PIONEERING POWER

Transforming lives through off-grid renewable electricity in Africa and Asia

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Terminology

We use the term 'off-grid systems' as a collective term to refer to stand-alone systems and also to mini-grids that are not connected to a larger centralised grid.

'Stand-alone systems' refer to electrification systems for individual appliances/users that are not connected to any grid outside of the individual user premises.

'Mini-grids' to refer to small grid systems linking a number of users who are not connected to a larger main power grid.

‘ENERGY IS THE GOLDEN THREAD THAT CONNECTS ALL THE SUSTAINABLE DEVELOPMENT GOALS…THAT MEANS TRANSFORMING THE WORLD’S ENERGY SYSTEMS. IT MEANS PROMOTING MODERN TECHNOLOGIES THAT CAN FULFIL ENERGY NEEDS WITHOUT POLLUTING THE ENVIRONMENT AND PUMPING GREENHOUSE GASES INTO THE ATMOSPHERE.’

António Guterres, Secretary-General of the United Nations

‘IT IS TIME FOR DECISION-MAKERS TO FULLY EMBRACE THE TRANSFORMATIVE POWER OF DECENTRALISED SOLUTIONS – ROOFTOP SOLAR AND RENEWABLE MINI-GRIDS IN PARTICULAR – TO IMPROVE THE DELIVERY OF EDUCATION, HEALTH CARE, CLEAN WATER, IRRIGATION AND THE MANY OTHER BENEFITS.’

Adnan Amin, the Director-General of the International Renewable Energy Agency

‘WE ARE IN A RACE AGAINST TIME TO REACH OUR 2030 ENERGY GOALS AND TO GET THERE WE WILL NEED A LOT OF INVESTMENT AND A LOT OF MONEY – BOTH PRIVATE AND PUBLIC.’

Riccardo Puliti, Senior Director and Head of energy and extractives at the World Bank

CONTENTS

PIONEERING POWER

Transforming lives through off-grid renewable electricity

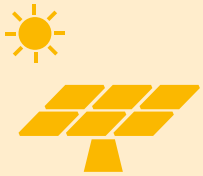
ON THE CURRENT PATH, ALMOST 700 MILLION PEOPLE WILL STILL LIVE WITHOUT ELECTRICITY IN 2030

7 AFFORDABLE AND CLEAN ENERGY

OFF-GRID RENEWABLE ELECTRICITY OFFERS A NEW PATH TO ENSURE THAT EVERYONE HAS ELECTRICITY

✔Cheaper ✔Faster ✔More reliable ✔Safer ✔Cleaner

…than grid electricity, diesel and kerosene, in many places.



'BEFORE I BOUGHT A SOLAR PANEL I USED TO USE A KEROSENE LAMP. I USED TO HAVE A LOT OF HEALTH PROBLEMS, THE SMOKE AFFECTED MY CHEST AND I FELT CHEST PAINS. NOW I FEEL THAT MY LIFE HAS CHANGED BECAUSE I HAVE SOLAR.'

Grace, a 66-year-old entrepreneur in Tanzania, no longer has these health problems and has increased her income by 22–44 USD every month since buying a solar panel.

OFF-GRID RENEWABLE ENERGY IS A CATALYST TO TRANSFORM LIVES, IMPROVING HEALTH AND OTHER SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

SDG 3

Almost a third of hospital burn patients have been injured by kerosene fuel exploding while using kerosene lamps in Nigeria.

4 QUALITY EDUCATION

SDG 4

Primary and secondary school completion rates increased from less than half to nearly 100 per cent after providing solar electricity in Tanzania.

5 GENDER EQUALITY

SDG 5

Small enterprises specialising in solar lamps and home systems are empowering women to become leaders of their own decentralised energy businesses in Nepal.

8 DECENT WORK AND ECONOMIC GROWTH

SDG 8

Renewable technologies have the potential to employ 1.8 million people in sub-Saharan Africa alone.

13 CLIMATE ACTION

SDG 13

The full transition to decentralised renewable technologies could be equivalent to removing 1.6 million mid-sized cars from the roads in Nigeria.

THREE-POINT PLAN FOR GOVERNMENTS

SUPPORTED BY DONORS, DEVELOPMENT BANKS, THE PRIVATE SECTOR AND CIVIL SOCIETY

Develop a roadmap with national targets to scale up off-grid renewables so that everyone has sustainable and affordable electricity by 2030.

Build a strong enabling environment to improve confidence of investment in decentralised renewables.

Improve monitoring and reporting frameworks to track investment in off-grid renewables and the impact on improving energy access.

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EXECUTIVE SUMMARY

This report examines the challenge of how to bring power to over one billion people who live without electricity, mostly in very remote, rural areas in sub-Saharan Africa and South Asia. Countries in Africa and Asia need reliable energy to power economic development, and off-grid renewable electricity offers new ways to provide reliable sources of energy. African and Asian countries also have the opportunity to become world leaders in renewable energy.

This report demonstrates that off-grid renewable electricity, particularly solar, now offers a wider range of modern solutions, such as solar lamps and stand-alone solar panels, that are often cheaper, faster, more reliable, safer, and cleaner than extending a centralised grid, or using kerosene and diesel. This technology is a game changer to power people in rural areas and is challenging the historical approach that extending a centralised grid is the best way to electrify a whole country. Faster progress is needed. Under a business-as-usual scenario, almost 700 million people will still be without access to electricity in 2030, mostly in sub-Saharan Africa. That is equivalent to double the population of the UK and USA combined.

Off-grid renewable electricity, especially solar, provides the most viable way to ensure that everyone has access to electricity in rural areas (contributing to Sustainable Development Goal (SDG) 7), according to the International Energy Agency (2017). It offers a bottom-up and demand-led approach that can complement a top-down planning approach based on the grid.

Drawing on five case studies from the Democratic Republic of the Congo (DRC), Nepal, Nigeria, Myanmar and Tanzania, these country examples show that off-grid renewable electricity can also contribute to the transformation of lives by improving health (SDG 3), education (SDG 4), gender equality (SDG 5), income generation (SDG 8) and environmental sustainability (SDG 13). There are many challenges that prevent the growth of off-grid renewable electricity and getting electricity into the hands of those who need it most, and this report makes recommendations to overcome these barriers in the policy environment.

'FOR A LONG TIME, THERE WAS NOTHING. THE DAYS WERE DARK. AT NIGHT, WE COULD ONLY SLEEP. NOW THE HYDROPOWER IS HERE, IT IS LIKE HEAVEN.'

Sanjeev, 58, a carpenter in Nepal

A cheaper source of energy

Off-grid renewable electricity, like solar and small-scale hydropower, is generally cost-competitive and can be more cost-effective than grid electricity, diesel and kerosene in some country contexts.

Rapidly developing renewable technology is providing new options for millions of people beyond the grid. The costs of renewable energy options like solar are plummeting and will continue to fall, making investments more attractive for consumers, policymakers and private investors, while the costs of fossil fuels fluctuate.

For example, in rural areas of Myanmar, the projected capital costs of connecting to the central grid in the future are more than double (at 819 USD per household) the cost of connecting to solar mini-grid pilot projects (357 USD on average).

The falling cost of renewables has brought the price of solar lamps and solar home systems (SHSs) within reach of many low-income households in developing countries, and made solar and small-scale hydropower more cost-effective than diesel generators, for example in Myanmar and Nigeria. The market for pay-as-you-go and mobile money payment mechanisms has grown, which is also reducing the cost of entry-level power by bringing solar lamps and SHSs to consumers.

In sub-Saharan Africa, off-grid and mini-grid renewable energy like solar is recommended as the lowest-cost solution to reach three-quarters of people without electricity, mostly in remote areas, based on geospatial modelling by the International Energy Agency.

'IT WOULD BE EXPENSIVE TO BURN ENOUGH CANDLES TO GET THE SAME AMOUNT OF LIGHT AS FROM SOLAR.'

Biak Ku from Ma Kyauk Ar village, Myanmar. The average household in the area spends a quarter of their monthly income on candles.

A faster delivery of energy

Off-grid renewable electricity provides access faster than extending the grid to rural areas.

The grid has a role to play in bringing electricity, especially in urban areas. However, it mostly serves wealthier households and progress is too slow. Investments in grid extension take too long, whereas people can set up solar lamps and SHSs in just a few days or weeks, rather than waiting years or even decades for the grid to be extended.

Despite this, research has found that large-scale grid development and extension is still the main focus for governments to increase access to electricity in these five countries, and many others in Africa and Asia. In addition, government subsidies can support traditional alternatives, such as kerosene and diesel, that are dangerous, unhealthy and expensive.

'A LOT OF AREAS STILL AREN'T CONNECTED. TRYING TO CONNECT VILLAGES TO THE NATIONAL GRID IS A LONG WAY OFF. THERE'S A LOT OF CAPACITY IN TERMS OF PUTTING IN MICRO-HYDRO PLANTS THAT WILL HELP A VILLAGE AREA.'

Peter Lockwood, Programme Advisor for United Missions of Nepal

A more reliable source of energy

Household solar, mini-grids and small hydropower can offer alternative, more reliable and secure supplies of electricity, compared to unreliable grid connections or diesel generators in regions experiencing intermittent fuel supply.

For example, electricity production in Nepal is almost entirely from hydropower but the country's electricity system is unreliable and a quarter of power is lost in transmission. Power cuts in rural Nepal can last nine hours, putting health clinic patients' lives at risk from an absence of lighting or the failure of oxygen machines. Whereas, health care has improved in health clinics that are powered by solar, as they are no longer forced to rely on diesel generators.

'THE BIG CHALLENGE I HAD LAST YEAR WAS ELECTRICITY... BECAUSE WE USE COMPUTERS IN OUR FACULTY AND WE WERE NOT ABLE TO PLUG IN EVERY TIME. BUT THIS YEAR WE HAVE SOLAR PANELS AND WE ARE ABLE TO WORK WHENEVER WE WANT, EVEN AT NIGHT.'

Naomi, a student in Applied Sciences at the Bilingual Christian University of Congo, DRC

A catalyst to transform lives

Off-grid electricity like solar and small-scale hydropower often provides people with electricity for the first time. It can improve health, air quality, women's empowerment, safety, education, and open up opportunities for new sources of income, savings and setting up small enterprises. It can also be used in humanitarian and conflict situations.

'ACCESS TO ELECTRICITY IS A CENTRAL BUILDING BLOCK FOR SOCIO-ECONOMIC DEVELOPMENT. IT EMPOWERS COMMUNITIES TO INCREASE INCOME AND PRODUCTIVITY, GAIN ACCESS TO HEALTH CARE AND EDUCATION, ENHANCE WATER AND FOOD SECURITY, AND IMPROVE GENERAL WELL-BEING.'

