Clean energy and mini-grid toolkit

Information sheet 1

Energy, electricity and access

Empowered lives. Resilient nations.

1. Energy and electricity concepts

In physics, **energy** is the property that must be transferred to an object in order to perform work on, or to heat, the object. Energy is expressed in the unit of Joule, which is defined as the energy transferred to an object by the work of moving it a distance of 1 metre against a force of 1 newton. Energy can be found in a number of different forms. It can be chemical energy, electrical energy, heat (thermal energy), light (radiant energy), mechanical energy and, nuclear energy. Energy can be transformed into another form of energy. It can be converted from one of these forms to another but not created or destroyed, which is known as the 'Law of conservation of energy'.

Electricity is the set of physical phenomena associated with the presence and motion of electric charge; most commonly these are electrons, but any charge in motion constitutes a current. The presence of an electric charge, which can be either positive or negative, produces an electric field. The movement of electric charge is known as an **electric current**, the intensity of which is usually measured in amperes (A). An **electric potential** (also called the electric field potential or the electrostatic potential) is the amount of work needed to move a unit positive charge from a reference point to a specific point inside the field without producing any acceleration. The value is given in the unit of volts (V). Electric power P is the rate at which electric energy is transferred by an electric circuit. The unit of power is the Watt (W) or Joule per second, an is the electric current I passing through a voltage V, in formulae $P = V \times I$.

To produce a flow of current in any electrical circuit, a source of electromotive force or potential difference is necessary. Various sources are available for electric energy generation. In *electromagnetic generators,* current is generated by mechanically moving conductors through a magnetic field or a number of fields. Sources of mechanical energy include steam turbines, gas turbines, water turbines, water wheels, and internal combustion engines that run on diesel or fuel oil. The combination is called an engine-generator or turbine-generator. Although turbines are most common in commercial power generation, smaller generators can be powered by gasoline or diesel engines. These may be used for generation in mini-grids. *Voltaic cells* (such as batteries and fuel cells) produce an electromotive force through electrochemical action. *Photovoltaic cells p*roduce electromotive force by the action of light in solar cells.

Electrification is the process of powering by electricity and, in many contexts, the introduction of such power by changing over from an earlier power source. Electricity is a very convenient way to transfer energy, and it has been adapted to a huge, and growing, number of uses. The invention of a practical light bulb in the 1870s led to lighting becoming one of the first publicly available applications of electrical power. Electricity is however still a highly practical energy source for heating and refrigeration, with air conditioning/heat pumps representing a growing sector for electricity demand for heating and cooling. The effects of electromagnetism are most visibly employed in the electric motor (working as the reverse of the before-mentioned generator), which provides a clean and efficient means of motive power. In the mid-19th century, coal-powered steam technology ushered in a new economic era in the form of the first industrial revolution. A new phase of the global industrialisation began with electricity and electrification of industries. The changeover from steam power to electrification of factories led to a 300% increase in productivity in the first half of the twentieth century. Nowadays, electricity powers electronics, telecommunications, mobile phones and the Internet.

Early electric energy was produced near the device or service requiring that energy. Later, electricity companies started building stations from which power was generated and distributed to customers through a grid. An **electrical grid** is an interconnected network for delivering electricity from producers to consumers. It consists of generating stations that produce electrical power, high voltage transmission lines that carry power from distant sources to demand centres, and distribution lines that connect individual customers.

2. Electricity in the world

World energy consumption is the total energy used by the entire human civilization. Typically measured per year, it involves all energy harnessed from every energy source applied towards humanity's endeavours across every single industrial and technological sector, across every country. World total **primary energy supply** (TPES), or "primary energy" differs from the world final energy consumption because much of the energy that is acquired by humans is lost as other forms of energy during the process of its conversion into usable forms of energy and its transport (transmission) from its initial place of supply to consumers. In 2014, world primary energy supply amounted to 155,481 terawatt-hours(TWh) or 13,541 Mtoe, while the world final energy consumption was 109,613 TWh or about 29.5% less than the total supply.

In 2015, and world energy consumption for electricity production 24,345 TWh, of which was coal 40.8%, natural gas 21.6%, nuclear 10.6%, hydro 16.4%, 'others' (solar, wind, geothermal, biomass, etc.) 6.3% and oil 4.3%. Coal and natural gas were the most popular energy fuels for generating electricity. The world's electricity consumption was 20,200 TWh; this figure is about 18% smaller than the generated electricity, due to grid losses, storage losses, and self-consumption from power plants (gross generation)[1].

