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Renewable energy through the public sector in Africa: the potential for democratic electrification

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1. INTRODUCTION

Africa has one of the lowest rates of generation across all regions, and this, together with supply of electricity often being unreliable, means that access is very low (Kapika & Eberhard 2013). This is particularly the case in the rural areas across Africa where only 10% of rural dwellers have access. Approximately 41% of the population across Africa live in areas far from the electricity grid, making it difficult for them to connect into the electricity grid. And yet Africa is rich in renewable energy sources – such as solar, wind, and geothermal.

This paper takes as its starting point that electricity is best delivered through the public sector – as it represents the best possibility of democratic control, accountability and citizen involvement in questions of equitable access.

To date, the focus in Africa has tended to be on extending on-grid electricity access, a focus which accords with the dominance of national, centralised, and (largely) state-owned utilities in most countries across Africa. But renewable energy opens up possibilities for off-grid access and localised solutions. This could have major implications for rapidly escalating access.

What then, does this localised, more accessible access to renewable energy look like in terms of ownership and control? This is the questions that this paper focuses on as it begins to map out the different options that are being implemented in different parts of Africa.

Section two of the paper highlights the importance of renewable energy in current energy debates. Second three goes on to explore the possibilities of renewable energy as a viable energy source in the African context. Section four then focuses on the different ownership and control scenarios that exist in relation to the roll-out of renewable energy. Section five highlights some of the limitation with local level, small-scale mini-grids as the solution to Africa's energy crisis. Section six then goes on to outline some of the key issues that need to be taken into account in mapping the way forward.

2. WHY THE FOCUS ON RENEWABLE ENERGY?

With climate change having an increasing impact around the world, there has been an increasing emphasis on the need to shift to renewable energy. The major advantage of renewable energy is that it does not emit greenhouse gasses, and is thus a major factor in mitigation strategies.

But it also has other advantages. There are no costs of fossil fuels associated with electricity generation, which means that it is not subject to volatile prices. It increases a country's energy independence because it is no longer reliant on fossil fuels being imported. While in the past the cost of renewable energy technology was high, the price of the technology has dropped considerably over the last few years. Wind turbine prices, for instance, have dropped 30% in the last four years and the cost of installing PV solar power have fallen by 50% in the last five years (WEF 2014).

In addition, renewable energy plants can be assembled quickly and become operational much more rapidly than conventional fossil fuel plants. This allows for a much quicker response to energy needs in a country. Renewable energy plants can also be expanded or reduced in size fairly quickly and are thus much more adaptable to energy needs (WEF 2014)

All the reasons noted above are important motivations for shifting to renewable energy. But there is also another very important reason – with renewable energy it is possible to generate electricity at a small scale and a local level. This allows communities who live far from the national grid, or who are not connected to the grid, to access electricity off-grid.

3. RENEWABLE ENERGY IN AFRICA

3.1. Problems facing Africa in relation to electricity

Lack of access to electricity is the key energy related challenge facing sub-Sahara Africa. Electrification rates are among the lowest globally, with 35% of the people in the world who live without electricity, located in sub-Saharan Africa (Simelane & Abdel-Rahman 2012 pg 71). On average there is only 15% access in Tanzania and Mozambique, and in Mozambique the figure drops to 1.7% in the rural areas (WEF 2014).

Part of the reason for the low access is low levels of installed electricity- capacity. Installed capacity for sub-Sahara Africa is 77GW, and if South Africa is excluded, it is 33 GW – which is equivalent of Sweden's installed generation capacity (Kapika & Eberhard 2013 p 1). But not only does it have low generation capacity, much of this capacity is not available because of servicing and maintenance problems with the infrastructure. This results in access to electricity being unreliable and uneven, with some countries experiencing as much as 20% downtime per year as a result of power outages (Eberhard, A; Rosnes, O et al 2011 p 56). However, power outages are not only caused by insufficient generation capacity having been installed or breakdowns in ageing infrastructure which is inadequately maintained. Many countries that rely on hydropower have experienced power outages when drought hits the country. Tanzania and the Democratic Republic of Congo have both been affected by this.

3.2. Africa and renewable energy

Africa is rich in renewable energy sources. These include solar, wind, hydro, biomass and geothermal. The table below indicates the extent of renewable energy resources across Africa.

Table 1: Extent of renewable energy resources across Africa

Solar	5 – 6 kWh/m^2 (excellent in North Africa, Sahel, the Horn and Southern Africa)
Wind	3 – 5 m/s (more than 9 m/s in North, South, West and the Horn) 10 – 20 000 MW in North Africa
Biomass	Extensive
Geothermal	9 000 MW
Hydro (Large)	Massive, approximately 7% harnessed
Hydro (small)	Extensive

Table reproduced from Simelane, T and Abdel-Rahman, M (2012) Energy Transition in Africa

For all these sources of renewable energy, small-scale as well as large-scale, utility-sized applications are possible.