Adnan Amin, the Director-General of the International Renewable Energy Agency

During 2017, hundreds of thousands of Rohingya refugees fled from Myanmar into neighbouring Bangladesh. For many, a solar panel was one of the few things they carried with them, or that they bought on arriving in Bangladesh. In Kutapalong camp, Radika, 38, uses the solar power charging station to charge her mobile phone so she can stay in contact with a relative back in Myanmar.
Photo: Andrew Philip/Tearfund

Safer, healthy lives (SDG 3)

Traditional fuels like kerosene and candles are dangerous as they can cause accidents and create fire hazards. In Nigeria, almost a third of hospital burn patients have been injured by kerosene fuel exploding while using kerosene lamps. Children can also suffer from poisoning after drinking kerosene by mistake, as it is sold in bottles and looks like water. The toxic fumes from both kerosene and small diesel generators contribute to indoor and outdoor air pollution, which leads to conditions such as respiratory illnesses, strokes, cancer, kidney damage and blood clots. Switching from kerosene and diesel to solar power reduces all of these risks.

'BEFORE I BOUGHT A SOLAR PANEL I USED TO USE A KEROSENE LAMP. I USED TO HAVE A LOT OF HEALTH PROBLEMS, THE SMOKE AFFECTED MY CHEST AND I FELT CHEST PAINS. MY EYES DIDN'T WORK PROPERLY, EVEN THE ATMOSPHERE WAS NOT GOOD.' NOW GRACE DOES NOT HAVE THESE PROBLEMS ANYMORE: 'NOW I FEEL THAT MY LIFE HAS CHANGED BECAUSE I HAVE SOLAR.'

Grace, 66, an entrepreneur in Makutupora, Tanzania

Inclusive and equitable education (SDG 4)

Almost two-thirds of schools in Africa don't have electricity. Without electricity, children's ability to get a decent education is severely affected. This means no power for computers, the internet, televisions and radios for information.

In Tanzania, after providing solar electricity, primary and secondary school completion rates increased from less than half to nearly 100 per cent. Solar power has also enabled basic computer classes to be held and has improved teacher retention rates in Tanzania's rural areas. And solar, installed in ten villages, powered households and six schools – increasing study hours and improving literacy rates and performance in national exams.

After switching to solar, over a quarter of SolarAid and SunnyMoney (a solar company) customers interviewed in East and Southern Africa used the savings for school fees and education.

'CHILDREN WHO HAVE ACCESS TO ELECTRIC LIGHTING ARE DOING BETTER [IN SCHOOL] THAN THE ONES WHO DO NOT HAVE ACCESS.'

A school teacher in Ma Kyauk Ar village, Myanmar

Gender equality and empowerment (SDG 5)

Off-grid renewable electricity can improve women's economic empowerment, including through access to financial services and participation in public life, the creation of jobs and business opportunities.

In Tanzania, through a network of women entrepreneurs, most Solar Sister (solar company) customers have substituted kerosene with solar lamps, using the savings for school fees, farming inputs and investment in businesses.

'LIGHT WAS EXPENSIVE, LIKE BUYING KEROSENE, BUT WITH ELECTRICITY THERE ARE A LOT OF THINGS WE CAN DO AT NIGHT. I AM BUSY IN THE AFTERNOONS SO NOW I CAN USE THE TIME IN THE EVENINGS.'

Rachel is a tailor in Makutupora in central Tanzania. Now that she has a solar light, she can work in the evenings, making clothes to sell to people in the village. By working three or four hours each evening, she has increased the family's monthly income from 70–80,000 TZS (31–35 USD) to sometimes as much as 150,000 TZS (66 USD).

Economic empowerment and growth (SDG 8)

At present, bottlenecks in the energy sector and power shortages are estimated to cost the African continent between two and four per cent in GDP losses. The decentralised renewable energy sector can create a vibrant market, providing jobs to the local population. Renewable technologies have the potential to employ 1.8 million people in sub-Saharan Africa alone. In DRC, connecting energy-poor households to off-grid and mini-grid electricity solutions would create a market worth 921 million USD a year, by one estimate.

In East Africa, SunnyMoney, has reported an average increase in income of almost a third for its network of 600 solar distributors (as compared with previous employment).

'THE MICRO-HYDRO PLANT MAKES A BIG DIFFERENCE – LIKE THE DIFFERENCE BETWEEN THE LAND AND THE SKY. BEFORE I FELT SO SAD. NOWADAYS I AM HAPPY. BEFORE I HAD VERY DIFFICULT WORK. NOW IT IS VERY EASY. I AM WORKING FULL-TIME AT MY BUSINESS, AND I AM ENJOYING IT AND EARNING ENOUGH MONEY.'

Hari, 49, lives close to the village of Chanitar in Nepal. From early childhood, he wanted to work as a carpenter. Since the micro-hydropower plant was installed, he has been able to open a sawmill.

Cleaner energy: reducing air pollution and tackling climate change (SDG 13)

The energy sector as a whole is responsible for about two-thirds of global greenhouse gas emissions. Off-grid renewable energy offers clean development, rather than getting locked into increasing emissions through grid and off-grid fossil fuel energy options. It provides a way to leapfrog traditional grid-based power lines to low carbon pathways, in line with the Paris Agreement climate goals.

For example, in Nigeria, the full transition to decentralised renewable technologies could mean reducing carbon dioxide emissions by 6.4 million tonnes each year, which is equivalent to removing 1.6 million mid-sized cars from roads.

Switching from kerosene to solar lamps reduces the toxic and soot-like black carbon emissions that have a large impact on climate change and air pollution.

Barriers

Despite these benefits, many governments, donors and international finance institutions are not yet convinced of the critical role that off-grid renewable electricity can play in the energy sector. Many countries have been electrified through a grid and most national energy policies have been built around this approach in the past. Overall, the governments of the five case study countries in this report – DRC, Nigeria, Tanzania, Myanmar and Nepal – continue to focus on the role of centralised and grid-connected energy in energy sector development. However, energy policies have not kept pace with rapid developments in new energy technology, and countries are missing opportunities to achieve electrification.

There are many challenges that prevent the growth of decentralised renewables. Research in these five countries found barriers in the enabling environment for decentralised renewables, including:

- **Inadequate policies and a lack of policy coherence** – such as the lack of a clear framework and bureaucracy for developing mini-grids – can be particularly challenging for private investment. And government officials' limited expertise in off-grid renewable electricity hampers their ability to design effective policies and ensure implementation. Mini-grids require effective national governance frameworks. In Nigeria, local governance frameworks were developed by Plateau State in the absence of effective national frameworks, which can be led by the government or community.
- **A lack of access to finance** affects the ability to invest in off-grid renewable electricity. For example, in Nigeria, stringent banking regulations affect competition and the development of mobile banking. In Nepal, complex procedures and high interest rates reduce lending to lower-income households and small- and medium-sized enterprises (SMEs).
- **Fiscal barriers**, for example, high tariffs for off-grid solar products or components, such as solar batteries in Nigeria, are a constraint on imports which reduces the cost-competitiveness of solar systems, and different tariffs for renewable energy components create confusion for customs officers.
- **Subsidies:** a high level of public subsidy for on-grid electricity and off-grid fossil fuels discourages private investment in renewables and does not provide a level playing field for off-grid electricity. This is evidenced in the case of Myanmar and Nepal, for example.
- **Low-quality solar products and a lack of quality standards** in most of the five countries results in a poor reputation for solar energy, which hampers the retention of solar customers and growth in solar markets.
- **Low levels of consumer awareness** of solar power prevent the expansion of solar markets in most of the five countries.

'I FELT THE DARKNESS WITHOUT ELECTRICITY. WE WERE LIVING UNDER THE DARK. NOW WE FEEL LIGHT AND WE ARE LIVING UNDER LIGHT – ELECTRICITY LIGHT.'

Ram Bahadur, 26, is a micro-hydro technician in Mahadevsthan, Nepal

Policy recommendations

Modern, affordable, reliable and safe energy is achievable for everyone by 2030 (SDG 7) if policymakers, practitioners and investors seize the opportunities and solutions that off-grid renewable energy offers. Improving energy access will also contribute to reducing poverty, boosting inclusive growth, and achieving development and climate change goals.

National energy policies need to harness the potential of decentralised renewable technology options to scale up and speed up access to electricity, rather than relying mainly on a grid approach, which is unlikely to reach energy-poor households in remote rural regions.

Other actors – in particular, bilateral and multilateral donors including the Department for International Development (DFID), development banks including the World Bank, and the private sector and civil society – should continue to play a significant role in promoting the role of decentralised renewables and improving the enabling environment.

It is also vital to improve monitoring systems and data gathering to monitor progress on investments aimed at accelerating energy access, as currently, countries and donors do not systematically track electrification through decentralised renewables.

1 Develop an 'energy access roadmap' which sets clear national targets to achieve access to modern, sustainable and affordable energy by 2030, or earlier

National governments in low-income countries, especially those with low rates of energy access, should:

- **integrate a decentralised approach** of off-grid and mini-grid solutions with the existing centralised grid approach in energy policies and financing;
- **set targets for off-grid and mini-grid renewable electricity solutions** to achieve energy access – this will send a market signal of the country's commitment to encourage the entrance of private sector actors;
- **use the cost-effectiveness of different energy technologies** to identify areas that are more suitable and are priorities for off-grid and mini-grid systems;
- **strengthen coordination and policy coherence** between energy and other government ministries and sectoral plans in order to capitalise on the development gains from off-grid renewable electricity.

Bilateral and multilateral donors and international finance institutions should:

- **shift from prioritising a fossil fuel grid approach and infrastructure to prioritising decentralised renewable energy**, in line with the International Energy Agency recommendation that almost three-quarters of additional energy spending should go towards off-grid and mini-grid renewable energy in order to ensure universal access to energy by 2030 (SDG 7);
- **develop energy access plans as a key pillar of their energy strategies** to show how they will scale up their technical and financial support for off-grid and mini-grid solutions in order to meet SDG 7.

2 Build a strong business and supportive enabling environment to improve confidence of investment in decentralised renewables

National governments, donors and international finance institutions should overcome barriers, for example by:

- **strengthening policy frameworks** and market conditions for renewable energy mini-grids that provide higher tiers of energy access, for example through fast, low-cost licence and permitting processes;
- **promoting innovative business models and pay-as-you-go mobile systems** so that low-income households can afford the upfront cost of renewable energy products and pay in instalments;

- **facilitating the import of renewable energy products** with supportive tax policies, including tax exemptions and low tariffs to incentivise investment, and providing clarity and transparency in fiscal policies –they should also ensure effective implementation through training customs officials;
- **promoting public–private cooperation and multi-stakeholder platforms** that include civil society, to improve coordination in the energy sector and provide a united force to accelerate electrification;
- **improving quality and safety standards** and accountability mechanisms so that consumers can put their trust in reliable and high-quality products.

3 Improve the monitoring and reporting frameworks for energy access

National governments, donors and international finance institutions should:

- **track investments in off-grid renewable electricity** as a share of total support for energy, and report on investments to improve transparency;
- **carry out impact assessments** to improve data on the development impact of investments on energy access and poverty reduction;
- **use meaningful metrics to measure the quality of electricity access** – including affordability, reliability and safety, building on the World Bank's Global Tracking Framework and Multi-Tier Framework surveys; there should be a focus on the perspective of energy service users to provide an accurate picture of the real levels of access to electricity.