Table 1 Estimated RE share in global final energy consumption in 2015

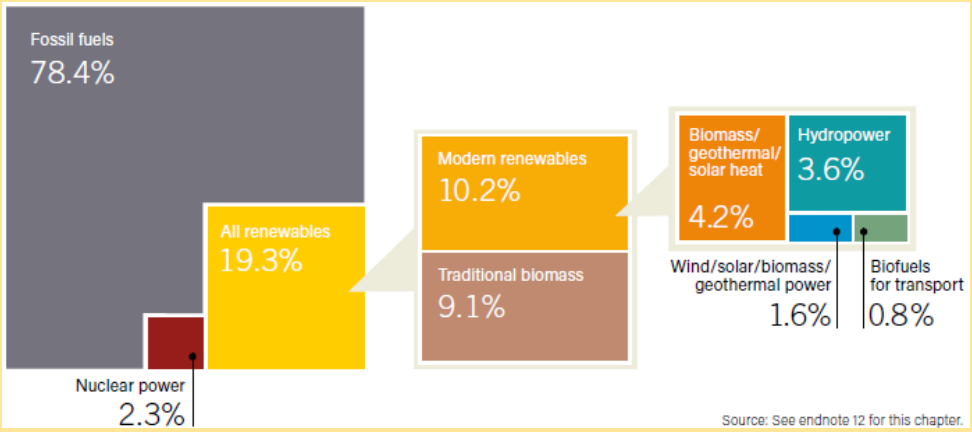
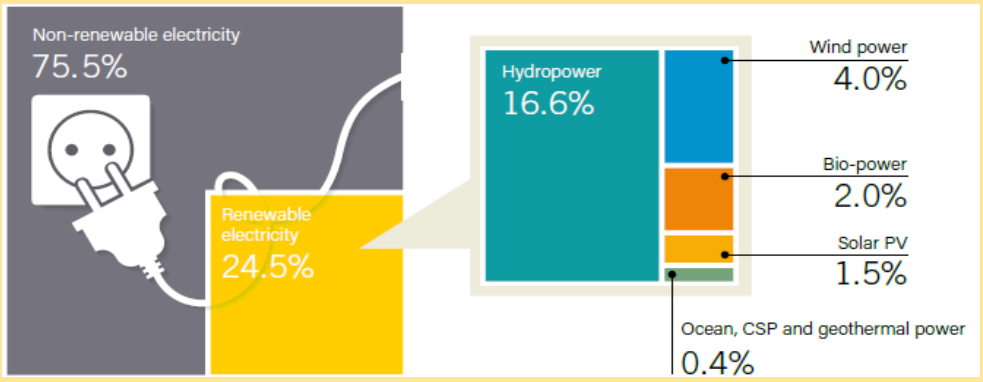


Table 2 Estimated RE share in global electricity production in 2016



Source: REN21 (2017)

From 1973 to 2015, world gross electricity production increased from 6,144 TWh to 24,345 TWh, an average annual growth rate of 3.4%, the same as the growth rate of electricity final consumption in the world since 1974.

The world's appetite for electricity lifts demand by more than 70% by 2040, and there will be a concerted effort to reduce the environmental consequences of power generation. Renewables will overtake coal as the largest source of electricity by the early-2030s and will account for more than half of all growth over the period to 2040. Renewables-

[1] Key World Energy Statistics (IEA. 2017p. 38); REN 21 (2016)

based generation will reach 50% in the European Union by 2040, around 30% in China and Japan, and above 25% in the United States and India. Coal's share of total electricity generation will drop to 30% in 2040, and the output from inefficient sub-critical plants will decline by 45%. Renewable energy is being used increasingly in power generation. In 2015, the total installed global power generating capacity was nearly 6,142 GW (gigawatt), of which 1,849 GW renewable energy. The world now adds more renewable power capacity annually than it adds (net) capacity from all fossil fuels combined. In 2015, renewables accounted for an estimated more than 60% of net additions to global power generating capacity (REN21, 2016).[2]

The ongoing growth and geographical expansion of renewable energy were driven by the continued decline in prices for renewable energy technologies (in particular, for solar PV and wind power), by rising power demand in some countries and by targeted renewable energy support mechanisms. Such declines are particularly important in developing and emerging economies and in isolated electric systems (such as mini-grid systems) (if they are not heavily subsidised), where there is a shortage of generation and where renewable energy resources are particularly plentiful, making renewable electricity more competitive relative to other options (REN21, 2017)[3].

Good information sources on statistics are the International Energy Agency (IEA), REN21, World Energy Council (WEC) and have regular publications on the state of energy consumption and production in the world (see Bibliography).

3. Sustainable energy for All (SE4All) and Sustainable Development Goals (SDG)

In September 2000 the United Nations Millennium Declaration was adopted committed nations to a new global partnership to reduce poverty, and set out a series of eight time-bound targets, with a deadline of 2015, that have become known as the Millennium Development Goals (MDGs). Unfortunately, energy was not included as one of the goals, although it was accepted that energy was crucial to achieving many of the MDG goals (see Annex 2). Of course, energy had been an integral part of the climate change mitigation efforts since the early 90s (UNFCCC, Kyoto Protocol), but these efforts have focussed on greening energy supply or using energy more rationally rather than bringing 'modern' energy to those that do not (yet) have access. The international community formulated sustainable energy objectives in the SE4All initiative.

Energy is an essential factor for sustainable development and poverty eradication. The complex challenges of energy and sustainable development were highlighted at the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992. Energy was discussed throughout Agenda 21. In 2011, the Sustainable Energy for All initiative was created by the UN Secretary-General to pursue three major objectives by 2030:

- Ensuring universal energy access to modern energy services;
- Doubling the global rate of improvement in energy efficiency;
- Doubling the share of renewable energy use in global energy.

In 2009, about 1.3 billion people had no access to energy and almost 2.7 billion had to rely on traditional use of biomass for cooking. If the universal goal in 2030 is to be achieved, not only these people must be provided with energy access, but also the future generations that will be added as a consequence of population growth. It was estimated in the AGECC Summary Report (2010) that ensuring universal access to modern energy services would involve providing new electricity connections to around 400 million households by 2030, and modern fuels and technologies to 700 to 800 million households over the same period. For electricity, global access rates would have to need to increase by just over 2% per year, while in Sub-Saharan Africa an increase of 8% would be needed[4]. In its World Energy Outlook (WEO, 20100), the International Energy Agency (IEA) presents projections on how many people need to be provided access in the year 2030.

Sustainable Energy for All (often shortened as SE4All) has generated significant momentum since its launch. Nevertheless, it is estimated that in 2015 still about 2.8 billion people had no access to modern energy services and over 1.1 billion do not have electricity. Furthermore, around 4.3 million people are dying prematurely every year due to indoor pollution resulting from cooking and heating with unsustainable fuels.

