Off-grid renewable energy in Africa

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KEY MESSAGES:

- Off-grid renewable generation capacity in Africa currently amounts to about 717 MW, with an additional 100 MW coming from small solar appliances (solar lights and solar home systems). This is a small proportion of total generation capacity, but may be a significant share of total off-grid capacity.
- Off-grid renewable energy provides electricity access to about 60 million people in Africa. Of these, about 36.5 million use small solar lights, 13.5 million use solar home systems with the capacity to power lights, mobile phones and radios and another 10 million are connected to mini-grids or have stand-alone systems with a higher power rating.
- Off-grid renewable capacity in Africa is increasing rapidly, with a four-fold increase in the last 5 years. Solar energy has been the main source of growth, although hydropower to supply mini-grids has also expanded. Wind energy is yet to make a significant impact in off-grid electricity supply.
- In recent surveys, about 40% of households report using electricity for lighting. Over half of these are now using solar devices or battery powered lights, so a significant transition away from burning fuels for lighting is already underway. With appropriate financing, off-grid solar devices may continue to gain ground, as they are cheaper than alternative lighting sources and provide more functionality.
- To monitor progress towards renewable energy and energy access targets, countries should ensure that censuses and household surveys of electricity use cover all appropriate renewable technologies (e.g. solar lanterns, solar panels, small-scale hydro and biogas used for lighting). They should also ensure that data collection efforts measure both off-grid capacity/generation and numbers of households using off-grid renewables where this is feasible.

Off-grid renewable energy and development

At present, it is estimated that about 1.1 billion people have no access to electricity. Most of these people live in rural parts of Africa, Asia and Latin America. Increased energy access would improve their quality of life in many different ways by providing benefits for health, education, public safety and gender equality. It may also support the development of agriculture and other small-scale rural enterprises, leading to reduced poverty and increased food security.

Renewable energy is an attractive option for electricity supply in remote rural areas, as it does not require regular fuel deliveries and is fully cost-competitive with fossil fuels at a small-scale. It also provides a broader range of global and national benefits in terms of reduced carbon dioxide emissions, less air pollution and a diversification of energy supply.

With these benefits in mind, increasing energy access and renewable energy have been included as two of the three main targets for the Sustainable Development Goal on energy (SDG 7) adopted in September 2015. One of the indicators of energy access is the proportion of the population with access to electricity and the indicator for renewable energy is the share of renewables in total final energy consumption.

Monitoring progress towards these targets will require statistics that measure the production and use of renewable energy, including from off-grid facilities. This note provides some estimates of off-grid renewable power capacity and use in Africa and some suggestions and examples about how this can be measured more accurately in the future.

The contribution of off-grid renewables to power supply in Africa

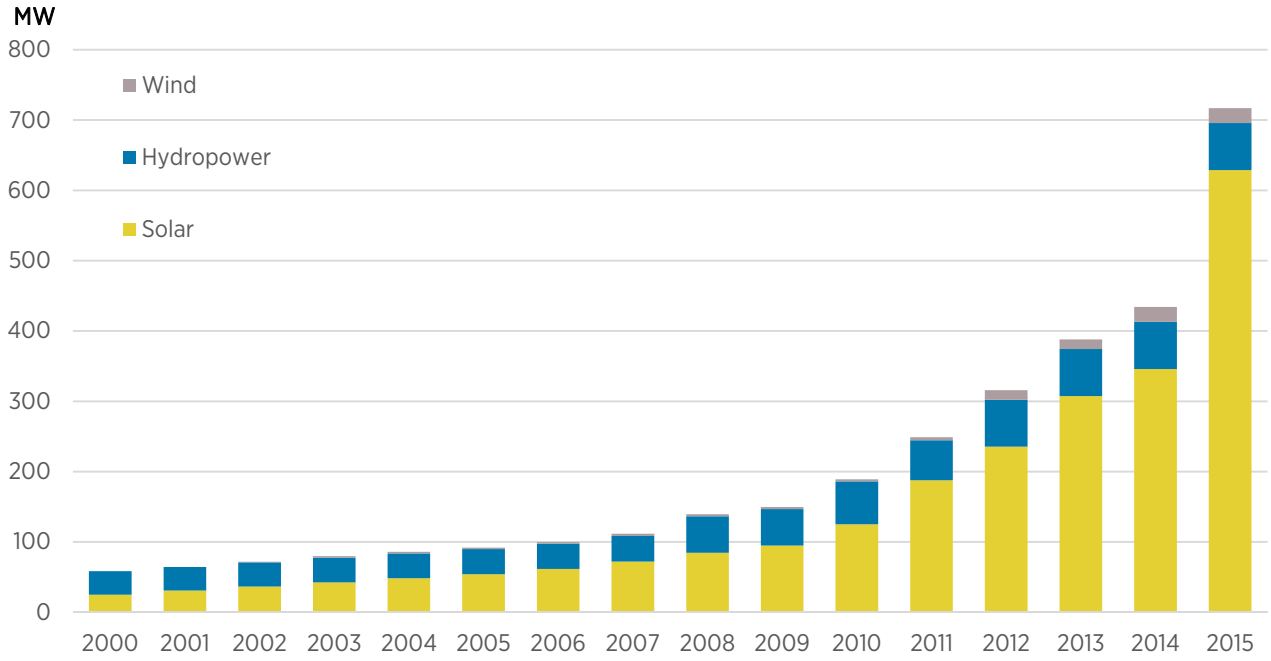
At the end of 2015, total renewable electricity generating capacity in Africa was just over 36 GW (or 21% of the 173 GW of total generating capacity on the continent).

