Nigeria
Current state of play

According to the IEA, approximately 61 per cent of Nigeria’s 186 million people had access to electricity in 2016,\(^1\) while the Global Tracking Framework estimated this at 58 per cent in 2014.\(^2\) In rural areas, about two-thirds of the population lacks access to electricity, but there are big differences between access rates and electrification rates in different states. Northern and eastern states have much lower levels of access than the rest of the country. In urban areas, 86 per cent of the population had access in 2016.\(^3\)

Nigeria is Africa’s largest oil exporter and the fourth largest liquefied natural gas exporter in the world (2012 data).\(^4\) Yet a lack of refineries results in a petroleum import dependence. The electricity sector relies on natural gas plants and hydroelectricity (see Figure 5). Natural gas supply shortages due to excessive gas flaring and an inadequate gas evacuation and distribution infrastructure, as well as inadequate water management, cause frequent power outages.\(^5\)

Data collected during the interview and scoping missions suggest that independent decentralised generators generate between two and three times more electricity than the central grid.\(^6\) In total in urban areas, 8–14 GW of off-grid diesel and gasoline generators serve as back-up power during power outages. In rural communities, kerosene, candles and biomass form the prevalent source of energy.\(^7\) The Rural Electrification Agency (REA) lists 445 rural electrification projects that have been developed to date, but fewer than ten per cent have been completed.\(^8\) And in July 2016, the state-owned Nigerian Bulk Electricity Trading company provided the first power purchase agreements for solar projects, with a combined capacity of 1,200 MW (involving 14 companies).\(^9\) The federal government plans to deploy 10,000 renewable energy mini-grids across the country,\(^10\) and launched the National Solar Programme in February 2017 to electrify 20,000 off-grid rural households.\(^11\) A number of initiatives by renewable energy companies are also contributing to decentralised electricity access, including for example Solar Sisters, which is deploying a female sales workforce as agents.\(^12\)

\(^{1}\) IEA. (2016) IEA Energy Access Database. IEA website.
\(^{2}\) http://gtf.esmap.org/country/nigeria
\(^{3}\) IEA. (2017) IEA statistics. IEA website.
\(^{6}\) Key informant interview.
\(^{7}\) Key informant interview.
\(^{8}\) http://rea.gov.ng/projectdashboard/
\(^{9}\) http://www.pv-tech.org/interviews/pv-talk-nigerias-20-renewables-target-could-be-met-just-with-solar, And: Key informant interview.
\(^{10}\) Key informant interview.
\(^{11}\) Ibid.
Cost-effectiveness of decentralised renewables

On-grid electricity costs are lowest for hydropower and gas in Nigeria (at less than approximately $0.075 per kWh), which is not necessarily surprising given these are the dominant technologies. At grid-scale, solar PV and concentrated solar power (CSP) are not necessarily cost-competitive with the LCOE of fossil fuels, with costs ranging upwards of approximately $0.1 per kWh. It is worth noting that large hydropower is cheaper on average than fossil fuel alternatives (see Figure 6).\textsuperscript{13}

Nigeria’s off-grid households spend between $156 and $228 on traditional lighting sources and mobile charging (2015 data).\textsuperscript{14} Focusing on decentralised solutions, small-scale hydropower and off-grid natural gas are the cheapest technologies (at just over $0.1 per kWh). The LCOE of small-scale hydropower and solar PV are both lower than decentralised diesel (see Figure 6).\textsuperscript{15} For lower energy tiers, LCOE estimates are not readily available. A kerosene lamp with a glass cover ($5.80) is, however, a third of the cost of a small solar lamp ($18), or a sixth of a large solar lamp ($35), in Nigeria.

An interview conducted with a Nigerian solar PV stakeholder noted the installation of a solar PV system at their place of work resulted in the avoided expenditure of $22 a day (or 8,000 Nigerian naira per day), for a year.\textsuperscript{16} Power For All cites the work by some stakeholders in the decentralized renewable energy space who have adopted innovative business models to use solar PVs for productive use. In one of their cited case studies, they highlight work done by a company providing PV solar to barber shops which led to about 100 barbers saving between $5.5 and $13.9 weekly (or between 2,000 and 5,000 Nigerian naira) by shifting from petrol generators to solar pay-as-you-go schemes.\textsuperscript{17}

Towards 2035, the levelised costs of decentralised solar PV and hybrid systems are expected to continue to decline, while off-grid gas technology costs increase (see Figure 7).\textsuperscript{18} Along a similar