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2 WEO (2015), REN21 (2016)

3 REN21 (2017)

4 AGECC Summary report (United Nations, 2010)

Approximately 1.2 billion people (about 16% of the global population) lived without electricity in 2013-14, although this is about 84 million people fewer than in previous years. Numbers and trends differ greatly by region. The vast majority of people without access to electricity are in Sub-Saharan Africa and the Oceania region, and most of them live in rural areas. In Sub-Saharan Africa, nearly 60% of people have no access to reliable electricity. In sub-Saharan Africa, around 150 million people are estimated to have gained electricity access since 2000, but this has lagged population growth, resulting in a worsening picture overall – the latest estimates reveal that over two-thirds of the sub-Saharan population (634 million people) are without access to electricity.

To put these numbers in perspective, the entire continent of Africa has about 150 GW of installed power generating (less than Germany) and accounts for only about 1% of the world's CO2 emissions. The official electrification rate for sub-Saharan Africa is 35%, and only 13 of the region's 38 countries have power systems larger than 1.7 GW. With only 50 GW of installed capacity, the entire electricity supply of sub-Saharan Africa (excluding South Africa) is less than that of the Republic of Korea (REN21 2015, 2017)

Table 3 Global estimates of number of people to be provided with access to modern energy (over 2010-2030)

People to be provided with access to electricity

ACCESS TO ELECTRCITY	People without access to electricity (2009) (million)	People to be provided access over 2010-2030 (million)	Investment needed over 2010-2030 (USD million)
North Africa & Middle East	22	24	13,850
Sub-Saharan Africa	586	875	504,970
China	8	9	5,190
India	289	269	155,170
Rest of Asia & Pacific	379	374	215,560
Latin America & Caribbean	30	35	20,260
Total	1,314	1,586	915,000
Grid extension		698	395,000
Mini-grid		581	325,000
Stand-alone		307	195,000
Total		1,586	915,000

Total investments needed to achieve SE4All goals

	Amount (in USD billion) needed over 2010-2030		Amount (in USD billion per year)
	Industrial world	Developing world	Developing world
Total, energy access (2010-2030)		1,010	48
Total, energy efficiency (2010-2030)	5,650	650	31
Total, renewables (2010-2020)	6,700	771	37
TOTAL	12,350	2,431	116

Source: World Energy Outlook 2011; The Secretary-General's Advisory Group on Energy and Climate Change (AGECC, 2010); Sustainable Energy for All: Technical Report of Task Force 2; High-Level Group of Sustainable Energy for All (SE4All, 2012)

In one of the IEA scenarios (New Policy scenario), the number of people without access to electricity declines to around 810 million in 2030 and 550 million in 2040. This means that around 550 million people in the world will remain without any access to electricity in 2040 – the majority of them in sub-Saharan Africa. To provide all with electricity is a daunting, but not impossible task.

Table 3 summarises how much investment would be needed over the period 2010-2030 to achieve universal access to electricity by 2030, as well as the global investments needed for greening energy supply (higher share of renewables) and increased energy efficiency. Achieving the goals of the SE4All initiative will require a substantial increase and reorientation of annual energy investments. Specifically, global annual energy investments would need to increase by about one-third from the present level of USD 1.25 trillion per year with around USD 0.7 trillion to $1.95 trillion per year. In developing countries, about USD 121 billion would need to be spent annually or USD 2.4 trillion in total over 2010-2030.

The 2030 Agenda was formally adopted by the international community at a UN summit in New York in 2015, to help eradicate poverty and achieve sustainable development by 2030. It includes an ambitious set of 17 Sustainable Development Goals (SDGs) which included a dedicated and stand-alone goal on energy, Sustainable Development Goal 7. The EU is determined to fully implement the 2030 Agenda, across the range of its internal and external policies aligning its own policies and actions to the objectives of the Agenda.

Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all

7.1 by 2030 ensure universal access to affordable, reliable, and modern energy services
7.2 increase substantially the share of renewable energy in the global energy mix by 2030
7.3 double the global rate of improvement in energy efficiency by 2030
7.a by 2030 enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies and promote investment in energy infrastructure and clean energy technologies

7.b by 2030 expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, particularly LDCs and SIDS

The global Sustainable Development Goals (SDGs) are meant to guide policy and funding for a new period of 15 years after the MDGs and have incorporated the sustainable energy goals (SE4All) as SDG No. 7 (sustainable energy), on renewable energy, energy efficiency, and energy access. It should be noted that 'energy' also indirectly impacts many other areas of sustainable development (and thus the SDGs), as is illustrated in Table 4.