Ninety-eight percent of renewable capacity was grid-connected, with hydropower accounting for the largest share (29.4 GW or 81%), followed by wind (2.4 GW), solar (1.3 GW), bioenergy (1.1 GW) and

geothermal (0.6 GW). The remaining 2% of off-grid renewable capacity amounted to 717 MW.

The three main sources of off-grid renewable power in Africa are: hydropower; solar photovoltaic power; and wind power. Off-grid solar photovoltaic capacity reached 630 MW in 2015, with a big increase during the year (+283 MW). Hydropower generating capacity was 67 MW (about twice what it was in 2000) and wind capacity was 21 MW. Some bioenergy projects are also sources of off-grid renewable power in Africa, but total recorded capacity only amounted to a few kilowatts in 2015.

Off-grid renewable generating capacity in Africa 2000 - 2015

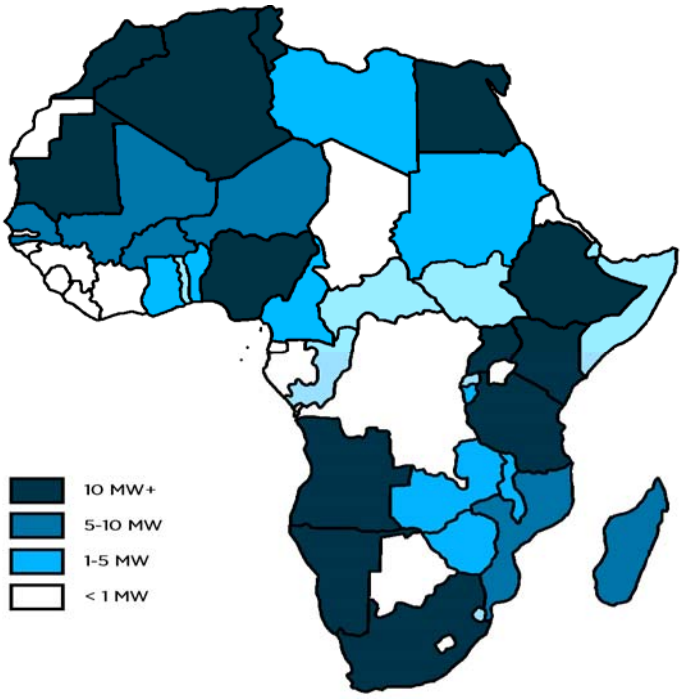


The figure above shows the development of off-grid renewable generating capacity in Africa since 2000. Off-grid hydropower is used by rural industries in the food and agricultural processing sector, some public services (e.g. churches, schools and clinics) and as a source of electricity for isolated mini-grids. The latter accounts for most of the off-grid hydropower capacity and most of the growth in this since 2000.

Wind energy has not been a major source of off-grid electricity generation so far. The few projects that do exist are wind-diesel hybrid systems that produce electricity for mini-grids or, in a few cases, single enterprises.