It is important to note that not all countries have the same potential from the same source of renewable energy. For instance, geothermal energy is mainly available in the Rift Valley in East Africa, while there are specific areas where the insolation rate is particularly high. In 23 countries there is extensive hydropower, and it is able to supply more than 50% of total power supply in the country (Simelane & Abdel-Rahman 2012 p11).

The table below illustrates the point that many countries across Africa already draw heavily on renewable energy, in the form of large hydropower plants, although many argue that large hydropower generation is not very sustainable.

Table 2: Breakdown of existing generation mix in Southern Africa

	Technology										
	Coal		**Hydro**		**Nuclear**		**CCGT (gas)**		**Distillate oil**		**Total**
Country (utility)	MW	%	MW	%	MW	%	MW	%	MW	%	MW
Angola (ENE)	492	32	833	55	-	-	190	13	-	-	1 515
Botswana (BPC)	282	64	-	-	-	-	-	-	160	36	442
DRC (SNEL)	-	-	2 442	100	-	-	-	-	-	-	2 442
Lesotho (LEC)	-	-	72	100	-	-	-	-	-	-	72
Malawi (Escom)	-	-	286	100	-	-	1	-	-	-	287
Mozambique (EDM & HCB)	-	-	2 573	97	--	-	-	-	51	3	2 624
Namibia (NamPower)	132	34	240	61	--	-	-	-	21	5	393
South Africa (ESKOM)	37 831	86	2 000	5	1930	4	-	-	2 409	5	44 170
Swaziland (SEC)	9	12	63	88	-	-	-	-	-	-	72
Tanzania (TANESCO)	-	-	561	50	-	-	485	43	78	7	1124
Zambia (ZESCO)	-	-	1802	99	-	-	-	-	10	1	1 812
Zimbabwe (ZESA)	1 295	63	750	37	-	-	-	-	-	-	2 045
MW	40 041		11 622		1 930		676		2 729		56 998
%	70		21		3		1		5		100

From: IRENA (2014) Analysis of infrastructure for Renewable Power in Southern Africa pg. 10

South Africa accounts for nearly four-fifths of installed and available generation capacity and an average of 85% of energy sent out and sold (IRENA 2014). So South Africa's renewable energy project is important – if there is a rapid shift to re – then overall shift to re in the region will be huge.

3.2.1. Hydropower

Africa sits on considerable amounts of potential hydropower – particularly in countries such as Democratic Republic of Congo, Ethiopia, Cameroon, Angola, Madagascar, Gabon, Mozambique, and Nigeria. Already many of these countries draw heavily on hydropower as the source of their electricity, with hydropower accounting for more than 50% of total power supply in 23 African countries. Despite this, it is estimated that only 5% of Africa's 1 750 TWh hydropotential power has been used.(Simelane , T & Abdel-Rahman, M 2012 pg 10).

At the same time, there are two problems with large hydropower projects.

Firstly, building large dams has a major impact on the surrounding farmlands and communities. It generally leads to the displacement of people, and communities, and can change the flow of the river, thereby having a ripple effect on communities further downstream. Even large run of the river projects can have these negative effects.

Secondly, the generation of electricity by hydropower is dependent on there being enough water in the dams and rivers. In times of drought and water scarcity, this can become a major problem. Many countries in both East and West Africa have been suffering severe electricity shortages because they rely on hydroelectric power but are suffering from drought. Therefore for many countries, the aim is to move away from dependence on hydropower. This, for instance, is the case in Kenya, which is aiming to increase geothermal and fossil power substantially.

However, many countries continue to explore the use of hydropower. Countries such as Botswana, Burkina Faso, Ethiopia, Gabon, Ghana, Senegal, Democratic Republic of Congo, Rwanda, Sudan, Uganda and Zambia, are planning to harness the hydropower they have access to by building large dams.

Hydropower plants can range in size from large (generating more than 500 MW), to medium sized to small (below 10MW). Small hydropower plants can be further subdivided into mini, micro and pico plants. These small hydropower projects are generally much more sustainable environmentally, with much less of an impact on the surrounding environment and communities than large projects. For this reason, they are often regarded as far more acceptable as an alternative source of energy than the large hydropower plants.

There are many stand-alone small and micro hydropower projects in many countries of Africa, particularly Kenya, Mozambique, Rwanda and Zimbabwe (Simelane, T & Abdel-Rahman, M 2012 pg 12). For instance, the Tungu-kabri mico-hydropower project in Kenya was organised by Practical Action East Africa and the Kenyan Ministry of Energy. It started in 1998, and has involved about 200 households forming a commercial enterprise to own and operate a micro hydropower plant. Each householder bought a share in the company and also contributed labour at least once a week for more than a year. The day-to-day operations are managed by a 10-person committee. The committee also consults with the broader community about how the power should be used. The project started generating electricity in June

2001 and currently generates approximately 18 kW of electrical energy, much of it used for micro-enterprises. (Microhydropower n.d.)