Table 4 Energy interlinkages in Sustainable Development Goals

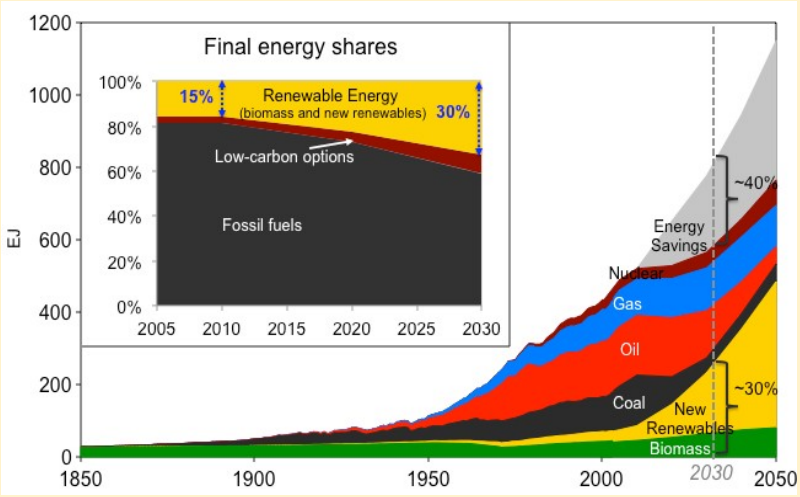
Sustainable Development Goal	Examples, energy linkage
1. End poverty in all its forms everywhere	Access to basic energy services is a requirement for poverty eradication
2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Agriculture and energy at times compete for land – for instance in biomass feedstock production
3. Ensure healthy lives and promote well-being for all at all ages	Air pollution from traditional biomass usage is a prime cause of premature deaths, particularly amongst women and children
4. Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	Basic energy services are required to deliver education
5. Achieve gender equality and empower all women and girls	Women's use of traditional biomass methods for cooking puts their health at risk
6. Ensure availability and sustainable management of water and sanitation for all	Conventional forms of power generation have substantial water requirements
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work	The energy intensity of economic growth needs to be reduced.
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Resilient grid and transport infrastructure across borders is required to ensure access to energy for all, and to maximize energy efficiency
10. Reduce inequality within and among countries	Distributed generation brings potential to genuinely bring energy for all, including in rural areas, thus reducing inequalities
11. Make cities and human settlements inclusive, safe, resilient and sustainable	Cities require careful energy planning, in particular to minimize combustion-driven air pollution for residents
12. Ensure sustainable consumption and production patterns	Renewable energy and energy efficiency are a key part of a future in which there is sustainable consumption.
13. Take urgent action to combat climate change and its impacts	The carbon-intensive energy sector is a key driver of climate change.
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development	The ocean and lake space can be used for marine energy (e.g. offshore wind; ocean energy).
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Energy projects need to be carefully sited and the energy mix needs to be carefully planned to avoid a negative impact on ecosystems and biodiversity.
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Transparent and corruption-free regimes are key to delivering energy services affordably
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development	Finance is required for capex-heavy energy infrastructure investments. Free trade will help to ensure affordability.

Box 1 Relation between energy access, energy efficiency and renewable energy

The United Nations Framework Convention on Climate Change (UNFCCC) since the Rio summit in 1992 has been supporting measures and efforts to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system but failed to reach global binding agreement on GHG. This has culminated, for now, in the agreement in Paris at its 21st Conference of Parties (COP21) meeting in December 2005. Countries have agreed to keep increase in global average temperature to well below 2°C in 2100 above pre-industrial levels) and pursuing efforts to limit he increase to 1.5°C (country commitments are known as Intended Nationally Determined Contributions (INDCs)

Doubling the rate of energy efficiency improvements and providing universal access to modern energy services via renewables would raise the renewable energy share to as much as 36%, double from the current share of renewables (see Table 1). The various goals do not exclude, but can mutually enforce each other. Energy efficiency can dramatically improve the economics of energy access by reducing the upfront investment and ongoing fuel costs and by improving system reliability and performance where existing supply resources fall short. For example, LED lighting and highly efficient televisions, fans, refrigerators and other appliances that are designed and optimised for use with off-grid renewable energy technologies deliver higher orders of energy service. representing nearly 9% of world final energy consumption (TFEC) worldwide. Renewable energy can help to improve the access situation. Renewable resources have characteristics that make them the best solution for access to electricity in rural areas. Solar photovoltaics (PV), wind, small hydropower and biomass power are the main solutions for off-grid and mini-grid electricity access.

Historical energy transformations and an energy future that meets the SE4All objectives. Source: Global Energy Assessment – Toward a Sustainable Future, 2012 (IIASA)



Scenario work by the International Renewable Energy Agency (IRENA) shows that the doubling of the renewable energy share in the global energy mix requires a combined approach. Action will be required to ensure the development of different technologies, not only renewables, but technologies also related to SE4All goals of modern energy access and energy efficiency. In the REMap 2030, the global renewable energy share can reach 36% by 2030 with current renewable energy technology (hydro, solar, wind, biomass heat and power, biogas, biofuels, geothermal), better energy efficiency (and reduction of traditional biomass from 9% to 2%) and improved energy access.

This assumes that the three SE4All objectives will be met, i.e. renewables, access and energy efficiency. When the potentials of energy efficiency and renewable are combined, the growth in total primary energy supply (TPES) can be reduced by up to 25% compared to business as usual in 2030. The emission reduction from this increased renewable energy deployment, coupled with achievable energy access improvements, while providing access to modern energy for all, could at the same limit global temperature increase below 2ºC. In the baseline (Reference case of IEA (2012), annual emissions would be about 42 gigatonnes (Gt) of CO_2 in 2030. In the REMap 2030 scenario, renewable would provide over half (8.6 Gt) of the CO2 emission reduction needed in 2030 from the energy sector with 7.3 Gt from EE. When emissions would drop below 25 Gt this would to keep CO_2 concentrations at 450 ppm, and having around a 50% chance of limiting the global increase in average temperature to 2°C by the end of the century.