'FOR MOST ENERGY SYSTEMS, THE RULES WERE WRITTEN FOR CENTRALISED AND GRID-CONNECTED THERMAL POWER GENERATION, AND THAT'S GOT TO SHIFT. AS IT SHIFTS, YOU'RE SEEING COUNTRIES REALLY BE REWARDED BECAUSE THE PRICE OF RENEWABLES HAS COME DOWN SO FAR.'

Rachel Kyte, Special Representative of UN Secretary General and CEO of Sustainable Energy for All

1 INTRODUCTION

The *2030 Agenda for Sustainable Development* includes the Sustainable Development Goal (SDG) to 'ensure access to affordable, reliable, sustainable and modern energy for all' by 2030 (SDG 7). Globally in 2016, one person in seven (almost 15 per cent of the population) lacked access to electricity, defined as the availability of an electricity supply to a household. Energy poverty – the lack of access to modern energy services, such as electricity and clean cooking fuels – is now increasingly localised in remote, rural regions of the world, particularly in Africa and Asia.[1] Access to electricity has traditionally been delivered through grid-connected fossil fuels.[2] Grid connections for dispersed populations are becoming increasingly cost-prohibitive, with prolonged timelines for grid extension. Decentralised renewable energy solutions,[3] which may be grid-connected or off the grid, using sources of energy such as sunlight, wind and water, present opportunities that are increasingly cost competitive.

Tearfund commissioned the Overseas Development Institute (ODI) to conduct a literature review on the impact and value for money of off-grid renewable electricity on poverty reduction and economic development. This report summarises evidence on the cost-effectiveness of off-grid renewable electricity and how it can contribute towards the achievement of several SDGs. It firstly provides a global perspective on meeting SDG 7, with a focus on Africa and Asia. It highlights the linkages and the role of off-grid renewable electricity as an enabler for SDG 3 (healthy lives), SDG 4 (equitable and inclusive education), SDG 5 (gender equality), SDG 8 (economic growth, employment and decent work) and SDG 13 (tackling climate change). The report then looks at the policy barriers, enablers and opportunities for off-grid renewable electricity in five countries: the Democratic Republic of the Congo (DRC), Myanmar, Nepal, Nigeria and Tanzania. A total of nine key informants were interviewed across the five selected countries about the challenges and opportunities in the country's enabling environment for off-grid renewable electricity. The interviews, conducted over Skype, focused on political economy and fiscal aspects, complementing factual evidence from the literature.

Time and data limitations have prevented a more comprehensive analysis of the development impacts and political economy considerations for decentralised electricity solutions in the five countries. Further research, focused on the enabling environment and political economy analysis, would help identify more specific policy recommendations.

The report focuses on off-grid electricity provided by solar lamps,[4] solar home systems (SHSs)[5] and renewable energy mini-grids. These are classified according to the tier of energy access provided.[6] Solar lamps have a capacity of up to ten watts, enabling low levels of access (Tiers 0 and 1). For example, solar lamps of less than 1.5 watts can power a single light. Above 1.5 watts, they can also provide mobile phone charging, and above three watts they can power multiple lights. SHSs are larger solar products with a capacity of 11 to over 100W. They can also provide power for radios, fans or televisions (providing access up to Tier 2). Some larger SHSs can provide access at Tier 3, powering appliances such as refrigerators and food processors.[7] Mini-grids[8] can be described as 'one or more local generation units supplying electricity to domestic, commercial or institutional consumers over a local distribution grid'.[9] They include systems ranging in capacity from a few kilowatts to as

1 International Energy Agency (IEA) (2017) *Energy access outlook 2017: from poverty to prosperity*, Paris, International Energy Agency

2 Ibid.

3 Renewable energy is defined as energy that is obtained from renewable sources (ie sources that can be replenished) such as sunlight, wind and geothermal resources.

4 A solar lamp is defined as a single light (light bulb) powered by a solar photovoltaic (PV) cell. Some solar lights also have a socket that enables mobile phone batteries to be recharged.

5 An SHS is defined as a stand-alone PV system, comprising a solar panel or multiple panels connected to a charge controller, inverter and battery, which can supply appliances as well as multiple lights.

6 Tiers of energy access can be defined as the level of access to electricity, as described by the Multi-Tier Framework (MTF) in terms of capacity, hours of service and qualitative attributes. There are six tiers of access, from Tier 0, the lowest, to Tier 5, the highest. The MTF aims to measure the quality of energy supply provided; household-relevant energy access finance is allocated to five 'tiers' – from Tier 1 ('very low level of access') to Tier 5 ('very high level of access'), based on the MTF developed by the World Bank and supported by SEforALL (Bhatia and Angelou, 2015).

7 GOGLA, Lighting Global, World Bank Group, Berenschot (2016) *Global off-grid solar market report: semi-annual sales and impact data: July–December 2016,* Utrecht, Global Off-grid Lighting Association

8 A mini-grid is defined as a small electricity generation unit serving several premises, connected by a localised distribution network. Some mini-grids are connected to the national grid.

9 Deshmukh R, Carvallo JP, Gambhir A (2013) *Sustainable development of renewable energy mini-grids for energy access: a framework for policy design*, Clean Energy Ministerial

much as ten megawatts.[10] Renewable energy mini-grids can be based on biomass and wind as well as, more commonly, solar and hydropower. Biomass and wind are not considered in detail in this report. Although mini-grids can, in principle, provide up to the top level of access (Tier 5), most of those connected to mini-grids receive access up to Tier 3.

CASE STUDY

Micro-hydropower connects remote households with the world

Eight years ago, a micro-hydropower plant was built in the village of Mahadevsthan, Nepal. The village is remote, and before having micro-hydro it was very isolated. There were many challenges for the people living there. Businesses did not have access to electricity so work was time-consuming and slow, relying on manual tools. It was hard to make a living. Families used firewood for cooking and kerosene lamps for light, which harmed children's health. Schoolchildren could not study full-time.

Now the power plant – which has a capacity of 26kW – provides electricity to 335 households, three sawmills, three rice mills, 20 poultry farms, three schools, one health clinic, one police station and one community building. In the past, the schools taught computer studies but didn't have any computers. Now, their studies are no longer theoretical; they have computers to learn on. Each household now has a television. Ram Bahadur, the technician for the micro-hydro plant, says this makes people feel more connected to the wider world: 'Living in their own home, they can see the world through the internet.'

Ram Bahadur, 26, started working at the micro-hydro plant when it opened. Having this job means that he can work close to where his family, including his mother and father, live. Other communities in the area still want, but don't yet have, access to electricity. When asked how the micro-hydropower plant had changed his life and his community, Ram Bahadur replied, 'I felt the darkness without electricity. We were living under the dark. Now we feel light and we are living under light – electricity light.'

Photo: Kit Powney/Tearfund

10 ESI (2016) *Renewable mini-grids: unlocking Africa's rural powerhouse*; SEI International (2016) *Renewable energy mini-grids: an alternative approach to energy access in southern Africa*, Stockholm, Stockholm Environment Institute

2 THE GLOBAL CHALLENGE OF ENERGY ACCESS AND THE STATUS IN FIVE COUNTRIES

Ensure access to affordable, reliable, sustainable and modern energy for all (SDG 7)

Over one billion people who are without electricity face challenges as they seek to find their own way out of poverty.[11] Living in remote rural areas of Africa and Asia,[12] they do not have access to the central grid. When the grid is extended, average connection costs increase as people closer to the grid are connected, and timelines are prolonged. These infrastructural and financial barriers mean that millions of people lack electricity in their homes, businesses, schools and health clinics. Under a business-as-usual scenario, nearly 700 million people will still be without access to electricity in 2030, the majority in sub-Saharan Africa.[13] Relying solely on grid-connected solutions means SDG 7 will not be met under current rates of progress. Countries are, however, increasingly recognising the important role of decentralised electricity services, such as solar and micro-hydro off-grid and mini-grid systems, for low-tier energy access solutions. By 2040, the African Development Bank estimates almost three-quarters (70 per cent) of new rural electricity supply in sub-Saharan Africa will be from stand-alone and mini-grid systems.[14]

Phul Kumari brings her family's grain to grind it quickly in a watermill, powered by hydroelectricity, in Mahadevsthan, Dhading District in Nepal. See case study on page 21.
Photo: Kit Powney/Tearfund

Access to electricity ranges significantly across the five countries analysed in this report, from 15 per cent of the population in DRC to 77 per cent in Nepal.[15] This leaves tens of millions of people without access to modern energy, including up to 67 million energy-poor individuals in DRC alone. Energy poverty is particularly

11 IEA (2017) op. cit.
12 IEA (2017) op. cit.
13 IEA (2017) op. cit.
14 AfDB, SE4All Africa Hub and Sustainable Energy Fund Africa (2016) *Green mini-grids in sub-Saharan Africa: analysis of barriers to growth and the potential role of the African Development Bank in supporting the sector,* Energy 4 Impact
15 IEA (2017) *IEA statistics*. Available at: www.iea.org/statistics

stark in rural and remote regions. In Tanzania, for example, access to electricity is as low as 17 per cent in rural regions (compared with 65 per cent in urban areas);[16] in Myanmar, only 43 per cent of rural households have access to electricity compared with 79 per cent of urban households.[17]

On-grid energy solutions are the primary source of electricity in all five countries, but decentralised renewables are playing an increasing role in energy provision. Though decentralised electricity solutions are not well documented in DRC, there are a number of scattered and independent mini-grids.[18] Diesel generators currently deliver 50 per cent of this capacity,[19] with the remainder through hydropower mini-grids and a rising number of household solar products.[20] In Nigeria, decentralised generators provide two to three times more electricity than the central grid[21] – with between 8 and 14GW provided by diesel generators (for back-up power).[22] Decentralised renewable programmes are, however, on the increase in Nigeria. In Tanzania, there has been a history of energy development through decentralised solutions – and as of 2017, 300MW of decentralised power generation capacity had been installed in the country. This includes 93 mini-grids (mostly hydropower based), serving about 800,000 people, as well as diesel generators.[23] Tanzania also houses the second-largest African market for household solar solutions, after Kenya.[24]

In Myanmar, over 135MW of decentralised capacity had been installed by 2016, serving approximately 20,000 villages.[25] Most of this capacity comprised diesel generator sets, but hydropower mini-grid and solar projects are on the rise.[26] In Nepal, micro-hydropower has been a major pillar of energy development. Currently, 15 per cent of the Nepalese population has access to renewable electricity – and as of 2017, 30MW of micro-hydropower and 20MW of decentralised solar solutions had been installed in the country.[27]

CASE STUDY

The engineer bringing clean energy to his home village

Augustine Otuokwa Ogar grew up in Mgbaeshuo village in Eastern Boki, Nigeria; a village that was not connected to the electricity grid. Despite the challenges this caused, Augustine went on to study Electronic and Computer Technology at the University of Calabar, a few hundred miles away from the village where he grew up. After graduating, Augustine returned to his village – which still did not have access to electricity.