3.2.2. Solar power

Africa is particularly rich in solar energy potential, with a daily radiation lelve of 5 – 6 kWh/m2 in many areas. (Simelane , T & Abdel-Rahman, M 2012 pg 16)

There are two types of technology which can be used to harness the sun's energy. These are concentrating solar power (CSP), and photovoltaic solar power (PV).

CSP technology uses the heat of the sun, concentrated by huge mirror-like structures into a receiver, which uses the energy to run a generator which produces electricity. Until recently CSP technology has been expensive, although there have been CSP plants for many years in Spain and the USA. In Africa, most CSP plants are in North Africa, or in South Africa. A number of these countries brought on line CSP plants in 2011- including Egypt (20MW), Morocco (20MW), and Algeria (25 MW).

PV generates electricity directly from solar power through semiconductors in solar panels. Over the last few years there has been an increasing trend towards large utility-scale PV plants. Egypt is one such country with a utility-size PV plant. The Solar PV sector has been growing rapidly, and the price has, at the same time, been falling, making it a strong contender against CSP for utility size solar energy plants.

Currently the largest solar PV system in sub-Sahara Africa is in Kenya. It has capacity for 0.5MW (Ren21 2012 p49). However, as noted elsewhere in this paper, a 8.5 MW solar PV plant is being planned in Rwanda.

While PV has the advantage of being cheaper, CSP has the ability to be stored and is better able to hybridise with other energy sources. For instance, in North Africa, all the CSP plants are integrated solar combined cycle (ICSS) plants.

PV solar power is used for small-scale solar energy at household and business level. South Africa, with 11 000 kWp of installed capacity, and Kenya, with 3 600 kWp of installed capacity, are the two largest users of small-scale solar PV on the continent. (Simelane , T & Abdel-Rahman, M 2012 pg 17)

3.2.3. Geothermal

Geothermal power relies on natural heat, generated by the earth's core, which is trapped under the earth's surface in rocks and water. The East African Rift Valley, which spans 11 African countries, has great geothermal potential, but presently only a fraction of it is being tapped. It is estimated that if the geothermal energy in the Rift Valley could be more comprehensively tapped, it could provide 10 – 25% of East Africa's energy (The Economist 2008).

In Kenya there is a proven potential of 7 000 MW, but there is only installed capacity of 198MW. Kenya aims to meet 50% of its electricity needs with geothermal by 2018 (Ren21 2012). Ethiopia has a pilot geothermal plant at Aluto Langano, which was established in 1998, but which only started producing electricity in 2007. The Japanese government undertook an investigation of the plant, and estimated that the plant could produce an additional 35 – 70MW electricity. Rwanda is also exploring geothermal energy. Geologists have predicted that there is about 740MW geothermal energy potential in the Karisimbi area alone.

3.2.4. Wind power

Worldwide, wind power had the most capacity put into operation in 2011 (Ren21 2012). However, so far relatively few wind power plants have been built in Africa, although there were at least 11 countries with commercial wind installations by the end of 2010. At the beginning of 2008 there was approximately 476 MW of installed wind-energy generation capacity in Africa compared to a global figure of 93 900 MW of installed wind power. (Simelane , T & Abdel-Rahman, M 2012 pg 15) These figures refer to large-scale wind energy.

There is, however, also use of small-scale wind energy in many countries. These small scale installations are mainly used for water pumping, and some mini-grid electricity generation.

3.2.5. Biomass

Both traditional and modern technology biomass are important sources of energy in Africa. Traditional biomass, such as charcoal, firewood and dung, is used extensively as an energy source for cooking and heating in rural areas. Often the biomass is burned in inefficient devices, and apart from being a waste of energy, can also affect people's health and safety.

Cogeneration is used in agro-based industries, such as paper and pulp, sugar, wood and rice, to meet their own energy needs, and at times they are able to feed the excess electricity generated into the national grid. Cogeneration happens frequently in the sugar industry, where bagasse, which is produced as part of the processing in sugar mills, is used to generate electricity. Grid-connected bagasse plants can be found in Kenya, Mauritius, Tanzania, Uganda, and Zimbabwe. In addition, Cameroon, Cote d'Ivoire, Ghana, Liberia, Nigeria, Rwanda, Senegal, Sierra Leone and Sudan are planning such plants or are in the process of constructing them.

3.3. The solution?

It can be strongly argued that a rapid transition to large and small-scale renewable energy electricity generation could go a long way to solving Africa's energy problems. Not only does Africa, as shown above, have abundant sources of renewable energy, but all these sources can also be used to generate on-grid electricity, as well as provide off-grid, small scale solutions to energy access. This could be a major contributor to increasing electricity access in rural areas. Geothermal generation is perhaps the only exception to this – it cannot be done on a small scale.