\textsuperscript{13} Boell (2017) True Cost of Electricity: Comparison of Costs of Electricity Generation in Nigeria. Boell Website.
\textsuperscript{15} The analysis shows that small-scale energy solutions remain more expensive than large-scale solutions. However, with prohibitively high grid connection costs in remote and rural regions, they remain essential for meeting SDG 7. Source: Boell (2017) Op. cit.
\textsuperscript{16} Based on a conversion rate of 1 NGN = 0.00277041 USD. Source: Key informant interview.
\textsuperscript{17} Installed by Consistent Energy. Source: key informant interview.
\textsuperscript{18} This is likely to be the result of natural gas price assumptions.
theme, GIZ commented that shifting diesel and gasoline generators to hybrid solar systems could also reduce future fuel price risks.19

Figure 6 LCOE of energy technologies in Nigeria (§ per kWh), data from 2017. A: on-grid. B: off-grid (unsubsidised).

Note: Assumes 11% weighted average cost. Source: Boell (2017)

Contributions to the SDGs
As noted by one Nigerian stakeholder, ‘We have seen evident impact of renewable energy contributing positively to the development of our people.’

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 has 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.’

SDG 3 Healthy lives
In Nigeria, an estimated 30 per cent of hospital burn cases are due to kerosene lamp explosions. Heating services, as well as cooking (though not a direct focus of this study), create household air pollution that leads to respiratory illness and kerosene poisoning. The latter is the most prevalent

---

20 Key informant interview.
form of child poisoning in Nigeria. With 136 million Nigerians affected by household air pollution, primarily from cooking energy, 64,500 people die annually.

Decentralised renewables can provide opportunities for improved healthcare, particularly in rural regions. SolarAid and Sunnymoney have reported that midwives in Nigeria find that solar lights and home phone charging contribute to better patient care. Under the Kaduna Solar Clinics project, a part of the Solar Nigeria Programme, and the Lagos Solar Project, decentralised solar systems have been deployed in 45 primary health centres in the Kaduna and Lagos states. A key informant noted improved night-time care, capabilities in vaccine and medicine refrigeration and an increase in the number of patients seen. In Gukuru, in Nasarawa state, the installation of a solar power system greatly improved night services and healthcare provision at the Gukuru medical centre. In the Dakwa community, in the outskirts of Abuja, the installation of a solar energy system (3 kW) has displaced kerosene lamps, helping to reduce accidents and safety risks from kerosene use.

SDG 4 Inclusive and equitable education

For the Nigerian electorate, electricity was the primary issue for the incoming administration (under President Buhari) in 2015, while education was the third. These issues are linked. Nigeria’s schools regularly go without electricity and the more affluent schools rely on diesel generators, with the associated fuel costs. The absence of electricity in 65 per cent of primary and secondary schools prevents their use of technology-based educational services. The majority of schools without electricity are in rural areas, where decentralised renewables could play a vital role. But decentralised electrification initiatives for schools are underway. For example, the Lagos Solar Project (as part of the Solar Nigeria Programme) has provided decentralised solar to 175 schools in Lagos state. The result has been extended study hours and computer usage, as well as increased child enrolment and better school performance.

SDG 5 Gender equality

Women are in the majority among Nigeria’s poor, and improved decentralised energy services can help support female-led rural development. Women are the most affected by energy poverty and are the prime beneficiaries of decentralised energy solutions. Savings from kerosene use and renewable energy entrepreneurship are creating opportunities for women. For example, Solar Sister Nigeria employs a network of female entrepreneurs to distribute such solutions. Power For All Nigeria’s gender programme is also empowering women to adopt decentralised solutions.

Decentralised solutions can improve health outcomes for women. Every day across the world, 830 women die from preventable causes related to pregnancy and childbirth, half of them in sub-Saharan Africa. In Nigeria, the Rural Women Energy Security Initiative is using small-scale renewable energy projects to target rural energy-poor women with the highest incidence of health-

---

22 Key informant interview.
25 Key informant interview.
26 Ibid.
27 Quartz Africa. (2017) Nigerians say reliable electricity should be president Buhari’s top priority—not corruption. Quartz Africa Website.
29 UN Nigeria Resident Humanitarian Coordinator. In: ThisDayLive. (2017) 65% of Nigerian Schools Lack Electricity. ThisDayLive Website.
30 Key informant interview.
32 Key informant interview.
33 Key informant interview.

Pioneering Power - Country report
related issues from ‘harmful energy practices’. Such energy practices can include the use of kerosene, diesel and charcoal.