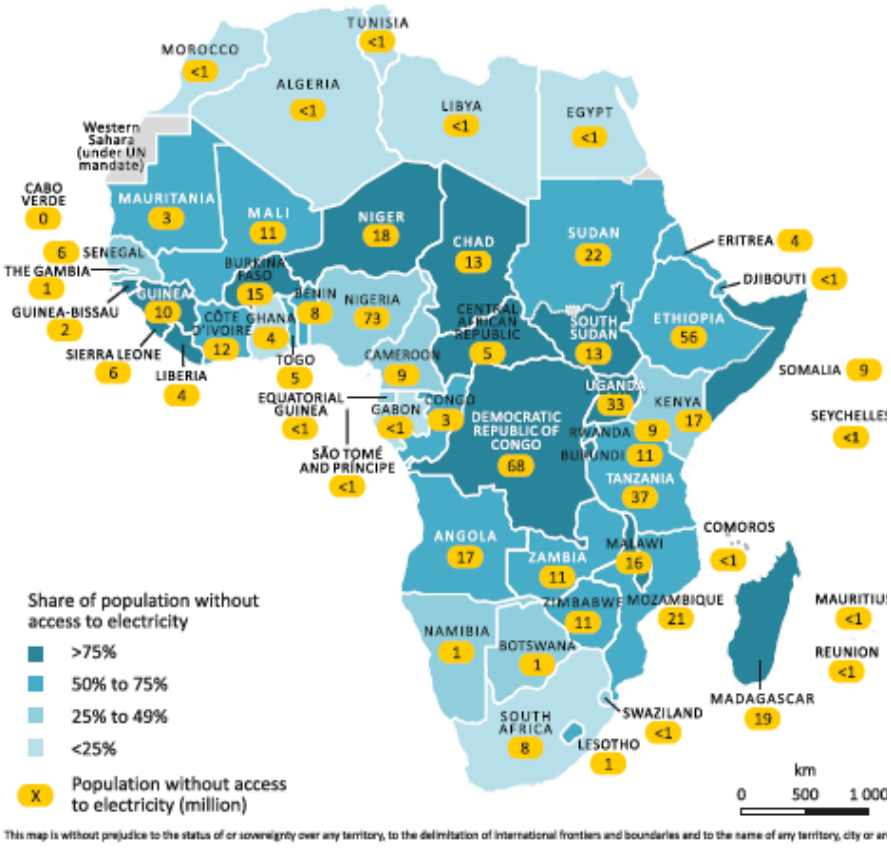
Source: IRENA RE Roadmap 2030, Renewable Energy Roadmap (2014); UNEP Emission Gaps report (2015), IRENA, Rethinking Energy: Renewable Energy and Climate Change (2015)

Accountability and transparency are essential for tracking Sustainable Energy for All's global progress. For this purpose, the Global Tracking Framework that established baseline energy data and continuously provides regular bi-annual updates on trends in energy access, renewable energy, and energy efficiency. GTF reports have been published in 2013. 2015 and 2017 and can be found on the website http://gtf.esmap.org.

3. SE4All in Sub-Saharan Africa

The number of **people without access to electricity in sub-Saharan Africa** stopped increasing in 2013 and has since declined, led by strong efforts in Cote d'Ivoire, Ethiopia, Ghana, Kenya, Sudan and Tanzania. Since 2012, the pace of electrification has nearly tripled relative to the rate between 2000 and 2012. East Africa, in particular, has made significant progress; the number of people without access has declined by 14% since 2012. Despite this turn-around, 590 million people – roughly 57% of the population – remain without access in sub-Saharan Africa, making it the largest concentration of people in the world without electricity access as efforts have often struggled to keep pace with population growth. Over 80% of those without electricity live in rural areas, where the electrification rate is less than 25%, compared with 71% in urban areas (IEA, Energy Access Outlook, 2017)

Figure 1 Number and share of people without access to energy (2016)