Already the development of renewable energy electricity projects is moving rapidly across Africa – driven by increasing oil prices, low generation capacity, and increasing demand (Karekezi, S 2002). Renewable energy has to be the energy source of the future. The key question then becomes who has, and who should have, ownership and control over its generation, transmission and distribution.

The next section of the paper begins to map out the answer to this question.

4. OWNERSHIP AND CONTROL OF RENEWABLE ENERGY: THE CURRENT SITUATION

4.1. Centralised state utilities

The generation, transmission and distribution of electricity in Africa still rests largely in government hands, despite heavy promotion of privatisation by institutions and bodies such as the World Bank since the 1990s. The state also remains the main investor in the electricity sector, with nearly 90% of investments being carried out by the state.

77.7% of countries in Africa have retained the transmission and distribution of electricity in public hands, largely in the form of public utilities (van Niekerk & Hall 2013). At the same time, however, while the number of countries that have privatised their electricity utility is small, many have gone through processes of unbundling, decentralizing, corporatizing and commercializing their utilities.

Most of the generation that happens through state utilities uses conventional fossil fuels, or large scale hydropower.

4.2. **Private sector involvement**

The private sector has got involved in transmission and distribution to some extent – largely through concessions (for instance distribution in Cote d'Ivoire, Gabon, Morocco and Uganda) and management contracts (for instance distribution in Gambia) (van Niekerk & Hall, 2012).

With regards to the generation of electricity, there are increasing numbers of Independent Power Producers across the continent. Until a few years ago, IPPs were all fossil-fuel based, using either diesel, gas, heavy fuel oil or natural gas (Eberhard & Gratwick 2010).

Numerous problems have been experienced with IPPs. They are susceptible to corruption, for example in Kenya, Westmont Power was accused of paying bribes in 2003, and the contract was not renewed at the end of the 7-year contract period. They are generally very expensive for the country. Tanzania is an example of this, where Tanesco is spending about 90% of its revenue on IPPs. IPPs are also frequently not able to meet their contractual obligations consistently. This was found to be the case with IPPs in Senegal, Code d'Ivoire, Tanzania and Equatorial Guinea.

Today, most of the renewable energy generating plants are being developed as IPPs. For example, in Uganda, the Bujagali Hydropower plant, which has a capacity of 250 MW, is owned by Bujagali Energy Limited, with Sithe Global and IPS/Aga

Khan as the main shareholders. It officially started commercial operation in August 2012 (Kasita 2012).

Development of the Lake Turkana Wind Project in Kenya is meant to start in 2014, and once fully commissioned, it will be the largest wind project in Africa (at 300 MW). Companies involved in the consortium to develop the project include KP&P BV Africa, a Dutch-registered company, and Aldwych International Limited. Part of the delay in starting this project has been difficulty in finding sufficient funding. (Lough, R 2013)

Rwanda has recently announced that a utility-scale solar photovoltaic plant (8.5MW) will be build outside Kigali by Gigawatt Global, a Dutch company. Gigawatt will have a 25-year power purchase agreement with REWSA (Rwanda Energy, Water and Sanitation Authority) (Clark 2014). This will be the second solar plant feeding into the grid but by far the largest. The first is Kigali Solar Project owned by Stardwerke Mainz AG.

4.3. Local level generation and distribution of renewable energy

The development of off-grid mini-grids based on renewable energy generation has generally been happening on an uncoordinated basis by donor organisations and private companies (RECP 2013). Some countries, such as Kenya, emphasise grid extensions as the way to increase access in rural areas, and a relatively small part of the government's rural electrification plan is focused on off-grid mini-grid systems. In contrast the many mini-hydro and solar PV systems have been established by the private sector, NGOs, communities or donor bodies. In other countries, such as Ghana, the government has actively encouraged other bodies to install wind, solar or micro-hydro renewable energy projects in rural areas. In many of these projects, the community is encouraged to take on responsibility for contributing financially to the installation, and for taking control of operations once the system is established. In some instances, communities have initiated projects themselves.

The table below illustrates a range of different ownership options that are in operation in mini-hydro projects in Zimbabwe, Mozambique and Malawi.

Table three: Different ownership options for mini-hydro projects in Zimbabwe, Mozambique and Malawi

Scheme name	Country	Owner	Generation (kW)
Bondo	Malawi	Community cooperative	88
Nyafaru	Zimbabwe	School Development Committee	20
Chipendeke	Zimbabwe	Community Cooperative	25
Dazi	Zimbabwe	Community Trust Fund	20
Ndiriri	Mozambique	Private	27
Nyamwanga	Zimbabwe	Community Cooperative	30
Nerufundo	Mozambique	Private	24
Chitunga	Mozambique	Private	33
Hlabiso	Zimbabwe	Community Cooperative	30
Ngarura	Zimbabwe	Community Cooperative	25

RECP 2013 p 57

For all these schemes the investment costs included grant financing, community own contribution and local material. Individuals within the community were involved in the technical operation of the plant and the maintenance.