There is a small, slow-flowing stream in the village. Using the skills and knowledge gained from his degree along with locally sourced materials, Augustine developed an innovative hydropower generator that could turn that low flow rate into enough energy to generate 2kW of power – enough to light up local business centres so they can now sell their products at night. Young people are now able to charge their phones, laptops and batteries.

Augustine's plans go beyond this 2kW generator. He says, 'The people are waiting expectantly to see the community electrified by a power generator I will make with a higher capacity – to light up the entire village, state and nation.'

16 United Republic of Tanzania (2017) *Energy access situation report 2016, Tanzania mainland,* National Bureau of Statistics and Rural Energy Agency

17 IEA (2017) op. cit.

18 World Bank (2017) DRC Electricity Access and Services Expansion (EASE) Project, Combined Project Information Documents/Integrated Safeguards Data Sheet, PIDISDSA21011

19 IRENA (2011) *Prospects for the African power sector,* Paris, IRENA

20 IEA (2017) op. cit.

21 Key informant interview.

22 GIZ (2015) *Nigerian energy sector: an overview with a special emphasis on renewable energy, energy efficiency and rural electrification,* Bonn, GIZ

23 IRENA (2017) *Renewable Readiness Assessment: United Republic of Tanzania,* Abu Dhabi, IRENA.

24 Tice D (2017) *Energy Africa – plan of action Tanzania,* Evidence on Demand; Dalberg Advisers and Lighting Global (2018) *Off-grid solar market trends report 2018*, GOGLA and Lighting Global

25 Dobermann T (2016) *Energy in Myanmar,* London, International Growth Centre; Ministry of Livestock, Fisheries and Rural Development (2015) 'Rural electricity access', presentation to off-grid rural electrification in Myanmar workshop, Nay Pyi Taw, 28 January 2015

26 Thorncraft S, Wang P, Travill P, Tham HD (2017) 'Part B – IES scenarios', in WWF, REAM, Spectrum, IES (2017) *Myanmar's electricity vision: updating National Master Electrification Plan,* World Wildlife Fund

27 SREP (2017) *Upscaling mini-grids for least cost and timely access to electricity services*, SREP round table, Myanmar, 6 February 2017

3 THE COST-EFFECTIVENESS OF DECENTRALISED RENEWABLES

The cost of different energy options is highly variable across regions and countries. The report uses the levelised cost of energy[28] (LCOE) to deal with this variation and assess the cost-effectiveness of decentralised renewable technologies for electricity access. The global levelised costs of renewables have declined rapidly in recent years.[29] In many circumstances, renewable energy technologies have become cost competitive with the global LCOE of grid-connected fossil fuels. Decentralised renewable systems can also be cost competitive with off-grid fossil fuel technologies, such as diesel mini-grids. The LCOE of solar PV is plummeting, having declined by 58 per cent between 2010 and 2015,[30] making this option an increasingly viable solution to energy poverty in developing countries. The LCOE of a medium SHS is estimated at 0.55 USD per kW and for a micro-hydropower plant at 0.24 USD per kilowatt hour (kWh), compared with 0.60 USD per kWh for diesel generator sets.[31]

From a regional perspective, Asia is one of the most cost-competitive regions for all renewable energy options. Levelised costs are higher in Africa, but decentralised renewables are still often more cost-effective than traditional alternatives.[32] For example, while evidence suggests that African energy-poor households spend up to five per cent of their total income on kerosene lighting, SolarAid found that when small solar lamps are adopted, the product cost can be recouped in ten weeks and lighting expenditure falls to two per cent of annual income.[33]

Phul Kumari could not always afford to buy kerosene for lighting her home in Kalanga village, Dhading District in Nepal. Now her family has electric lighting from hydropower.
Photo: Kit Powney/Tearfund

28 The LCOE can be defined as the cost of a unit of energy (eg a kilowatt hour) from a specified energy technology, taking into account all costs (fixed and operating) over the lifetime of the equipment. These costs are discounted to reflect the time value of money.

29 IRENA (2017) *Renewables cost database*. Available at www.irena.org/costs

30 IRENA (2016) *Solar PV in Africa: costs and markets*

31 Comparison based on systems of 20kW capacity. World Bank (2017).

32 IRENA (2017) op. cit.

33 Acumen (2017) *An evidence review: how affordable is off-grid energy access in Africa?* London, Acumen; Solar Aid and SunnyMoney (2015) *Impact report: autumn 2015,* London, SolarAid

'WE BELIEVE VERY MUCH IN OFF-GRID AS THE BEST WAY TO REACH COMMUNITIES THAT ARE NOT CONNECTED TO THE GRID.'

Riccardo Puliti, Senior Director and Head of energy and extractives at the World Bank

At the country level, cost-effectiveness is one of the first aspects to be considered in making the case for decentralised renewables as a viable option for the remaining energy-poor households that are increasingly located in remote and rural regions – and hence not readily connected to the grid (financially and logistically). Myanmar demonstrates that the costs of household grid connections are higher (at 819 USD per household) compared with connection costs to solar mini-grid pilot projects (estimated at 357 USD on average).[34] In DRC, analysis of least-cost solutions finds that between 45 and 85 per cent of DRC's population would be best served by mini-grids and stand-alone systems (when compared with central grid access options).[35]

Some of the countries studied also have a cost-comparative advantage for certain decentralised renewable technologies. Of the five case study countries analysed, the costs (LCOE) of small hydropower are the lowest for Myanmar and Nepal, but the highest for Nigeria and second-highest in DRC. The LCOE estimates for solar PV, in comparison, are lowest for Myanmar but highest for Nigeria.[36] These cost considerations should be borne in mind when policymakers, and other energy sector stakeholders, make decisions on electrification projects and plans.

The country analyses highlight the cost-effectiveness of decentralised renewable solutions compared with grid-connected and off-grid fossil fuel options. In Tanzania, for example, the LCOE of solar PV (at 0.12–0.14 USD per kWh) was close to the global LCOE of fossil fuels in 2015.[37] Should the LCOE of fossil fuels in Tanzania approach the global LCOE, this would make solar a viable alternative to grid-connected thermal power plants. In Myanmar, technology improvements in distributed solar PV and very small-scale hydropower have made these solutions less expensive than diesel generators.[38] In Nigeria, the LCOE of small-scale hydropower and solar PV are both lower than for decentralised diesel generators.[39] In DRC, households spend up to 100 USD a year on kerosene, whereas entry-level solar lamps can cost as little as 5 USD.[40] Thus despite the initial product investment, savings are soon realised through avoided fuel costs. This creates a strong case for the cost-efficiency of addressing energy poverty through decentralised renewables.

'IT WOULD BE EXPENSIVE TO BURN ENOUGH CANDLES TO GET THE SAME AMOUNT OF LIGHT AS FROM SOLAR.'

Biak Ku from Ma Kyauk Ar village, Myanmar. The average household in the area spends a quarter of their monthly income on candles.

34 Nexant (2017) *ADB off-grid renewable energy*, Investment Forum, 9 May 2017

35 Deshmukh R, Mileva A, Wu GC (2017) *Renewable riches: how wind and solar could power DRC and South Africa,* International Rivers

36 Henbest S, Mills L, Orlandi I, Serhal A, Pathania R (2015) *Levelised cost of electricity: DFID 28 priority countries*, London, UK Department for International Development

37 IRENA (2014) *Renewable power generation costs in 2014: Executive summary,* Paris, IRENA; Scaling Up Renewable Energy Programme (SREP) (2013) *Investment plan for Tanzania*, available at: www.climateinvestmentfunds.org/sites/default/files/SREP_Tanzania_Investment_Plan_Design.pdf

38 Bloomberg New Energy Finance (2011) *Power to the people? PV and batteries for the 150 GW diesel market*, New York City, Bloomberg LP in, WWF, REAM, Spectrum and IES (2017) *Myanmar's electricity vision: updating National Master Electrification Plan,* World Wildlife Fund

39 The analysis shows that small-scale energy solutions remain more expensive than large-scale ones. However, with prohibitively high grid-connection costs in remote and rural regions, they remain essential for meeting SDG 7. Source: Heinrich Boell Stiftung (2017) *True cost of electricity: comparison of costs of electricity generation in Nigeria*, available at https://ng.boell.org/2017/06/19/comparison-costs-electricity-generation-nigeria-technical-report

40 Élan RDC (2015) 'Bringing clarity to solar energy in North Kivu'. Available at: www.elanrdc.com/latest-news/2015/8/27/bringing-clarity-to-solar-energy-in-north-kivu

4 TRANSFORMING LIVES AND CONTRIBUTING TO MANY SDGS

Each of the 17 SDGs is in some way connected to the production or use of energy.[41] This section summarises the evidence on SDGs gathered from the literature for off-grid renewable electricity.

Safer, healthier lives (SDG 3)

Solar power can improve people's health as they switch from kerosene and diesel fuels. Kerosene (used for cooking and lighting) and small diesel generators create both indoor and outdoor air pollution, and are major contributors to ill health, such as respiratory illnesses, burns caused by accidental household fires, headaches, child poisoning, kidney damage, blood clots,[42] cardiovascular disease, strokes and cancer[43] – and hence can impact negatively on national health and health budgets. Solar lighting, on the other hand, contributes to improved health, with reductions in coughing, flu-like symptoms, eye irritation and respiratory illnesses through improved indoor air quality.[44] SolarAid and SunnyMoney report that 60 per cent of customers who switched from kerosene to solar found an improvement in their health, with reductions in flu-like symptoms, eye irritation and respiratory illness.[45] Solar also reduces risks from accidents involving kerosene. In Nigeria, for example, almost a third of hospital burn patients are due to kerosene lamp explosions.[46]

> **'SOLAR IS SAFE BECAUSE THE FUEL IS SUNLIGHT.'**
>
> Man No in Saw Chaung village, Myanmar

Insufficient electricity affects one-third of health facilities in sub-Saharan Africa and Nepal,[47] and nearly half of those in Tanzania.[48]

> In Nepal, power cuts can last for up to nine hours and put patients' lives at risk, due to an absence of lighting or the failure of oxygen machines.[49]

Decentralised technologies offer opportunities for lighting and other energy services during central grid power outages.

Priya, 33, is a volunteer at a medical health post in Saleri, Nepal, which uses solar power for light, mobile charging and to heat water for sterilising medical equipment. Now that they have light, the medical staff and volunteers can help patients at night. Priya says, 'There's a brightness now – there are no dark corners, everything can be seen. It makes life easier and happier.'