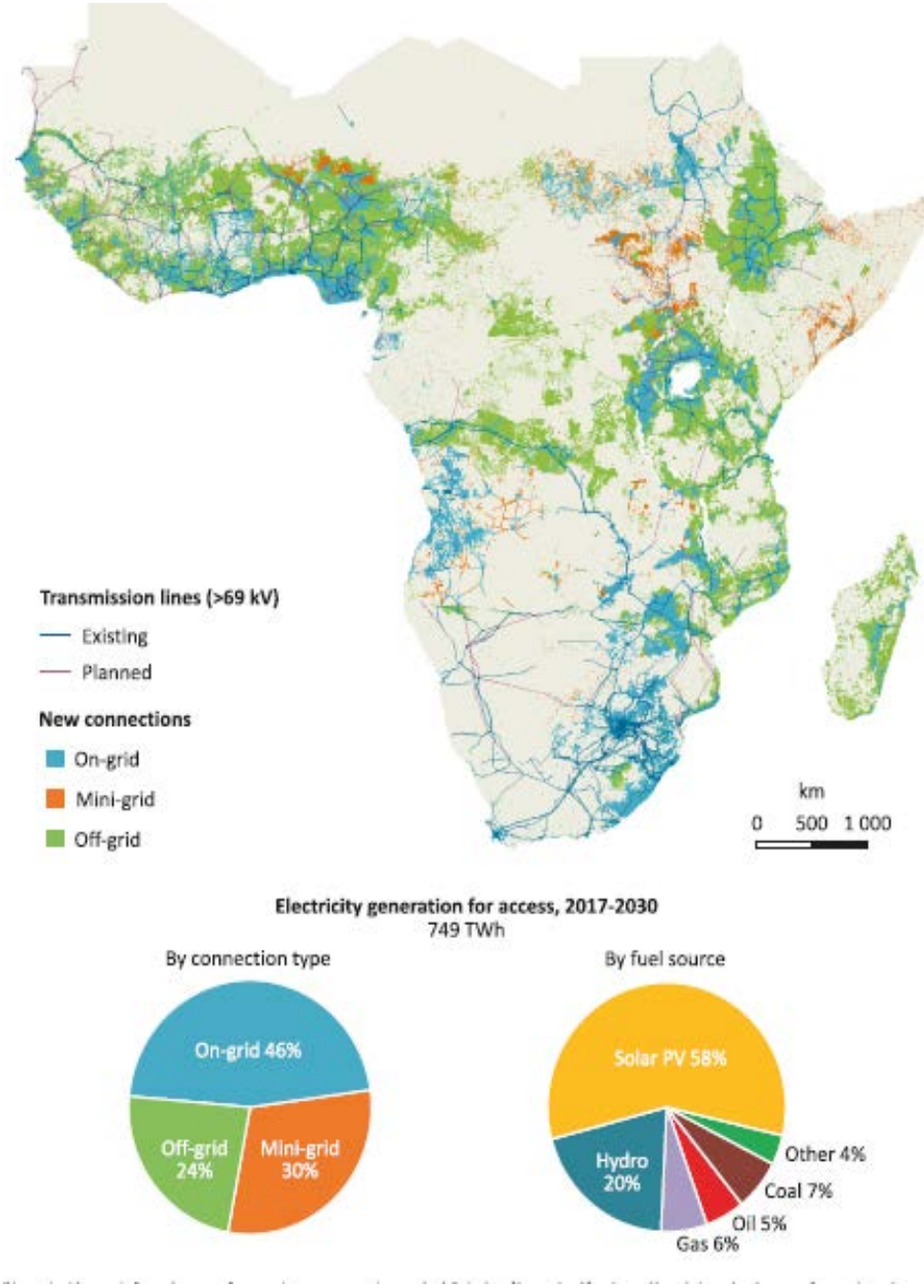


Source: IEA Energy Access Outlook (2017)

The IEA predicts (in its New Policies scenario) that almost 60% of the population of sub-Saharan Africa, 850 million people, will have access to electricity by 2030. This would represent an increase of over 15% and 410 million people since 2016. Grid extension remains the primary pathway to gain access, while renewables comprise about two-thirds of total capacity additions and are responsible for 75% of the population gaining access. Over 60% of the population growth to 2030 in the region will take place in urban areas, but over half of the population will still reside in rural areas. In 2030, 29 countries in sub-Saharan Africa remain below the regional average access rate of 60%.

A more aggressive IEA scenario, the Energy for All Case develops a pathway that would allow Sub-Saharan Africa to meet the goal of universal access to electricity by 2030. To achieve this aim, 600 million people need to gain access by 2030, over 43 million per year, in addition to the 200 million people who gain access in the New Policies Scenario. The Energy for All Case meets this increase in access mainly through an accelerated deployment of **mini-grids and stand-alone** systems, which together are the source of 75% of the additional connections. In total, 30% of the additional people that gain access get it through off-grid solar PV, which is particularly well-suited for delivering access to rural areas where grid access is impractical or very expensive. Mini-grids experience even higher growth, an order of magnitude higher than in the New Policies Scenario, providing access to 44% of the additional people. The IEA estimates that cumulative investments between 2017 and 2030 under current policies and commitments are less than one-fifth of the level needed to achieve universal electricity access in Sub-Saharan Africa, and that the additional cumulative investment required amounts to USD 370 billion between 2017 and 2030 relative to the New Policies Scenario, an average of USD 26 billion per year, of which about USD 15-16 million for mini-grids.

Figure 2 New connections and power generation for electricity access in Sub-Saharan Africa in the Energy for All scenario of the IEA



Source: IEA Energy Access Outlook (2017)

The SE4All partnership has promoted the elaboration of **SE4All Action Agenda** for countries. The Action Agenda provides the long-term vision which ensures the overall sector-wide coherence and synergy of the accumulated efforts towards the three goals of SE4All in the country, also including the nexus angles (food security, gender, health, water etc.). The development of an Action Agenda is a multi-stage process in most cases facilitated by technical assistance provided by a SE4All partner, in case of Africa, the African Development Bank (AfDB). Information can be found at www.se4all-africa.org.

The political adoption elevates the AA as the national framework under which the sectoral policies are elaborated and it should serve as the basis for donor co-ordination and assistance on energy, and as a reference document for the private sector and civil society. Accompanying the Action Agenda is the Investment Prospectus (IP). The purpose is the operationalizing the Country Action Agenda, possibly in a specific sector or subsector, by identifying and developing a of implementable programs and projects, including their investment requirements, that can be presented to set potential private and public investors.

The table gives the status of Action Agenda and Investment Prospectus in selected countries (as per 30-11-2017):