Although at times the lines between a privately run, for-profit mini-grid, and a non-profit, non-commercial mini-grid is blurred (when, for instance, the mini-grid project is run along commercial lines, but is not for profit), the different projects have been classified below into those run by the private sector, those initiated and run by communities, and those under the control of local government.

4.3.1. Private sector involvement at the local level

Organisations like the EU Energy Initiative, encourage private sector partnership in the establishment of mini-grids on the basis that it will unlock financial resources, and allow for effective technology transfer. (RECP 2013 pviii)

Gambia is an example of a country where electricity is supplied by a state utility, but the private sector is encouraged to get involved in renewable energy projects – particularly in the rural areas. The state owned utility, NAWEC, is the sole distributor of electricity and the single buyer. Presently there is only one Independent Power Producer (IPP), which uses conventional fuel. NAWEC is the only provider of on-grid electricity in rural areas. However the Department of State for Petroleum, Energy and Mineral Resources encourages the use of renewable energy in rural areas through private sector participation. A number of private bodies have installed stand-alone PV systems, solar water pumping systems, and wind turbines in various villages.

The United National Industrial Development Organization, UNIDO, not only actively encourages an approach which aims to achieve rural electrification targets by developing isolated mini-grids in rural areas, but is encouraging that these be done through the mechanisms of a market (Republic of the Gambia).

Tanzania has a regulatory framework in place for small power projects, which can be both on-grid and off-grid mini-grids. These small power projects have a standardised tariff methodology applied to them, as well as a standard power purchase agreement with TANESCO, the national energy utility. (RECP 2013) In effect, they are mini IPPs.

Mali has about 150 mini-grids in operation, 60 of them operated by the private sector. Most of these privately run mini-grids are diesel-based. Most of the private providers have received subsidies for their setting-up capital costs from the rural energy agency, a state body, but they receive no subsidies for ongoing operating costs. The result of this is that tariffs for electricity users are high in order to make the mini-grid commercially viable. But these tariffs are much higher than tariffs charged to those on the national grid. This has, not unexpectedly, led to tensions between different communities who might be near each other, but pay different tariffs depending on whether they receive electricity from the national grid, or from the mini-grid. (Tenenbaum et al 2014 p. 37)

4.3.2. Community-owned initiatives

Not all local projects are commercially based. There are a range of different non-commercial initiatives as well which are community based and owned. For example, with the chances of being connected to the national grid remote, the community at Thiba in Kenya established their own mini-hydro plant. They drew on the technical expertise of an NGO, GPower, and the system was commissioned in 2005. The system is owned by the community and operates as a cooperative. It has a capacity of 135kW, which is enough to power 180 households. In setting up the mini-hydro plant, the 180 community members of the project contributed USD 150, labour (volunteering every Tuesday for a year), and two poles each. The tariff, a flat rate, is set at a level to cover the full operating costs. Ten community members have been trained to operate and maintain the system.

There are limitations to the electricity supplied. The system does not provide electricity all the time, but operates for 14 hours of the day (6am – 8pm). Since no step-up or step-down transformers were installed in the distribution system most households experience voltage drops. This damages appliances. No electricity from the system is supplied to the schools and health centres.

Each community member who has made the requisite contributions gets shares in the project, with the idea that once the system starts making a profit, they will earn dividends. The problem is that the system has so far not shown a profit. From the start a great deal of money has been consumed in doing repairs. However there is not enough money to do the rigorous repairs required or to upgrade the system. As Yadoo has argued, “this self-reinforcing relationship between the lack of funds and ongoing technical problems is a major hindrance to the project’s sustainability.” (Yadoo 2012 p. 22)

Similar types of community initiatives, often set up with the assistance of NGOs, exist in a number of other countries. For instance, in Cameroon, where no government policy exists for small renewable projects, an NGO called ADEID helped a number of communities set up village electricity systems using microhydro power. In The Gambia, a wind project initiated by a German NGO, German Association for Rural Electrification, is now in community hands, and is overseen by an elected committee. At times the Batokunku Wind Power Project generates enough electricity to feed back into the national grid, made possible by an agreement signed between the project and the National Water and Electricity Company (NAWEC). (Hathaway 2012 p367). In more recent times, there have been complaints from villages that not all villages have benefitted from the project. (allAfrica 2013)

4.3.3. Role of local government and rural electrification agencies/boards

South Africa is probably the only country in Africa where local government is actively involved in electricity – mainly in the distribution of electricity, but with some municipalities also involved in generation. In many other countries, rural electrification agencies or boards have been established to focus on the extension of electricity to rural areas, while the national utilities remain responsible for electricity provision in the urban areas.