Renewable mini-grids serving health facilities can improve health care, through night-time operation, as well as reduce energy expenditure through savings on fuel.[50] They also enable the use of technologies such as

41 Nerini F et al. (2018) 'Mapping synergies and trade-offs between energy and the Sustainable Development Goals', *Nature Energy,* vol 3, pp 10–15

42 Acumen (2017) op. cit.; BNEF, Lighting Global, World Bank Group and Gogla (2016) *Off-grid solar market trends report 2016*; Eckley L, Harrison R, Whelan G, Timpson H (2014) *The social value of solar lights in Africa to replace the use of kerosene: scoping report,* Liverpool, John Moores University, Centre for Public Health

43 World Health Organisation (2017) *Air pollution impacts*, WHO website. Available at: www.who.int/airpollution/ambient/health-impacts/en

44 Acumen (2017) op. cit.; BNEF et al. (2016) op. cit.; Eckley et al. (2014) op. cit.

45 SolarAid and SunnyMoney (2015) *Impact report 2015*, London, SolarAid

46 BNEF et al. (2016) op. cit.

47 Africa Progress Panel (2017) *Lights, power, action*. Available at: www.africaprogresspanel.org/wp-content/uploads/2017/03/APP_Lights_Power_Action_Web_PDF.pdf

48 Ibid.

49 Balch O (2014) 'Rent to own solar systems hope to prevent blackouts in Nepal's hospitals', *The Guardian*, 18 August 2014

50 Alliance for Rural Electrification (2014) *Hybrid mini-grids for rural electrification: lessons learned,* Brussels, ARE; Council on Energy, Environment and Water (CEEW) (2017) *New research: rooftop solar can bridge India's gap in rural health services,* New Delhi, CEEW and Oxfam India

water filtering systems, refrigerators to store vaccinations in health clinics, and televisions to improve health knowledge.[51] Anecdotal evidence from Nepal finds that the installation of solar systems has improved lighting for night-time births, hence also reducing maternal and child mortality rates.[52] In the Ludewa district of Tanzania, anecdotal evidence suggests that community-owned hydro mini-grids have improved the retention of medical staff and enabled the use of microscopes and refrigerators (to store medical supplies). This has also had a positive impact in reducing child and maternal mortality rates.[53] In Myanmar, solar-powered refrigerators are enabling communities to store anti-venom for dangerous snake bites from the Russell's viper, responsible for 500 deaths annually.[54]

In Nepal, distributed solar systems played an important role in the country's health recovery following the 2015 earthquake. Their deployment to relief workers and in health facilities reduced the reliance on expensive diesel generators or kerosene and candles, which can create a fire hazard.[55] Certain civil-society organisations also financed and distributed solar-powered water purifiers in rural regions to promote recovery in remote villages and households.[56]

CASE STUDY

Saidi and Mariam's child no longer has breathing problems

Saidi and Mariam are farmers in the village of Makutupora in the Dodoma region of Tanzania. They have five children aged between 6 and 22. Saidi comes from Itigi in Singida region, and Mariam has lived in Makutupora her whole life.

They joined a Tearfund-supported community savings group (called 'Pamoja', which means 'together') in January 2017 when they heard how others had benefited from these groups. That year, they were able to use a loan from Pamoja to buy a solar panel for 170,000 TZS (75 USD), which they chose because they had heard it was easy to use compared with other energy sources.

Saidi and Mariam use the solar panel at home – for lighting so their children can study at night, and to power the radio so they can hear news from around the world. In the past, they had to travel to another village to charge their mobile phones; now they can do it in their own home.

One of the biggest benefits has been to their children's health:

'We had to use a torch and kerosene lamp before we had solar. Because of smoke, one of our children got a problem in her chest. She had breathing problems.' Now they have solar power, these breathing problems have stopped.

Saidi and Mariam are thinking of taking out another loan in the future so that they can buy another, bigger solar panel for their family.

Photo: Sarah Edwards/Tearfund

51 Brent W (2017) 'India: interlinking the SDGs through electricity access', IISD, available at: http://sdg.iisd.org/commentary/guest-articles/india-interlinking-the-sdgs-through-electricity-access; Asaduzzaman M et al. (2013) *Power from the sun: an evaluation of institutional effectiveness and impact of solar home systems in Bangladesh*, Washington DC, Bangladesh Institute of Development Studies; Khandker SR et al. (2014) *Surge in solar-powered homes: experience in off-grid rural Bangladesh*, Washington DC, World Bank; Lemaire X (2016) *Household solar: extent of evidence relating to the impacts of household solar,* London, Evidence on Demand, Department for International Development

52 https://ne2y.com/how-solar-powered-suitcases-are-helping-babies-in-nepal

53 Odarno L (2017) *Electrifying Africa with mini-grids: five Lessons from Tanzania*, WRI, available at www.wri.org/blog/2017/10/electrifying-africa-mini-grids-five-lessons-tanzania; TaTEDO and WRI (2017) *Accelerating minigrid deployment in sub-Saharan Africa: lessons from Tanzania,* Washington DC, World Resources Institute

54 Balch O (2016) 'Off-grid solar to help Myanmar bring electricity to all by 2030', *The Guardian*. Available at: www.theguardian.com/sustainable-business/2016/dec/02/off-grid-solar-to-help-myanmar-bring-electricity-to-all-by-2030

55 Lohan T (2015) 'How solar is lighting the way for recovery in Nepal', *The American Prospect*. Available at: http://prospect.org/article/how-solar-lighting-way-recovery-nepal

56 Tweed K (2015) 'How solar is playing a role in Nepal's disaster relief', *GreenTech Media*. Available at: www.greentechmedia.com/articles/read/role-for-solar-in-nepal-disaster-relief#gs.3V3SCfY

Inclusive and equitable quality education (SDG 4)

Almost two-thirds of schools in Africa don't have electricity.[57]

The years of schooling that an individual receives are positively linked to health and economic outcomes.[58] Decentralised renewables, such as SHSs and mini-grids, can improve lighting conditions in schools and create opportunities for night-time classes for those who are unable to attend during normal class hours, or for computer classes (as evidenced in the cases of Tanzania, Myanmar and Nepal).[59] Access to modern lighting in homes can increase the number of hours available at night for children to study, as well as for teachers to plan lessons.[60] However, different studies have shown both positive and zero effects of study hours on school performance and completion rates.[61] Gender and age have been found to be determinants in the ability to access such household lighting solutions – with the younger generation or girls missing out.[62] Decentralised renewables can therefore create or reinforce gender- or age-based differences in educational opportunities.

'CHILDREN WHO HAVE ACCESS TO ELECTRIC LIGHTING ARE DOING BETTER [IN SCHOOL] THAN THE ONES WHO DO NOT HAVE ACCESS.'

A schoolteacher in Ma Kyauk Ar village, Myanmar

A survey conducted in the Karen and Kachin regions of Myanmar[63] found that half of female and a quarter of male respondents identified the main benefit of access to electricity as the enhancement of their children's education.[64] In Tanzania, primary and secondary school completion rates increased from less than half to nearly 100 per cent upon the provision of solar electricity.[65] Solar power has also enabled basic computer classes to be held and has improved teacher retention rates in Tanzania's rural areas. In 2014, solar units (15kWp) installed in ten villages powered households and six schools; increasing study hours and improving literacy rates and performance in national exams (in the districts of Kongwa, Dodoma, Uyui, Tabora and Mlele Katavi).[66]

Savings on household energy expenditure – through shifts from traditional energy to decentralised renewables – can also contribute to increases in education and health spending (eg school fees), particularly at low tiers of energy access.[67] SolarAid and SunnyMoney report that over a quarter of interviewed customers used the savings they made for school fees and education (in Tanzania, Kenya, Zambia, Uganda and Malawi).[68] In Myanmar, the provision of solar lanterns alleviated the need to collect funds from parents for diesel generators to support night-time classes.[69]

57 Africa Progress Panel (2017) op. cit.

58 European Union Energy Initiative Partnership Dialogue Facility (EU EI) (2014) *Mini-grid policy toolkit: policy and business frameworks for successful mini-grid roll-outs,* Eschborn, EU EI

59 Key informant interview; Spectrum (2017) *Electricity: the view from CSOs and intra-community issues*, Yangon, Spectrum; www.globalelectricity.org/content/uploads/The-Nepal-Energy-for-Education-Project-Publication.pdf

60 Acumen (2017) op. cit.; Lemaire (2016) op. cit.

61 SolarAid and SunnyMoney (2015) op. cit.; Africa Progress Panel (2017) op. cit.; Lemaire (2016) op. cit.

62 Lemaire (2016) op. cit.; SolarAid and SunnyMoney (2015) op. cit.

63 This included 20 gender disaggregated focus groups, 20 key informant interviews with civil society organisations and 20 semi-structured interviews with village leadership.

64 Spectrum (2017) op. cit.

65 Africa Progress Panel (2017) op. cit.

66 TaTEDO and WRI (2017) op. cit.

67 Brent (2017) op. cit.; SolarAid and SunnyMoney (2015) op. cit.

68 Solar Aid and SunnyMoney (2015) op. cit.

69 Panasonic (2017) 'Myanmar: precious light supports children's education in off-grid villages', available at http://panasonic.net/sustainability/en/lantern/2017/06/myanmar-meikswe.html.

CASE STUDY

The solar-powered university

Solar power has transformed the way students and staff study and work at the Bilingual Christian University of Congo (UCBC) in Beni, DRC. The university was first established in 2007 and now 360 students study there, over half of whom are women. For eight years, the campus relied on a weak diesel-powered generator for electricity. The generator only ran for four hours a day, and cost 1,500 USD a month to run. This limited the time during which students could use computers and study, and staff could prepare their classes.

In 2015, the university changed this by installing a 35kW solar system to power the campus; three years later, it is still the largest solar installation in the whole of North Kivu region. Solar power has been a game changer throughout the campus. Classrooms, offices and the carpentry workshop can now operate all day. The campus is safer to walk around at night due to solar-powered exterior lights. The university also saves money; after two years, the solar system was paid for and now costs nothing to run.

Naomi, a UCBC student in Applied Sciences, says 'The big challenge I had last year was electricity. We use computers in our faculty and we were not able to plug in every time. But this year, we have solar panels and we are able to work whenever we want, even at night.'

One of the biggest changes has been in the library, which is now open from 8am until 11pm. The diesel generator only powered five computers; with solar energy, the library lab now has 50 networked computers, all being used at the same time. Students and teachers are now able to access UCBC's new digital library, which houses over one million articles, videos and book chapters.

Lwanzo Katuka, UCBC Head Librarian, says, 'Solar energy has changed how I view my work as a librarian. My work has changed from bookkeeper to information broker.'

These benefits go beyond the university itself. Students from local high schools come to the library for computer lessons in English. The campus radio station, Radio Télé Bilingue, now broadcasts uninterrupted, bringing local news, English instruction and environmental education from UCBC to over 600,000 listeners across an area of 60 square kilometres. Inspired by the transformation that solar technology brought to their campus, UCBC alumni set up a solar energy start-up company, Kivu Green Energy, creating the first mini-grid in North Kivu and bringing electricity to around 75 local households.