Solar photovoltaic power is by far the most common type of off-grid renewable electricity generation in Africa and off-grid applications accounted for about one-third of all solar capacity on the continent in 2015. Mini-grids in North Africa account for about half of this capacity, with significant recent investments in Algeria, Egypt, Mauritania and Morocco. Most of the remaining capacity is likely to be stand-alone facilities serving individual buildings and this has grown more gradually over the period.

The map to the right shows that 40 countries in Africa had some recorded off-grid solar photovoltaic capacity at the end of 2015. Twelve had more than 10 MW and another six had 5 - 10 MW of capacity. In many African countries, solar photovoltaic power is the only known source of renewable off-grid power.



Off-grid solar PV capacity in 2015

Off-grid renewables and energy access in Africa

Based on the off-grid renewable capacity reported above, it is estimated that about 2 million households (or 10 million people) in Africa may consume electricity either from solar panels or from mini-grids powered by renewable energy. However, this figure does not include households that use smaller solar appliances such as solar lights and SHS, which are not usually recorded as part of national solar panel statistics.

The Lighting Global programme of the International Finance Corporation has recently published a comprehensive study of market trends in off-grid solar products.[1] Based on sales and international trade data, it presents estimates of the number of units sold in the last few years and the number of households that may now be using these products. Based on their findings, the renewable energy provided by solar lights and SHS may be summarised as follows:

- In Africa, annual sales of solar lighting products (10W and under) are currently about 6 million units. In addition, about 200,000 SHS (over 10W) are also sold each year.
- Approximately 50 million people in Africa are currently using such products, of which about 13.5 million are using products that provide sufficient energy for task lighting and phone charging or radio use.
- Based on the above and assumptions about average power rating and product durability, IRENA estimates that these products may amount to an additional 100 MW of off-grid solar power that is currently unrecorded.

The figures above may also be minimal estimates, considering the rapid growth in this sector and the conservative assumptions used in estimation.

Recent indications of solar energy use from censuses and large-scale household surveys in Africa

Country	Year	Reported source of energy for lighting (%)				Population using solar (thousands)
		Grid or generator	Solar energy	Lantern or torch	Other or none	
Burkina Faso	2007	14.3		15.6	70.1	0
Burundi	2014	6.6			93.4	0
Chad	2011	3.2	0.1	65.0	31.7	12
DR Congo	2013	15.4		39.3	45.3	0
Ghana	2010	64.9	0.2	15.7	19.2	49
Guinea	2012	20.3	0.3	69.2	10.2	35
Madagascar	2010	13.3			86.7	0
Malawi	2014	8.9	1.6	73.6	15.9	267
Mali	2009	17.3	2.5	32.3	47.9	367
Rwanda	2012	17.1	0.4		82.5	43
Sierra Leone	2004	17.0		0.3	82.7	0
Sudan (former)	2009	5.4	1.1		93.5	494
Togo	2011	35.1	0.2	24.7	40.0	13
Uganda	2013	13.9		12.3	73.8	0
Zambia (lighting)	2010	21.6	3.3	11.0	64.1	459
Zambia (IT)	2015	30.0	17.0		53.0	2,756
Average/total	2015	17.7	1.2	22.8	58.3	4,217

Note: An additional 0.2% of households use biogas for lighting in Sudan and 0.2% use small-scale hydro in Rwanda.

Rapid growth in the use of off-grid electricity for lighting is confirmed by recent survey data (see table above). Electricity in one form or another is used by over 40% of households in these 15 African countries, with about 4.2 million people using solar energy.

The recorded use of solar energy is relatively small, but it may be recorded under lanterns or torches in some countries. This shows the need to make sure that solar products are included in such surveys in the future.

Many of the surveys are now also a few years old, so these figures may not reflect current levels of usage. For example, the two survey results for Zambia show a significant shift in use in just 5 years. Although not strictly comparable, the 2015 survey shows that 17% of people there are now using solar energy to power small devices (phones, notebooks, etc.), compared to 3% using it for lighting in 2010. This confirms the rapid growth in the sector reported by Lighting Global.