Fifteen countries in sub-Sahara Africa have Rural Electricity Agencies (Tenenbaum et al p3). In some countries rural energy programmes have been established as a department within the utility, as is the case in Ghana. In some cases, the agency focuses on connecting rural communities to the national grid, while in other cases they focus on establishing mini-grids for rural communities, or individual household systems (Hathaway 2012 pg 363). In many cases, the intention is for these off-grid mini-grids to eventually become connected to the national grid and taken over by the national utility.

Particularly where the focus is on local solutions, rather than connecting to the national grid, there is an obvious interconnection between the rural electrification programme of the country and the Renewable Energy plan. The potential for these mini-grids to use renewable energy such as solar, wind, micro-hydro and biomass as their energy source is huge. Despite what would seem to be an obvious overlap between a countries rural electrification programme and its renewable energy programme, most sub-Saharan African countries run them as two separate programme. (Tenenbaum et al 2014 p. 361) In addition, many countries across the continent use diesel fuel for off-grid mini-grids – and have done so extensively in the past. In the 1970s a rural electrification programme was initiated in Ghana which relied on the installation of diesel generating plants, benefitting about 70 communities. Today, a comprehensive National Electrification Scheme (NES), which falls under the Department of Energy, and is highly centralised, is in place. It focuses both on on-grid connections but also on off-grid renewable energy-based solutions including biomass, solar, wind and small hydro. The NES aims to bring electricity services to every community of 500 or more people by 2020.

The slow and uneven shift to mini-grids powered by renewable energy rather than by diesel, has been propelled by the increase in the price of diesel, the development of renewable energy technology and the increasing focus on the importance of its use as a sustainable energy source. Of 48 examples of community energy systems identified by Hathaway, 17 used microhydro, 6 used solar and another 6 used wind, and 5 used diesel (Hathaway 2012 pg 366).

In Kenya, a Rural Electrification Programme was established in 1973 to increase access in rural areas. It invested in 13 off-grid diesel-powered power stations. Ownership of these passed to the Rural Electrification Authority which was established in 2007 to speed up the rural electrification programme. The current Rural Electrification Master Plans calls for renewable energy and hybrid off-grid systems to be established to electrify 330 public facilities and 66 000 connections in 200 areas. In addition, the Renewable Electrification Authority will run pilot demonstration projects on using biogas for cooking and electricity generation in school, biomass gasification for off-grid electrification of communities as well as community micro-hydro plants. (Yadoo 2012 p.14)

Even where local government is not involved in the generation or distribution of electricity, many local government structures have taken steps to promote renewable energy and improvements in energy efficiency in a number of ways. For instance, they set targets to run municipal operations from renewable energy, establish building codes and standards that will reduce energy-use considerably, and implementing solar water heating projects. (REN21 2013 p75)

Local government in South Africa is directly involved in the energy sector as it is responsible for electricity distribution.

Eskom, as the state utility in South Africa responsible for electricity, generates about 95% of the electricity used in the country. Most of this energy is generated from coal, but small amounts are also generated from gas, hydro and nuclear. It also has a wind farm that has a generating capacity of 3MW of electricity. Eskom transmits electricity to the municipalities for distribution and also does some direct distribution, both in cities (on a very small scale) and in rural areas. The Department of Energy has a rural electrification programme as part of the plan to ensure access to electricity for all.

The bulk of the renewable energy generation (any renewable energy plant which generates more than 5MW of energy) in the country has been handed over to the private sector for development through a competitive bidding process known as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Eskom is the sole buyer of electricity generated through the Renewable Energy Independent Power Producers (IPPs). So far three windows have been opened for private sector bids to generate electricity using wind, biomass, small hydro and solar power. Agreements reached under the first two windows will result in 47 projects contributing approximately 2 400 MW of power. Effectively, Eskom and municipalities have been shut out of the Renewable Energy programme for plants larger than 5 MW by the government's insistence that Renewable Energy must be done through market mechanisms.

Municipalities, which cover the country wall-to-wall, play a key role in distributing electricity. They buy electricity from Eskom, and then sell it on to residents, industry, and business. For many municipalities, the income generated from the sale of electricity is a vital source of funding for cross-subsiding other municipal services.

Ironically then, municipalities across the country have taken seriously the call to be more energy efficient, and have implemented a range of measures designed to increase energy efficiency. Ironically, because the more energy efficient individual households and communities are, the less revenue local government can earn from electricity sales and the less cross-subsidisation that is possible.

Some of these energy efficient initiatives include the Solar Water Heater (SWH) Programme which involves the roll-out of SWHs to low-income areas, using a rebate provided by Eskom. Many municipalities have also implemented solar lighting for informal settlements. In addition, many businesses and residents have installed PV solar panels that reduce the amount of electricity they draw from the grid.