Photo: Bilingual Christian University of Congo

Gender equality and empowerment (SDG 5)

Decentralised electricity access can be an enabler of positive health and education for women and girls, and improve their participation in public life. Lighting from solar lamps and SHSs provides time flexibility when care work is carried out, and improves access to information and financial services[70] (eg via mobile phones). Electricity for water pumping eases the considerable burden of water collection, which is predominantly carried out by women and girls, and gives them more free time for study or productive activity. Lighting in public spaces can help women feel safer to go out at night, while lighting at home can also increase feelings of security. A survey in Myanmar, for example, has found that a third of women use electricity for care work, including cleaning and the care of children (based on a survey in Karen and Kachin regions).[71]

70 European Report on Development (2015) *Combining finance and policies to implement a transformative post-2015 development agenda*, Brussels, Overseas Development Institute (ODI), in partnership with the European Centre for Development Policy Management (ECDPM), the German Development Institute (Deutsches Institut fur Entwicklungspolitik) (GDI/DIE), the University of Athens (Department of Economics, Division of International Economics and Development) and the Southern Voice Network

71 Spectrum (2017) op. cit.

Access to electricity is also positively correlated with women's economic empowerment and can improve the productivity of their enterprises.[72] Decentralised electricity can provide business and employment opportunities for women in the supply chain for solar products. In the Kachin and Karen regions of Myanmar, over a third (36 per cent) of women and over half (54 per cent) of men planned to use electricity to start a business (survey evidence).[73]

Women's social networks, which are different to men's, may make it easier for women to access hard-to-reach households that might be interested in buying solar products. In rural regions of Uganda and Tanzania, Solar Sister operates through a network of 1,800 women entrepreneurs. Most Solar Sister customers have substituted kerosene lamps with solar, using the savings for school fees, farming inputs and investment in businesses. In Nepal, small enterprises specialising in solar lamps, home systems, improved cooking stoves and water filters are empowering women to become chief executive officers (CEOs) (of their own decentralised solution businesses). For example, Empower Generation has already employed and provided financial and managerial training to 23 CEOs in the Bardiya, Rupandehi, Chitwan and Siraha regions of Nepal.[74]

Access to electricity can also be important for women in conflict situations. In Nigeria's Borno state, Lilienthal has concluded that the night-time abduction of girls from Chibok secondary school by Boko Haram was in part due to the sense of confusion caused by a lack of lighting.[75] Central grid extension is unlikely to reach these remote regions.

CASE STUDY

Phul Kumari is starting a business, powered by hydroelectricity, so her children can become engineers

Phul Kumari is 32 years old, and lives with her husband, three daughters and a son in Kalanga, a village in Nepal. In the past, the village had no electricity. Phul Kumari had to get up at 4am to grind maize, wheat and corn by hand. It took so long that the whole family had to be involved.

Her family relied on kerosene for light. Phul Kumari had to walk a long way to buy it, travelling up to four hours on foot. It was expensive; sometimes she could not afford it. To help make ends meet, her children also got up early in the morning to work. At night, they had only the dim, smoky light of the kerosene lamp to study by. They didn't finish their homework.

Now that the village has a micro-hydropower plant, Phul Kumari can bring the family's grain to the newly opened mill – which uses water run-off from the micro-hydro plant – where the mill owner will grind it in just an hour. The whole family saves time.

'Before having hydroelectricity, our community felt like our lives were on a hard trajectory but after having electricity, we feel very happy because we are inside the light.'

Now that she has the time – and the inspiration from other businesses opening in the village – Phul Kumari is starting her own poultry and vegetable farm. The micro-hydro plant will provide light for the farm and heating to keep the chickens warm.

'Now I can engage in business. I support my children so they can go to school.'

With electric lights at home, her children can now complete all their homework. Phul Kumari is a member of the school management committee and regularly hears from teachers about her children's good progress at school.

'I support my children so they can go to school. The rate of school attendance is increasing because they can do their homework. I want my children to have a different life. They might be engineers or doctors. I hope my children will be good in the community.'

72 SEforALL (Sustainable Energy for All) (2017) *Scaling sustainable access pathways for the most vulnerable and hardest to reach people*, People-Centred Accelerator Working Paper, Washington DC, Sustainable Energy for All

73 Spectrum (2017) op. cit.

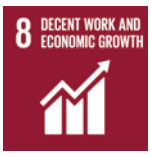
74 There are aims to increase the number of female CEOs to 100 and the number of male and female sales agents to 1,000 by 2020. Source: Purvis K (2017) 'Woman led company wins award for lighting up Nepal', *The Third Pole*. Available at: www.thethirdpole.net/2017/06/16/woman-led-company-wins-award-for-lighting-up-nepal

75 Lilienthal P (2016) 'Renewable energy for security: electricity and the Boko Haram kidnapping', *Renewable Energy World*. Available at www.renewableenergyworld.com/articles/2016/06/renewable-energy-for-security-electricity-and-the-boko-haram-kidnapping.html

Humanitarian contexts

Some of the 600,000 Rohingya refugees that migrated from Myanmar to Bangladesh in the face of conflict travelled with solar panels among the few things they took with them. A number of Rohingya refugees purchased solar panels upon arriving in Bangladesh, demonstrating the importance they place on access to electricity.[76]

Solar panels on a roof in Kutapalong camp in Bangladesh.
Photo: Andrew Philip/Tearfund



Inclusive and sustainable economic growth, employment and income generation (SDG 8)

Energy sector bottlenecks and power shortages are estimated to cost African economies between two and four per cent of their GDP every year.[77]

Decentralised renewable electricity can provide alternative options or back-up supply for locations with unreliable grid supply. Such solutions can also reduce reliance on diesel generator sets – with associated fuel costs, potentially unreliable supply of diesel, or a lack of locally available maintenance or repair services.

The decentralised renewable energy sector can create a vibrant market, providing jobs to the local population. Renewable technologies could potentially employ 1.8 million people in sub-Saharan Africa alone.[78] An associated decline in jobs from kerosene and diesel supply chains could meanwhile be alleviated through re-skilling into the renewable sector. In the case of East Africa, SunnyMoney has reported an average increase in income of 30 per cent for its network of 600 solar distributors (as compared with previous employment).[79] In DRC, the connection of energy-poor households to off-grid and mini-grid electricity solutions would create a market worth 921 million USD a year, by one estimate.[80]

76 Naqvi M (2017) 'Rohingya crisis: This is what Muslims take with them as they flee violence in Burma's Rakhine state', *The Independent*, 8 September 2017

77 African Progress Panel (2017) op. cit.

78 UNEP (2014) *Light and livelihood: a bright outlook for employment in the transition from fuel-based lighting to electrical alternatives*

79 SolarAid and SunnyMoney (2015) op. cit.

80 SE4All Africa Hub, AfDB and Sustainable Energy Fund Africa (2017) *Mini grid market opportunity assessment: Democratic Republic of the Congo,* SEforALL Africa Hub, African Development Bank

Decentralised electric lighting can create opportunities for new or existing businesses – as an increase in business hours could see a corresponding rise in the number of customers and in business profits. In Tanzania, for example, the deployment of decentralised renewables in rural areas has enabled sunflower seeds to be pressed locally for sunflower oil – which was previously imported. Other new business activities included poultry farming and fruit processing.[81] Financial savings, gained through reduced energy expenditure, could be used for investment in businesses, such as farming inputs.[82]

Hari, 49, wanted to work as a carpenter from early childhood. Before the micro-hydropower plant was opened in Archale, Nepal, he cut wood using a handsaw, which took a long time. Now he has opened a sawmill and uses electric tools. The work that used to take three to four days can now be done in just one, which means he can earn more money. In the past, it was difficult to earn enough to provide food, clothing and education for his family so he worked on a farm to earn extra money. Now Hari can afford to buy food and clothes, invest in his children's education and increase his business.

Hari works faster and earns more money as a carpenter, using electric tools powered by hydroelectricity in Archale village, Dhading District in Nepal
Photo: Kit Powney/Tearfund

'NOW I AM WORKING FULL-TIME AT MY BUSINESS, AND I AM ENJOYING IT AND EARNING ENOUGH MONEY.'

Hari, 49, sawmill owner

Decentralised electricity services also enable people to own and use mobile phones and televisions. Mobile phones are particularly important for access to modern financial services, market information and weather updates in certain country contexts. In Rungwe, Tanzania, access to mini-grid electricity has enabled the use of phones, radios, televisions and the internet; and allowed rural farmers to access market information and sell more produce, as well as receive higher prices for it.[83] In Myanmar, the use of mobile phones has created opportunities to access financial and agricultural information, and to adopt sustainable farming techniques. A not-for-profit renewable energy firm, Myanmar Eco Solutions, has also developed an innovative solar-powered irrigation system for rice farmers in the Ayeyarwady region.[84]

81 Ahlborg H (2015) *Walking along the lines of power: a systems approach to understanding co-emergence of society, technology and nature in processes of rural electrification,* Gothenburg, Sweden, Chalmers University of Technology, available at: http://publications.lib.chalmers.se/records/fulltext/215043/215043.pdf; TaTEDO and WRI (2017) op. cit.

82 Eckley et al. (2014) op. cit.

83 Mwakaje AG (2010) 'Information and communication technology for rural farmers in Tanzania', *Journal of Information Technology Impact,* vol 10, no 2, pp 111–28

84 Balch O (2016) op. cit.; Taylor J (2014) '5 things to know about working in rural Myanmar', *Devex*. Available at: www.devex.com/news/5-things-to-know-about-working-in-rural-myanmar-84605

CASE STUDY

Ali has doubled his income using a solar panel

Ali is 35 years old and lives in Kinangali village in the Dodoma region of Tanzania with his wife and two children, aged 12 and 4. He moved to this village four years ago. When he arrived, Ali identified a need in the village: local people kept cattle, but had to travel a long distance to Manyoni for treatment for their animals if they became sick. He opened a kiosk selling medical supplies for cattle, such as dipping solution and antibiotics.

Ali had been thinking of moving again, until the launch of a Tearfund-initiated Pamoja community savings group persuaded him to stay. There are 19 people in the group, which Ali joined in January 2017. He took out a loan from the group, and with 75,000 TZS (33 USD) bought a solar panel.

The government doesn't fund the national grid to reach Ali's village and it will be some years before it arrives. In the past, Ali used a torch with batteries for light, and had to close his kiosk at 6pm, when it got dark. Now, with the solar panel, he can stay open in the evenings. He can also charge his mobile phone, which he uses to buy goods for his business. Ali used to earn 5,000 TZS (2 USD) a day; now he makes 10–20,000 TZS (4–8 USD). He saved that extra money and has bought a plot of land. He plans to buy a house and would like to expand his business. With a more powerful solar panel, he could buy a fridge to sell cold drinks or to charge other people's mobiles.

The Pamoja group enables the local community to save money together, and share in their successes. 'I will continue to be in this Pamoja group so I can prosper and tell others to join the group because I know for sure we will start at the bottom and go to the top – step by step we will succeed in our lives.'