[1] Lighting Global and Bloomberg New Energy Finance (2016), Off-grid solar market trends report 2016, IFC, Washington DC, https://www.lightingglobal.org/wp-content/uploads/2016/03/20160301_OffGridSolarTrendsReport.pdf.

Improving the measurement of off-grid renewable energy

Off-grid renewable energy covers both stand-alone systems and mini-grids powered by renewable energy. Stand-alone systems vary in size from solar lights and small SHS to facilities that can generate many kilowatt-hours of energy. Solar photovoltaic energy is mostly used at the small-scale, but other renewables may be used in larger facilities and mini-grids.

To monitor energy access and renewable power consumption, it is necessary to measure both the number of people or households that have electricity access and the capacity and generation of renewable energy. This can be done using administrative data, household surveys and surveys of suppliers. Import data can also sometimes be used to estimate capacity.

Administrative data

Many projects and programmes have reported the installed capacity and numbers of people connected to off-grid power sources. For example, during 2014, the Lagos Solar Programme installed 1.2 MW of off-grid solar panels in 180 schools and clinics in Lagos State, Nigeria. In Egypt, the New and Renewable Energy Authority reports the capacity and number of households connected to off-grid solar power every year. At an even larger scale, Algeria installed 268 MW of solar photovoltaic systems to power 15 mini-grids in 2015. This accounted for much of the increase in off-grid capacity recorded in Africa last year.

Many national electricity companies also identify isolated systems in their electricity capacity and generation statistics and these can be used to measure off-grid renewable power production in mini-grids.

The advantage of using administrative data is the low cost of data collection if good systems for recording the data are in place. The disadvantage is that such sources are likely to be incomplete and may not cover, for example, privately owned off-grid power sources.

Surveys of manufacturers, retailers and installers

Surveys of renewable energy equipment suppliers can also be used to measure capacity expansion. For example, global market surveys have been used to chart the growth in sales of solar lanterns and SHS, particularly in Africa and Asia (see above). National surveys through trade associations are also often used to estimate capacity expansion in Europe and North America. In Africa, the Southern African Biogas Association is starting to compile data about the electricity capacity of biogas projects in the country. The Renewable Energy Industry Association of Namibia has also produced an estimate of off-grid solar photovoltaic capacity that is consistent with the data on imports of solar panels in the country.

The advantage of supplier surveys is that they can capture a lot of detail (e.g. plant size, location, end-use sectors) and are not expensive to implement. The disadvantages are that they may not distinguish between on-grid and off-grid applications or collect much data about how many people use these facilities.

International trade statistics

In some countries, all solar devices are imported. Import statistics should always include the weight and value of imports and, sometimes, the number of units imported. By converting these figures into estimates of capacity, it is possible to estimate annual capacity expansion and accumulate these figures to produce estimated total capacity. On-grid capacity can then be subtracted from this to produce an estimate of off-grid capacity. Power generation can then be estimated using data from other facilities or using tools such as the PVWatts calculator (http://pvwatts.nrel.gov). IRENA currently estimates off-grid solar power for some countries, using a conversion factor of 10W/kg to estimate capacity from solar panel import weight and the PVWatts calculator to estimate generation.

The advantage of using import data is that it gives a complete estimate of capacity expansion that can be easily calculated. The disadvantages are that trade statistics may not always be available or reliable and the conversion into capacity is likely to be imprecise. It is also difficult to use this approach to estimate the number of people using off-grid energy.

IRENA is currently working to improve this methodology, as well as the trade codes used for solar energy technologies in the international trading system (the Harmonized System). Solar lights and SHS are a focus of attention, as these are currently recorded under a variety of codes in different countries.

Censuses and large-scale household surveys

Censuses and large-scale household surveys are the most reliable way to measure energy access and many surveys already include questions about access to electricity or the source of energy used for lighting (see above). With many countries starting to prepare for their 2020 census, it is important to ensure that any energy access questions include modern renewables (e.g. solar lanterns and SHS) as possible answers. Questions about fuels used for heating and cooking (the other main dimension of energy access) should also reflect current renewable technologies.

The main disadvantage of household surveys is that they rarely collect details such as the capacity or amount of energy used. It is recommended that energy agencies should work with national statistical offices to develop modules to collect such data from a sample of respondents where the data suggest that renewables are an important source of energy for meeting basic needs for lighting, cooking and heating.