Apart from implementing and promoting energy efficient measures, there are other ways that municipalities could get involved in renewable energy. For instance, municipalities could also establish their own generating plants based on renewable energy technology. These could be small scale projects, effectively mini-grids which are either off-grid or connected to the national grid. Ekurhuleni, a metropolitan municipality in Gauteng, has shown that this is possible by building a solar power plant, the Leeupan solar photo voltaic project in the O R Tambo Centre, in Benoni –

a precinct which showcases energy friendly and energy sustainable facilities and functions. The plant was commissioned in October 2012, and produces 200 kW of electricity through 860 PV (photovoltaic) solar panels. It generates enough energy to power about 133 low cost houses, as well as nearby structures such as the OR Tambo Narrative Centre and the Environmental Education Centre. There are plans to expand the capacity of the plant to about 600 kW. Energy generated from the plant is fed into the municipal distribution network, which means that no batteries for storage are needed. The project was funded internally from the Energy Department budget and is owned by the municipality, but the city has an operations and maintenance contract with a private entity to actually run the plant. The funding for the contract will come from energy and capacity charges for electricity production, which will be transferred to a specially established Energy Vote number. (SA Cities Network (2012); City Energy (n.d.) This is effectively a mini-grid connected to the national grid.

There are other municipalities that are exploring the possibilities of waste to energy generating plants as well as small hydropower plants. Many of these plants are intended to provide electricity for powering municipal functions, such as water pumpls. In general, establishing their own renewable energy plants in order to provide electricity to communities has not been a major option pursued by municipalities.

Municipalities could also buy in surplus power generated by either large scale renewable generation companies or small energy generators. Such an agreement with a large scale renewable generator would effectively be a power purchase agreement with an Independent Power Producer (IPP). While there is nothing technically precluding this, but it would not be a simple option. In terms of the Municipal Financial Management Act, the municipality could not buy power at a higher rather than it pays for Eskom power. There would also have to be integration with the national grid because any large-scale generator brought onto the grid would have an impact on the grid. (City Energy Support Unit 2011 p.4).

Buying in power from small energy generators, such as household or business solar PV panels, has been a grey area for municipalities. Until recently, it was not clear if national policy or legislation allowed for this to happen, with the result that municipalities across the country adopted different approaches. Some clarity was given by Nersa in 2013, indicating that small generators (less than 100kW) only needed to be registered by the municipalities and did not need licences. Generation in these cases had to be for ‘own use. (Payne, T 2013b) However, in terms of the Municipal Financial Management Act, municipalities may not pay more for the electricity they buy in than they would pay to Eskom. The area of slightly bigger renewable energy generation plants (between 100kW and 1MW) is still a grey area.

The eThekwini municipality was the first municipality to go ahead with a process of inviting microgenerators to apply to supply the municipality with any surplus power generated. Already it is receiving power from six microgenerators and is opening up the process to other potential suppliers. The current six private generators include a Tongaat-Hewlett sugar mill, and a municipal waste dump project which produces methane. (Payne, T 2013a)

There are advantages to municipalities establishing their own renewable energy plants in that they would have access to their own, locally-produced, sustainable energy.

But there are also obstacles which make it difficult, if not impossible in the current legal, policy and financial context. In the current context, to establish a large renewable energy plant (more than 1 MW), means becoming part of the REIPPP process and it is not clear if municipalities can put in bids. The costs for municipalities would also be very large – the municipality would bear all the costs of setting up the plants, whereas if it is done at part of the national programme the costs are spread nationally across all electricity users.

By going ahead with a renewable energy strategy which is based on market provision, rather than state provision, the government has in effect severely limited the central role that municipalities in South Africa could be playing in the shift to a renewable energy future.

5. LIMITATIONS IN THE ROLL OUT OF RENEWABLE ENERGY AT LOCAL LEVEL

As outlined in the previous section, there are a range of possible ownership and control options for renewable energy, both at a national level, and at a local level.
Decentralised, largely off-grid renewable energy projects seem like an attractive route to follow in order to solve Africa's energy problems. Local, community-driven and owned projects are seen as holding out the possibility for community empowerment and local democracy as well as increasing access. However, there are limitations to this route.

These limitations include the following.

5.1. Cost of establishing mini-grids

The capital costs of establishing a local off-grid mini-grid based on renewable energy technology costs less, in many cases, than extending the grid to cover all rural areas or using an expensive diesel based system. However, despite the decreasing costs of renewable energy technology, it is still expensive to set up a generating plant and mini-grid. No community could completely cover the costs of doing this, and would require a subsidy of some kind. Thus without support from governments and/or donor bodies, small, local-level mini-grids are not viable.

