing programmes for solar PV modules, as well as other products such as charge controllers and DC lamps.[62]

Local solar retailers and distributors concur that the proposed solar panel

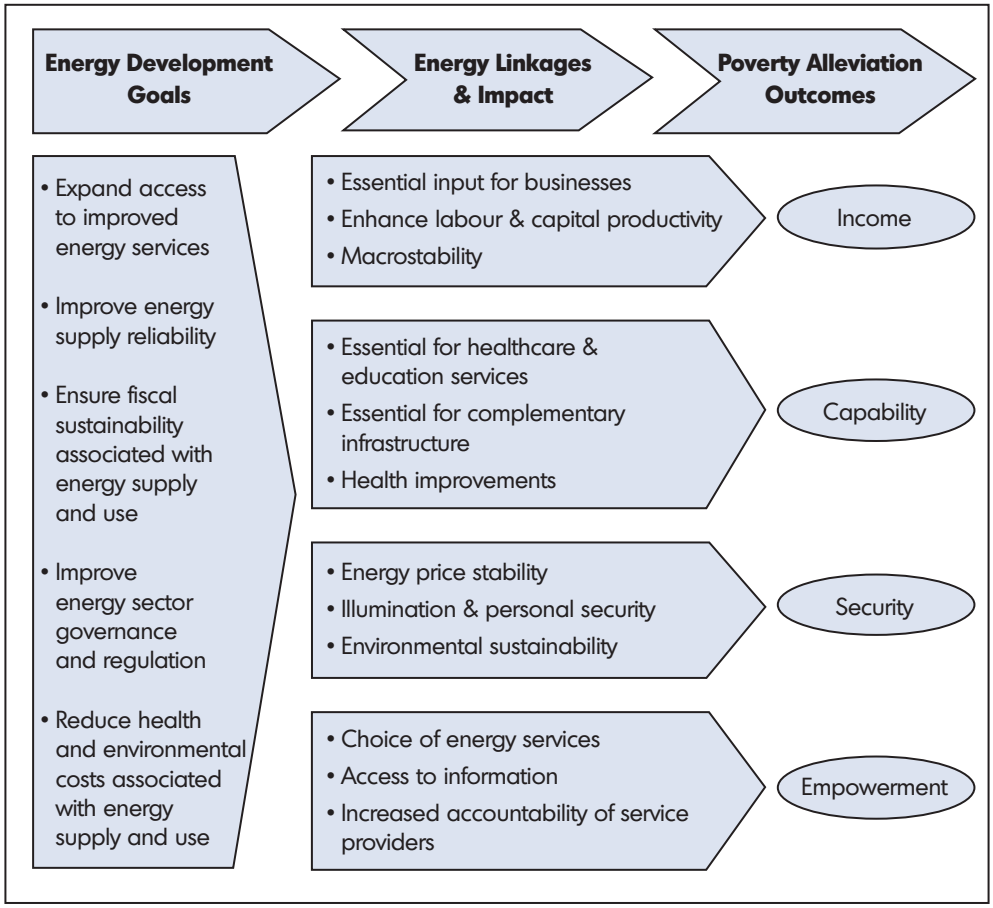
manufacturing factory could see the prices of solar panels drop by up to 70%, because currently domestic companies largely import their solar merchandise from abroad.[63] 'There is a huge market for solar panels in this market. Currently the near monopoly in the market means consumers pay more than they should. We see prices dropping to a third of what they are currently', said Michael Munyao of Electrogen Technologies.

Development impact

Although it has been the belief of SSA governments that increasing access to improved energy services through rural electrification causes poverty reduction on its own, this is only true to a certain extent. The impact of energy access on poverty outcomes such as health, education and income is visible when it provides opportunities (income and capabilities) and security to, and empowers the poor.

Improved energy services, when combined with other services such as transport, communications and water services, for example, lead to increased productivity; increased productivity leads to increased income; and increased income results in the ability to pay for increased energy services.[64] Figure 2 provides a graphical description of this theory.