Photo: Sarah Edwards/Tearfund

Clean energy to tackle climate change (SDG 13)

The energy sector is responsible for about two-thirds of global greenhouse gas emissions.[85] Solar products and renewable mini-grids can reduce or eliminate the need for emissions-intensive fuels, such as kerosene and diesel, for electricity.[86] However, their use will account for a small reduction in national greenhouse gas emissions – less than one per cent of annual emissions. When the black carbon[87] emissions of kerosene lighting are taken into account, the climate change mitigation effect is more significant.[88] For example, in Nigeria, full transition to decentralised renewable technologies could generate a reduction of 6.4 million tonnes of carbon dioxide emissions a year, equivalent to removing 1.6 million mid-sized cars from roads.[89]

85 IEA (2015) *Energy and Climate Change*, Paris, IEA

86 It is worth noting that as people continue to move up the energy ladder – for example, a pathway from kerosene lamps to SHSs and then to diesel generators – per capita emissions can both increase and decrease over time. In the long term, there is a need for governments to ensure that when people are being connected to the grid, the grid is not reliant on fossil fuels (hence increasing per capita emissions significantly).

87 Black carbon is defined as fine soot particulate matter made of pure carbon, which is formed through incomplete combustion of hydrocarbons and biomass. It contributes to global warming by absorbing sunlight and interacting with clouds.

88 SEforALL, Power for All, ODI (2017) *Why wait? Seizing the energy access dividend*, Washington DC

89 UNEP (2013) *Off-grid lighting assessment, Nigeria,* UNEP

5 POLITICAL ECONOMY OF DECENTRALISED RENEWABLES

This report considered the political economy context for off-grid renewables in five countries.[90] Overall, the governments in DRC, Nigeria, Tanzania, Myanmar and Nepal continue to focus on the role of centralised and grid-connected energy in energy sector development. This means that decentralised renewables are not always included in national energy or energy poverty alleviation policies and plans. The countries do, however, demonstrate a growing interest in the potential role of decentralised renewables – whether this is led by government actors, the private sector or civil society and multilateral development banks.

More specific conclusions drawn at the country level are summarised below:

- In DRC, decentralised solutions are under-developed but could present an opportunity to overcome governance challenges, and increase the resilience of electricity supplies during conflict and instability. However, the government needs to improve the policy and implementation environment, as well as access to finance, to deliver electrification on and off the grid.
- In Myanmar, the policy environment is currently inadequate, especially for mini-grids, though the electrification plan provides for decentralised solutions. The high level of public subsidy for on-grid electricity and fossil fuels and weak policy environment discourages private investment.
- In Nepal, the prolonged democratisation and decentralisation process presents an opportunity to target new leaders with the case for decentralised solutions. However, the current reliance on public finance, as in Myanmar, discourages private investment.
- In Nigeria, investment is needed to develop pay-as-you-go schemes for lower tiers of access (solar lamps and SHSs). Stringent banking regulations are affecting competition and the development of mobile banking. Different tariffs for renewable energy components and already assembled renewable technologies creates confusion for customs officers, constraining imports.
- In Tanzania, the government has recognised the potential for decentralised solutions and has introduced appropriate policies. However, procedures remain cumbersome and access to finance needs to be improved for the private sector to scale up.

Other major findings from the secondary literature and key informant interviews are presented in the tables in the Appendix.

> **'THE TECHNOLOGY FOR WORLDWIDE ENERGY CONNECTIVITY IS THERE. THE BARRIERS ARE INSTITUTIONAL, NOT TECHNOLOGICAL.'**
>
> Liu Zhenmin, Under-Secretary-General for Economic and Social Affairs, United Nations

90 This was based on literature and key informant interviews.

6 CONCLUSIONS

Historically, access to electricity in most countries has been achieved by extending a grid that is connected to centralised, large-scale thermal power plants. In developing countries – where energy poverty is a major constraint to development – governments continue to focus on high-cost and time-intensive projects that prioritise grid extension. The five countries included in this study are no different. Their electrification objectives give priority to grid connections. For the energy poor in rural areas, any delays in access to modern electricity services hinder opportunities to seek development gains – for example, for poverty reduction, female empowerment and economic empowerment.

Although the attractiveness of decentralised electricity options is increasing, they are not integral to policies and plans for the development of the electricity sector in many countries, including those analysed in this report. In addition, the responsibility for off-grid electricity might be held by a department or ministry that is separate from the ministry responsible for the power sector, as found in Myanmar, Nepal and Nigeria. This can lead to policy compartmentalisation and confusion about responsibilities. When decentralised renewable electricity options are included in policies and plans, as for example in Myanmar, they are regarded as an interim until the government or utility can extend the grid to all households and businesses.

At the current rates of progress, the SDGs – in particular SDG 7 – will not be achieved by 2030. Investments in grid extension may also require long lead times, whereas the distribution and installation of solar lamps and home systems may take only a few days or weeks, where suppliers are already operating.

The LCOE for decentralised renewable electricity is lower than the equivalent cost of grid extension in many places and is expected to decline further. It is also lower than the cost of decentralised diesel generators in many cases. However, robust and comparable cost information is not readily available everywhere (eg LCOE for solar off-grid in DRC).

As the grid is extended to remote communities and thinly populated rural areas, the average investment cost of a grid connection increases. In Myanmar, for example, grid connections are now estimated to cost just under 1,000 USD and are more than double the cost of pilot solar mini-grid connections. Connection costs may therefore be increasingly prohibitive for consumers, and the revenue from new connections to low-income households unattractive for utility companies. Public finance to extend the grid to every household may be unavailable or not scrutinised for its cost-effectiveness to highlight the lower cost option of electrification through off-grid renewables. Least-cost electrification planning, as used in Myanmar, is one way to identify which areas should be prioritised for grid extension. Other areas should be served by off-grid solutions. And for solar lamp and SHS purchasers, the savings on avoided kerosene and battery expenditure can often exceed upfront purchase costs within a short period.

The third factor influencing increased attention to off-grid renewable electricity is the interdependence of access to electricity and wider social and economic objectives. When households lack access to electricity, because they cannot afford it or because they are still waiting for the grid to arrive, there is an opportunity cost of missed development opportunities. This potentially constrains the achievement of the SDGs for healthy lives, inclusive education and gender equality, for example. The use of solar lamps has been shown in several countries to increase school students' hours of study. Decentralised renewable electricity avoids greenhouse gas and particulate emissions from the use of kerosene lamps or diesel generators, and therefore does not have the associated negative health impacts (burns and respiratory illnesses) and climate change effects. Although evidence for the impact of solar lamps and SHSs on productivity and production is mixed, some increase in retail businesses' operating hours has been noted. The higher capacity of mini-grids can create opportunities for economic uses of electricity, as well as lighting and communications.

7 RECOMMENDATIONS

Governments, bilateral and multilateral donors including DFID, development banks including the World Bank, the private sector and civil society can collectively play a significant role by promoting decentralised electrification and improving the enabling environment in low-income countries, especially those with low rates of energy access.

The following recommendations are made to accelerate uptake of decentralised renewables, and therefore improve energy access and energy security, reduce poverty, boost inclusive growth, and achieve development and climate change goals.

1 Develop an 'energy access roadmap' which sets clear national targets to achieve access to modern, sustainable and affordable energy by 2030, or earlier

National governments in low-income countries, especially with low rates of energy access, should:

- **integrate a decentralised approach of off-grid and mini-grid solutions with a centralised grid approach in energy policies and financing, and ensure that the decentralised approach is prioritised**

This would provide more policy certainty as a signal to encourage the entrance of private sector actors in decentralised technologies. It would also ensure a bottom-up and demand-led approach through off-grid and mini-grid systems, alongside planned centralised grid extension.

- **set energy access targets, in line with SDG 7, of universal access to energy by 2030, with specific sub-targets for off-grid and mini-grid renewable electricity solutions**
- **use the cost-effectiveness of different energy technologies to identify areas that are priorities for off-grid and mini-grid systems (eg through least-cost-effectiveness analysis and geospatial techniques)**

This will inform decisions on how to use scarce public finance. Targeting is key for low-access populations and remote regions of the country that would be best served by off-grid or mini-grid systems. Using cost-effectiveness can also give guidance for key actors like private companies that are providing market-based off-grid solutions.

- **strengthen coordination and policy coherence between energy and other national government ministries and sectoral plans in order to capitalise on the development gains from off-grid renewable electricity (eg in health, gender equality, inclusive education, economic empowerment, air quality and environmental benefits)**

This could be through an empowered national task force or a champion for energy access with clout and commitment from the highest levels of government. Integrated planning and energy services at the sub-national level would help facilitate decentralised decision-making for off-grid renewables and rural development.

Bilateral and multilateral donors and international finance institutions should:

- **shift from prioritising a fossil fuel grid approach and infrastructure to prioritising decentralised renewable energy**, in line with the International Energy Agency recommendation that almost three-quarters of additional energy spending should go towards off-grid and mini-grid renewable energy in order to ensure universal access to energy by 2030 (SDG 7);
- **develop energy access plans and targets as a key pillar of their energy strategies** (or economic development strategies) to show how they will scale up their technical and financial support for off-grid and mini-grid solutions in order to meet SDG 7.

2 Build a strong business and supportive enabling environment to improve confidence of investment in decentralised renewables

Based on lessons learned in countries, national governments, donors and international finance institutions should overcome barriers by:

- **strengthening policy frameworks** and market conditions for renewable energy mini-grids that provide higher tiers of energy access, which can support productive use of electricity, for example through fast, low-cost licence and permitting processes to reduce restrictions on private investment – mini-grids also need to be designed based on the needs of end users;
- **addressing governance issues** and cumbersome bureaucratic procedures to facilitate private investment;
- **promoting innovative business models and pay-as-you-go mobile systems** so that low-income households can afford the upfront cost of renewable energy products more easily and pay in;
- **improving access to finance**, for example microfinance and financing for SMEs;
- **facilitating the import of renewable energy products** with supportive tax policies, including tax exemptions and low tariffs to incentivise investment in off-grid components and technologies, and providing clarity and transparency in fiscal policies – they should also ensure effective implementation of such policies through adequate training for customs officials;
- **promoting public–private cooperation and multi-stakeholder platforms** that include civil society to improve energy planning processes and coordination and provide a united force to accelerate electrification – this will also improve policy design and implementation and spur on market growth;
- **improving quality and safety standards** and accountability mechanisms so that consumers can put their trust in reliable and high-quality products;
- **increasing consumer awareness** of solar and its benefits through education and product demonstrations;
- **improving technical skills** in off-grid renewable energy, for example in maintenance and repair, particularly in remote and rural regions; and strengthening technical and institutional capacity in off-grid renewable energy across government departments.

See more specific recommendations for the five country case studies below.

3 Improve the monitoring and reporting frameworks for energy access

Countries and donors do not systematically track electrification through off-grid renewable electricity. This is needed to monitor progress on achieving energy access targets and to provide a fuller picture of the impact of off-grid electricity on improving energy access.