5.2. Tariff charged

Mini-grid are meant to be stand-alone systems with the operating and maintenance costs financially self-sustaining. This means that the focus of the tariff has to be on cost-recovery. In order to achieve this, the tariff charged for the electricity generated by a mini-grid is going to be more expensive than the tariff charged for electricity supplied on-grid in urban areas.

This is for two reasons. Firstly, the costs of mini-grids per kWh are higher than grid costs. At a national level, the costs are averaged out, whereas for mini-grids all costs must be borne locally. In addition, many of the costs carried on the national grid by the government or national utility such as the cost of transmission have to be built into the tariff charged for an off-grid system. Secondly, with mini-grids the possibilities for cross-subsidisation that exist for grid connected users does not exist. (RECP 2013)

Communities can set the tariffs much lower, at a rate that is affordable for them, but this could have consequences such as undermining the long-term sustainability of the project. As the Thiba mini-hydro example in Kenya shows, the tariff, affordable to the community, was just enough to cover the costs of ongoing repairs to keep the system going, but not enough to do the rigorous repairs required. The result was that the system just manages to keep limping along, with frequent outages and limited availability of electricity.

In addition, PV panels need to be replaced after about 30 years, and batteries, DC lamps and regulators after about 5 years. The cost of replacing these parts is generally not built into the tariff and so a system that seems to be working well and viably can run into big problems a few years down the line.

5.3. Amount of electricity generated

Another set of problems relate to the amount of electricity generated by small off-grid projects and what that electricity is able to power. A system that generates just under 100 kW (97kW at peak) delivers 125 watts. There is a limit to what can be run off this power – a kettle uses 1800 watts to boil, a fridge uses about 100 watts on a continuous basis, and a cellphone chargers use between 1 – 4 watts to charge.

The result of this is that for many communities, off-grid renewable energy systems are second-best, and regarded as a transition stage until they can be connected to the grid. (Ahiataku-Togobo n.d.)

6. MOVING TOWARDS SOME CONCLUSIONS

The potential for countries across Africa to move to renewable energy as a key source of energy is huge, but completely underutilised. On-grid renewable energy plants are slowly starting to come on-line in many countries. And there are a large number of mini-grids across the continent that use renewable energy. But again, there is vastly less renewable energy being used for mini-grids than is available.

In extending the use of renewable energy in local solutions to the energy crisis facing Africa, there are a number of key points that can be made about a possible way forward.

6.1. National public sector on-grid provision is still important

As outlined above, local off-grid provision has its limitations and on-grid provision will need to continue to play an important role. However, unlike with conventional fossil-fuel generation, on-grid provision does not have to be centralised, but can consist of a number of decentralised renewable energy generating plants, of varying sizes, ranging from utility-sized plants to small scale projects.

It needs to be in public hands so that it can be properly co-ordinated and the need for equitable access can be addressed. Retaining it in public hands also allows greater possibility for the system as a whole to be developed in an accountable and transparent way, with democratic oversight.

6.2. Public Finance is necessary

As pointed out above, mini-grid systems generally require start-up capital costs to be subsidised, either by government or donor agencies. The private sector is not going to cover these costs. In evaluating different kind of mini-grids, Yadoo points out that the private sector is only likely to take on the financial cost of setting up a mini-grid if there are substantial subsidies (as much as 50%), equity or debt financing and an anchor load such as a factory. (Yadoo 2012 p. 34)

A 2003 workshop organised by the Stockholm Environment Institute, as part of their Climate and Energy Programme, made a number of important points about different types of electricity delivery mechanisms for rural electrification. Among these, they concluded that public support and finance are essential in the process of providing access to energy in the rural areas; and while local organisation for system management is important, it does also need external support. (Gullberg et al 2004 pg 5 & 6)

Rather than have communities, already poor and struggling, fund and service rural electrification infrastructure, public finance should be used. Communities can still be involved in local level projects in oversight and decision-making related to the project.

6.3 Decent jobs and working conditions

Generally, community-based mini-grid systems employ local community members to operate and maintain the system. These workers would be better employed by the government to do this work – in this way they would be assured of an element of job security, a decent wage and benefits – the same kind of conditions that all other public sector workers benefit from.

6.4 Union involvement in the debate is essential

In many countries across Africa public sector unions have been engaged in struggles against the privatisation of the energy sector. Recent examples include the struggle of the Nigerian public sector unions against the privatisation of the electricity sector in Nigeria.

It is important that the unions, in focusing on the national utilities and ongoing attempts to corporatize and privatise them, don't let privatisation of renewable energy, a greenfields area, creep in through the back door. This has already happened in South Africa with the privatisation of renewable energy through the REIPPP system.

The Tunisian federation for electricity and gas unions (UGTT) has set an important precedent with their recent successful struggle against the government's plans to privatise renewable energy. (PSI 2014)

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