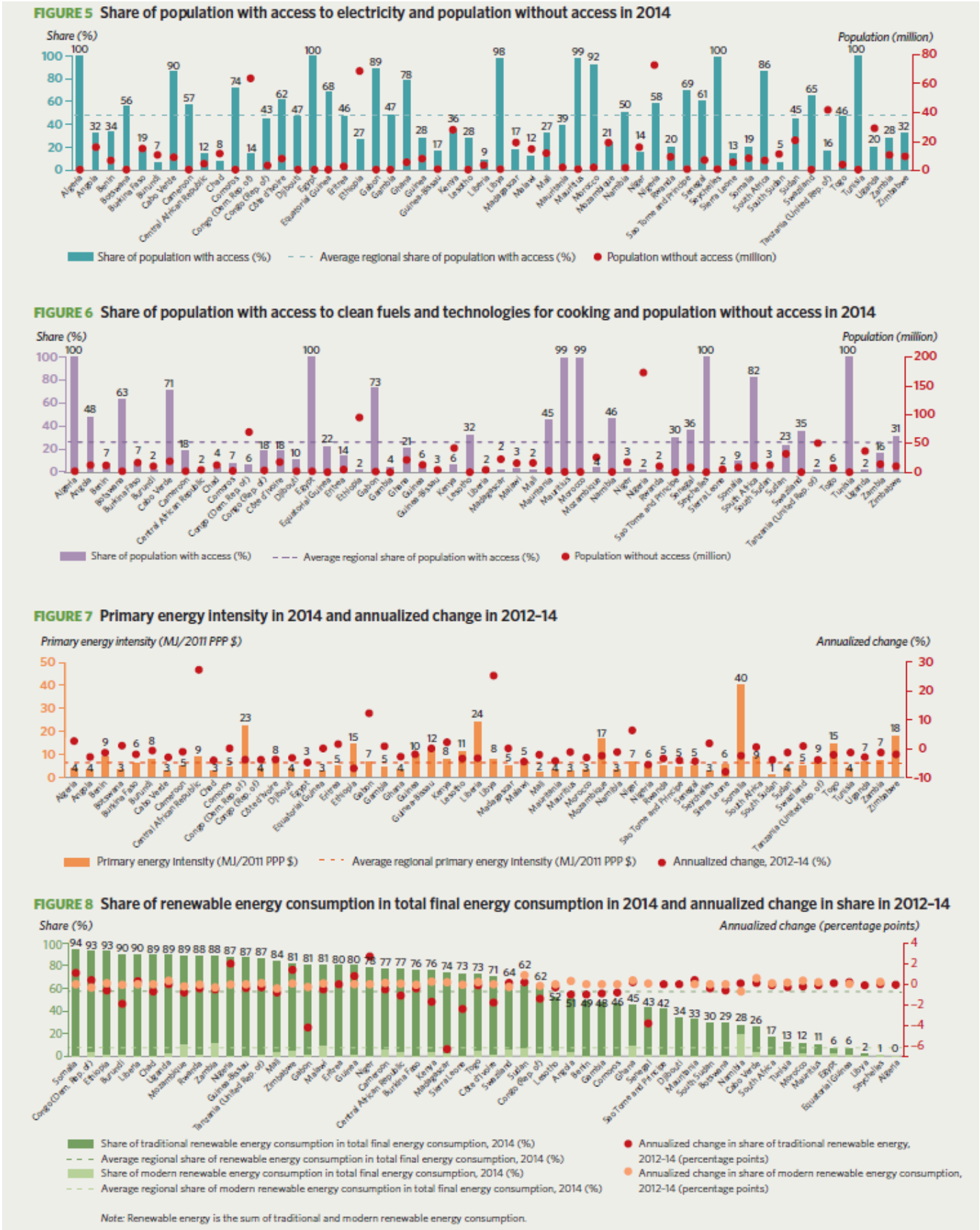
Table 5 Electricity access by country (in 2014) and status of access targets and SE4All Action Plans

	Electrification rate	People without access to energy (million)	Access target	Status Action Agenda (AA) and Investment prospectus (IP)
Angola	33%	16	100% by 2030	AA and IP finalised
Benin	29%	7	95% by 2025 (urb) 65% by 2025 (rur)	AA finalised, IP under devpt.
Botswana	53%	1	100% by 2030	AA and IP under devpt.
Burkina Faso	18%	14	95% by 2030	AA finalised, IP under devpt.
Burundi	5%	10		IP under devpt.
Cabo Verde	96%	0.2	100% by 2020	AA finalised, IP under devpt.
Cameroon	62%	9		
Central African Republic	3%	5	50% by 2030	
Chad	4%	13		
Comoros	69%	0,2		
Congo	42%	3		
Côte d'Ivoire	62%	8	100% by 2020	AA finalised, IP under devpt.
Dem. Rep. of Congo	18%	62	60% by 2025	AA and IP under devpt.
Djibouti	42%	0.5		
Equatorial Guinea	66%	0.3		
Eritrea	32%	3		
Ethiopia	25%	73	100% by 2030	AA finalised
Gabon	89%	0.2		
Gambia	45%	1	100% by 2030	AA and IP finalised
Ghana	76%	8	100% by.Y 2030	AA finalised, IP under devpt.
Guinea-Bissau	21%	1	80% by 2030	AA under devpt.
Kenya	20%	36	100% by 2022	AA and IP finalised
Lesotho	17%	2	40% by 2020	
Liberia	10%	4	100% by 2030	IP under devpt.
Madagascar	13%	21		
Malawi	**12%**	**15**		**AA and IP under devpt.**
Mali	26%	13	87% by 2030 61% by 2033 (rur)	AA finalised
Mauritania	29%	3		
Mauritius	100%	0		
Mozambique	40%	16		IP under devpt.
Namibia	32%	2		
Niger	15%	16	65% by 2030	AA finalised, IP under devpt.
Nigeria	45%	98	75% by 2020 90% by 2030	AA finalised, IP under devpt.
Rwanda	27%	8	100% by 2030	AA finalised, IP under devpt.
São Tomé and Príncipe	59%	0.1		
Senegal	61%	6	70% by 2017 100% by 2025	AA finalised, IP under devpt.
Seychelles	98%	0		
Sierra Leone	14%	5	92% by 2030	AA finalised, IP under devpt.
Somalia	15%	9		
South Africa	86%	8	100% by 2019	
South Sudan	1%	12		
Sudan	40%	24		
Swaziland	66%	0.4	75% by 2018, 85% by 2020, 100% 2025	AA and IP under devpt.
Tanzania	30%	36	75% by 2030	AA and IP finalised
Togo	27%	5	82% by 2030	AA finalised, IP under devpt.
Uganda			98% by 2030	AA finalised, IP under devpt.
Zambia				AA and IP under devpt.
Zimbabwe			66% by 2030	AA and IP under devpt.
Sub-Saharan Africa	**35%**	**632**		

Data compiled from SE4All-afruica website and from REN21 (2017)

Figure 3 Status of Africa in 2024 with respect to energy Sustainable Development Goals

Source: SE4All Global Tracking Framework (2017)



5. Malawi

Malawi's population was 16.8 million in 2014. Approximately 84% of Malawians live in rural areas, practicing subsistence farming as their main source of livelihood[5]. Malawi's energy supply is dominated by biomass (firewood, charcoal, agricultural and industrial wastes) accounting for 88% of the total primary energy supply, coal 2%, petroleum products 6% and electricity 3%[1].