National governments, donors and international finance institutions should:

- **track investments in off-grid renewable electricity, as a share of total support for energy, and report on investments to improve transparency;**
- **carry out impact assessments to improve data on the development impact of investments on energy access and poverty reduction;**
- **use meaningful metrics to measure the quality of electricity access – including affordability, reliability and safety, building on the World Bank's Global Tracking Framework and Multi-Tier Framework surveys**; there should be a focus on the perspective of energy service users to provide an accurate picture of the real levels of access to electricity.

Shanti works as a tailor in Tawal village, Dhading District, Nepal. Hydroelectricity means that she can work later and increase her income.
Photo: Kit Powney/Tearfund

Country-specific recommendations to improve the enabling environment in the five case study countries

National governments can improve the enabling environment by taking the following actions in these countries, supported by donor governments and international finance institutions.

Democratic Republic of the Congo

- Give higher priority to investment and policies in micro-hydro and solar mini-grids as cost-effective electricity access solutions. Decentralised renewable electricity solutions could be presented as an opportunity to overcome governance challenges, and to increase the resilience of electricity supplies during conflict and instability.
- Facilitate the import of solar panels and solar/hydro mini-grid equipment and their adoption throughout DRC through consistent fiscal measures.
- Raise consumer awareness of solar products across all of DRC's regions, including awareness of quality standards.
- Improve access to finance for decentralised renewable energy businesses and consumers (eg by facilitating mobile payment mechanisms, enabling affordable micro-finance for long-term leases, and mobilising investment finance).

Myanmar

- Further develop the policy framework to give higher priority to off-grid renewable electricity options, especially for mini-grids, as cost-effective alternatives for electrification. This could include improving coordination on energy policies between relevant ministries and departments.
- Phase out the high level of public subsidy to on-grid electricity and fossil fuels, to encourage private investment in off-grid renewables.
- Ease access to consumer finance (eg through mobile payment mechanisms and micro-finance).

Nepal

- Raise the awareness of local government leaders and consumers about the costs and potential of off-grid renewable household options.
- Explore ways to reduce public subsidies for fossil fuels and renewables that discourage private finance investment in decentralised renewable energy technologies.
- Facilitate access to affordable finance for off-grid electricity for consumers and businesses.

Nigeria

- Consider revisions to banking regulations that restrict the development of mobile banking, to facilitate the development of efficient payment systems for off-grid solar systems.
- Improve access to consumer finance, especially for SMEs and the rural population (eg mobile pay-as-you-go schemes and affordable micro-finance).
- Ease the stringent conditions for local entrepreneurs; increase ease of borrowing and lower exchange rate risks by enabling local financing to match international financing.
- Reduce import duties for renewable energy system components, matching those for assembled systems, and strengthen the capacity of the relevant agencies such as the Customs and Standards Organisation of Nigeria to implement product standards.
- Review subsidies for kerosene and petroleum fuels, or apply the waivers and incentives for fossil fuels to renewable energy technologies.
- Improve coordination on renewable energy policies and targets across government agencies.

Tanzania

- Streamline procedures for the implementation of off-grid renewable electricity schemes.
- Improve access to finance for businesses and consumers in the off-grid renewables market (eg by using risk guarantees for investors, mobile payment mechanisms and micro-finance for consumers).
- Introduce effective quality standards for solar lamps and home systems (such as Lighting Global's standards) to protect consumers and facilitate expansion of the market. Consumer awareness of standards and accountability mechanisms should also be increased.
- Give higher priority to off-grid electrification objectives in energy policy, and strengthen coordination of energy policy implementation (eg by making project information available across agencies), and remove uncertainty.

APPENDIX

Table of barriers and opportunities in the enabling environment

The tables for each country below summarise the major findings from the secondary literature and key informant interviews. See the Country reports for more in-depth analysis on each of the five countries at www.tearfund.org/climate_energy

Democratic Republic of the Congo	
Policy framework	Energy access and rural electrification targets exist. The government focus is on on-grid solutions, in particular, large-scale hydropower for export. Poor energy governance, including slow progress to privatise the electricity sector, means that the business climate remains hostile and negatively impacts investment. There is limited institutional capacity, in part due to the high turnover in the Ministry of Energy, and government appointees who are not necessarily energy sector experts.
Access to finance	Off-grid financing facilities are not readily available. Large-scale hydropower projects attract the majority of financing (eg by development banks). However, even these projects can struggle to attract financing.
Fiscal barriers	Tax levies are exonerated for renewable energy projects. These are not necessarily implemented at sub-national levels (eg provincial taxation can occur).
Consumer protection and quality assurance	Quality standards exist for stand-alone systems in the regulatory framework (eg solar lamps, SHSs). Informal vendors selling low-quality products have reduced trust in the potential market.
Level playing field	Available evidence suggests subsidies are not consistently applied to kerosene or diesel at the national level.
Consumer awareness	The DRC off-grid market is fledgling. There is growing awareness of solar products in certain regions.
Consumer financing	Pay-as-you-go schemes and long-term leases are made available to consumers. Such solutions are still in their early stages.
Level of local skills	Few local skills in rural areas are built through on-the-job training.

Myanmar	
Policy framework	There is a 2030 universal access to electricity target. An electrification plan provides for decentralised solutions. Policies are inadequate for private sector investment in mini-grids. The Ministry of Electricity and Energy has primary responsibility for development of the power sector, while the Department for Rural Development of the Ministry of Agriculture, Livestock and Irrigation is responsible for off-grid electrification. This creates strong compartmentalisation in energy policy.
Access to finance	Off-grid financing facilities exist. The short-term loans and inflexible rates provided by banks reduce investment. The World Bank is helping to finance the 2030 universal access target.
Fiscal barriers	Duty exemptions are available for mini-grid generators and solar modules, as well as charge controllers.
Consumer protection and quality assurance	Standards are not widely applied to decentralised technologies, and therefore, the average quality of solar lamps and SHSs is low. The exception is quality standards for mini-grids, which exclude provisions for grid connection.
Level playing field	There are public subsidies for electrification and electricity use. Kerosene and diesel subsidies are not consistently applied. Subsidies exist for stand-alone systems (eg solar), up to 100% of costs.
Consumer awareness	A lack of consumer and community awareness about electrification is hampering the deployment of off-grid solutions.
Consumer financing	National support programmes are provided. Financing mechanisms are available to consumers for stand-alone systems.
Level of local skills	Limited training – and limited trained staff – are available in rural regions, creating a lack of human capital for the operation and repair of decentralised technologies.

Nigeria	
Policy framework	The government's primary focus is on centralised grid electricity, but there is increasing commitment by the government and other actors to increase decentralised renewable generation. This includes creating a space for the private sector to operate. Progress on decentralised energy policy has also recently been achieved at the state level. Energy mandates are spread across different government agencies. Governance remains a challenge along the generation, transmission, distribution and regulation chain. Policy implementation also remains a challenge (eg restrictions on the development of mini-grids).
Access to finance	High interest rates and very low levels of access to banks among the population, especially for SMEs and consumers in rural areas. Renewable energy sector seen as high-risk.
Fiscal barriers	Zero tariffs exist for solar panels, but high-cost tariffs remain for the import of solar batteries, inverters, charge controllers, SHSs and other renewable energy system components. This reduces their cost-competitiveness.
Consumer protection and quality assurance	Non-existent consumer protection or quality assurance for solar products. This may already have caused a poor reputation and market spoilage.
Level playing field	Very high subsidies on kerosene and petrol. This is seen as a welfare measure and is greatly supported by Nigerians.
Consumer awareness	Low levels of awareness of solar power: up to 40% of the population have never heard of solar. Poor existing reputation due to previous failed solar programmes.
Consumer financing	Very low access to finance for SMEs and the rural population. Only 0.1% of Nigerians have access to mobile financing.
Level of local skills	Skilled renewable energy technicians are rare due to low national experience in solar PV and CSP (concentrated solar power) systems.

Nepal	
Policy framework	The government focus is on on-grid hydroelectricity. The decentralised opportunity is seen as an interim solution until the grid arrives. The Alternative Energy Promotion Centre is focused on small-scale renewables in rural centres, while the Nepal Electricity Authority focuses exclusively on large-scale projects. Cumbersome bureaucratic procedures restrict private sector involvement. Government plans to decentralise political representation through provincial elections.
Access to finance	Off-grid financing facilities exist. Complex procedures and high interest rates reduce lending to lower income households and SMEs. Donor and government financing can crowd out private financing of decentralised energy projects.
Fiscal barriers	Duty exemptions are applied to mini-grid systems and their storage, as well as mini-grid generators and distributors. Tax exemptions for stand-alone systems are not apparent.
Consumer protection and quality assurance	Quality standards are applied to stand-alone systems (eg small solar products). Government certification is applied to mini-grid equipment.
Level playing field	Subsidies are provided to mini-grid generators, as well as stand-alone (decentralised) solutions. Subsidies are provided for diesel and kerosene.
Consumer awareness	There is relatively little growth in the Nepalese solar market, which is dominated by SHSs. Awareness-raising could help increase market growth.

Tanzania	
Policy framework	Strong foundations are in place for a positive enabling environment, which has accelerated private sector investment in small renewable power production and distribution. The focus is on on-grid and mini-grid solutions, and more emphasis could be placed on off-grid solutions. There are specific plans for rural areas. Policy implementation and improved coordination among government ministries remain a challenge. Also, project development processes are cumbersome in some cases.
Access to finance	Although relatively well established, the solar market is still undercapitalised and vulnerable to exchange rate volatility. Finance for established players is slowly beginning to flow, but there is a 'missing middle' of medium-sized systems. Access to private sector funding (eg commercial loans) remains elusive.
Fiscal barriers	Solar products are exempt from VAT and tariffs, but batteries are not. Despite this, clearing costs remain. The financial challenges of the electricity utility, TANESCO, reduce its ability to pay agreed 'standardised power purchase tariffs' in the long term. Some of these tariffs are non-reflective of generation costs. TANESCO tariff payments may also be delayed.
Consumer protection and quality assurance	A large influx of low-quality and fake solar products onto the market has created huge challenges. This has resulted in short product lifetimes and high costs for users who need to replace faulty products or components.
Level playing field	Kerosene is not directly subsidised. Public subsidies for grid access and solar products may affect the solar market. Renewable energy mini-grids are not subsidised (ie solar, hydropower and biomass).
Consumer awareness	Consumer awareness is very high in certain regions (eg near Arusha, Dar es Salaam, Highlands and Lake Zones). There is low awareness of solar products in some other areas of the country.
Consumer financing	Pay-as-you-go financing for SHSs is now common in many regions.
Level of local skills	There is a relatively high level of human capital. Some training has been undertaken by the Tanzania Renewable Energy Association, as well as other market actors. More generally, there is readily available human capacity for installing smaller systems (eg SHSs). However, human capacity to install and maintain mini-grids remains a challenge.

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