Figure 2: The effect of energy access/use on poverty reduction



Source: World Bank, *op. cit.*

In the Kenyan context, the link between energy and poverty is not as clearly established as Figure 2 suggests. However, what is clear is that most poor people, irrespective of where they live, do not have access to modern energy services. Their primary source of energy is traditional biomass, namely firewood and charcoal, and this applies to both urban and rural populations.

It is anticipated that the proposed solar technology manufacturing plant would further stimulate the surge in the use of solar PV home systems, as it will become cheaper for end users to source the products. Coupled with government-sponsored PV electrification to public institutions, the social impact is evident. For example, with connection at schools, teachers will be able to mark papers and plan lessons in the evening using solar-powered lights. Moreover, more access to solar-generated electricity is likely to widen rural populations' scope of income-generating opportunities. For example, an egg business can use solar-powered lights in the chick brooding room to provide 24-hour lighting.

Furthermore, since solar power systems generate no air pollution during their operation, the primary environmental, health and safety issues involve how they are manufactured, installed and ultimately disposed of. Materials used in some solar systems can create health and safety hazards for workers and anyone else coming into contact with them. In particular, the manufacture of photovoltaic cells often requires hazardous materials such as arsenic and cadmium. This being the case, the Kenya Bureau of Standards would have to accelerate the establishment of testing programmes as soon as the solar technology manufacturing plant becomes operational.

CONCLUSION

It is common knowledge that a developing economy requires large quantities of affordable, good-quality energy to effect a prudent pace of transformation and economic development. Kenya is no exception. The minimal strides that Kenya has made toward sustainable energy provision for its population are commendable. However, the PV panel industry has not penetrated more than half of the potential market in Kenya. There is a need for additional investment in energy infrastructure, institutional capacity building, and research and development.

The proposed partnership between China's Tianpu Xianxing Enterprises and Kenya's Electrogen Technologies provides a good platform to build on the country's aspirations to extend electrification to its poor population through the use of solar energy. This relationship has potential spin-offs, not only for domestic suppliers and end users, but for the region as a whole and other countries aspiring to extend rural population electrification through the use of solar energy. Considering that there at least 80 million rural families off-grid in rural Africa,[65] this presents huge market opportunities for solar energy companies. However, Africa has immense developmental challenges in health, housing, education, water supplies and other basic human needs. This makes it difficult to prioritise solar energy development.

Research has shown that one way to help solar energy catch on is the provision of government subsidies.[66] Without the type of subsidy that has stirred PV and solar thermal industries in countries such as Japan, Germany, the US, Spain and elsewhere, it is impossible to expect rural African markets to start buying PV and solar thermal

equipment on even modest scales. Government rural electrification funds have not been made available for solar energy development and in some countries there are not even enough resources for grid electrification.

The importance of solar energy needs to be reflected in and be part of governments' rural electrification programmes (e.g. policy adjustment in order to provide incentives; procedures for connecting PV systems to the grid). A long-term vision is needed and targets must be set to promote the use of solar energy both off- and on-grid. Finally, investment by the private sector must be supported and encouraged and alternative financing mechanisms should be considered (e.g. carbon finance).

Governments in Africa should not delay the development of local manufacturing capacity for renewable energy technologies. The transition to sustainable energy is possible, and the sooner governments in Africa take the decisive steps, the better it will serve domestic needs. Kenya's experience with the PV industry demonstrates that it is possible to expand access to poor rural households through unsubsidised, market-based sales. While this occurs through sales of smaller systems, market-based solar electrification could also be utilised as a route for delivering energy for many of the key applications such as shaft power, irrigation pumping and cold storage that are so critical for rural income generation. China's emerging capabilities in solar technology offer the continent the opportunity to take these decisive steps towards producing sustainable energy.

ENDNOTES

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