Malawi has low levels of electrification with about 10% of the population having access to electricity[6]. Moreover, the national grid almost exclusively serves urban and peri-urban areas, around 37% of urban households have access to electricity, compared to only 2% of rural households. Rural areas currently rely mainly on kerosene for lighting and diesel for mechanical and electrical power.

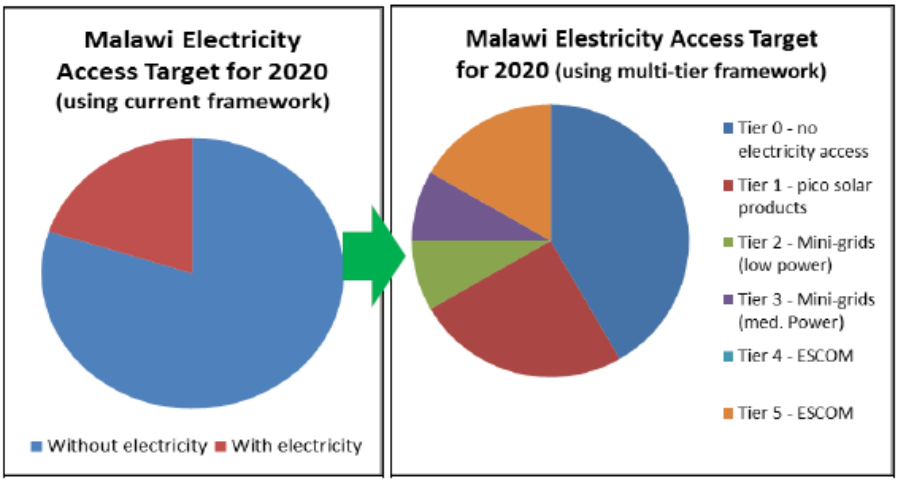
The new draft energy policy addresses some of the same themes the Sustainable Energy for All (SE4All) Action Agenda, particularly in the areas of increasing energy access and grid-connected renewable energy. The Action Agenda is being prepared (during 2016-17) with AfDB support and the draft text is being formulated with help of the consortium Ecolener-Deloitte.

The draft **Malawi SE4All Action Agenda** outlines how Malawi will achieve the SE4All goals of universal access to modern energy services, increase the rate of energy efficiency, and increase the share of renewable energy in its energy mix, by 2030. The target proposed is to have at least a basic (tier 1) access to electricity for 100% of the population by 2030, of which at least 32% of rural people (1.51 million people) served by grid extension, some 88,000 households by mini-grids and solar home systems and the remaining households (4.5 million) by pico-solar systems. The Action Agenda mentions the figure of 90 mini-grids that could serve about 13,500 households[7]. The draft Renewable Energy Policy (2016/17) mentions that by 2025 it is hoped that at least 50 mini-grids will be operational, including the first fully commercial schemes.

The method hitherto used for defining and measuring electricity access resolved around a grid connection – one either had a grid connection or did not. In view of the fact that off-grid technologies such as solar home systems and isolated mini-grids provide fundamental electricity services to users, the SE4All initiative has developed a broader and improved way of defining 'energy access'.

Following the definition of access in 'tiers', the Malawi government in its SE4All Action Plan and the draft National Energy Policy is proposing the following targets for access to electricity, given in Figure 3.

Figure 4 Number and share of people without access to energy (2016)



Source: National Energy Policy (draft, 2016)

5 http://www.worldbank.org/en/country/malawi; *Draft National Energy Policy* (pwc, 2016)

6 World Bank (2010); National Statistics Office (2009)

7 At 4.4 people het households, this would mean about 60,000 people. Draft Malawi SE4All Action Agenda (2016)

Table 6 Energy ladder of access to energy services, Malawi access targets (above) and power levels (below)

	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Energy - Power - Energy		Very low 1-10 W > 12 Wh	Low > 50 W > 200 Wh	Medium > 200 W > 1 kWh	High > 800 W > 3.4 kWh	Very high > 2 kW > 8.2 kWh
Hours - per day - evening		 > 4 > 1-2	 > 4 > 2	 > 8 > 2-4	 > 16 > 4 hrs	 > 23 hrs > 4 hrs
Energy services	Lighting	Lighting (1-2) Phone charging, radio	Lighting (4) Phone, radio, TV and/or fan	Lighting, mobile, TV, radio, AC loads	AC loads (buildings, services	Building AC loads; productive uses
Likely technology	Torch, candle, kerosene	Solar lanterns Pico PV system	Solar home system (DC or AC);	Residential PV system (AC); Mini-grid	Mini-grid On-grid	On-grid
Typical energy consumption (kWh/yr)		1.5-14.6	14.6-73	315-876	1,250-3,504	> 3000-4500

Source: EU SE4All, Technical Assistance Facility (TAF), *Sustainable Energy Handbook, Module 5.1* (2016)
ESMAP *Beyond Connection, Energy Access Redefined* (2015)

Table 7 Potential grid, mini-grid and off-grid (stand-alone) connections in Malawi

Connections (households, commercial, services)	Current situation (2016)	SE4All targets 2020-2030		DFID Low-carbon mini-grid study (potential, 2013) [million]
Connected to the grid	321,000	0.64-1.51 million	Grid-connected	5.056
Mini-grids	900	9,000-13,500	Small & mini grids	
Off-grid: solar home	900	50,000-75,000	- hydro	2.273
Off-grid: pico-solar	300,000	0.30-4.5 million	- solar	2.209
Not connected		-	- wind, biomass	0.264
Total			Off-grid	7.156
			Total	16.778

Source: *Support to SE4All Action in Malawi, draft Action Agenda* (Ecoloner/Deloitte, 2016);
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