Access to lighting can also be one contributing factor to improved perceptions of safety and security at night in conflict-affected states. In north-eastern Nigeria, Boko Haram has been responsible for the kidnapping of women and girls. Anecdotally, it has been argued the night-time abduction of girls from Chibok secondary school, in Borno state, was in part due to the sense of confusion through a lack of lighting. The Safe School Initiative launched by the previous administration provided solar lighting to schools in north-east Nigeria to improve lighting services and security, in the aftermath of the kidnapping. Such decentralised solutions are likely to play an important role, given central grid extension is unlikely to reach these remote regions.

**SDG 8 Economic empowerment, employment and decent work**

A major constraint for Nigerian businesses is a lack of access to electricity, resulting in a loss of competitiveness and profitability. A recent energy needs assessment found that 14.2 million households and 4 million small and medium-sized enterprises in Nigeria have no access to electricity. Other estimates suggest there are 37 million micro-, small and medium-sized enterprises experiencing energy poverty or a reliance on expensive petrol/diesel generators. The provision of electricity services can help overcome these business constraints, and may be particularly important in rural regions far away from the grid.

For every additional megawatt of renewable energy deployed in Nigeria, it has been estimated more than 3,000 jobs could be created. The National Solar Programme launched by the government and enterprise Azuri in February 2017 is aiming to create 500 direct jobs (eg solar installers and agents) and 5,000 indirect jobs. Mini-grid solutions provided by GVE Group in Egbeke-Etche Rivers state (24 kW) and Bisante-Katcha (34 kW) to 3,520 rural dwellers have created 182 new jobs.

Economic benefits can also be gained from the use of decentralised electricity. For example, in Plateau state, plans to use abandoned mining sites as water reserves for agriculture could use solar power to pump water to nearby farms. This could significantly increase productivity and reduce emissions.

**SDG 13 Tackling climate change**

In Nigeria, more than 60 million people use petrol and diesel generators for alternative power supply. By one estimate, the full transition to decentralised renewable energy technologies could generate 6.4 million tonnes of carbon dioxide emissions reductions a year for the country, the equivalent of 1.6 million mid-sized cars removed from roads. These savings would be equivalent to

---

37 Key informant interview.
41 Key informant interview.
43 Key informant interview.
45 Key informant interview.
46 Key informant interview.

Pioneering Power - Country report
1.3 per cent of Nigeria’s total emissions in 2014. Annual kerosene savings from the full transition to decentralised renewable technologies in Nigeria are estimated at 2.3 billion litres of kerosene. UNEP estimates a single kerosene lamp is responsible for 200kg CO₂. This could contribute to Nigeria’s Nationally Determined Contribution of unconditionally reducing carbon emissions 20 per cent by 2030. In Plateau state, government stakeholders have been advocating for the introduction of a green cities policy framework to increase renewable energy deployment in municipalities and reduce emissions.

The adoption of solar lamps in rural communities can also reduce pressure on forests, contributing to climate change mitigation and combat against desertification. Anecdotally, the Great Green Wall programme deployed 92 solar-powered boreholes in 92 communities in North Nigeria and has reduced water stress, by increasing irrigation and helping to combat the effects of climate change and desertification.

Political economy of decentralised renewables

An overview of Nigeria’s energy governance and major political economy findings are presented in Tables 10 and 11. The World Bank RISE indicators rate the Nigeria’s policy environment in relation to energy access and renewable energy poorly (at 22 per cent and 29 per cent, respectively). However, Nigerian stakeholders have argued such assessments are out of date and recent policy developments have improved the policy environment towards these aims. In particular, in 2015–2016, the National Renewable Energy Action Plan and the Renewable Energy and Energy Efficiency Policy were both introduced.

State-level policy-making is in some cases proving to be an enabler of decentralised renewable energy opportunities also, in inviting the entrance of private investors. As an example, Plateau state developed a renewable energy policy and strategy, with public-private partnership guidelines and an off-grid implementation plan (Rural Electrification Plan based on renewable energy), in partnership with donors (eg GIZ, EU). Other states are planning similar policies.

The federal government remains focused on large-scale grid-connected power projects, and is still investing in hydrocarbon exploration in the Lake Chad Basin and other inland basins in Nigeria, spending more than $340 million in the last three decades. Though the government is beginning to recognise the potential role of decentralised solutions, it creates mixed signals for investors. Some positive examples include the fact that in 2017 the government launched the Mini-Grid Policy and a $350 million World Bank/Rural Electrification Agency (REA) electrification facility, with $100 million dedicated to the deployment of mini-grids. The REA under the Rural Electrification Strategy and Implementation is also aiming to mobilise off-grid technologies in last-mile communities (including

---

48 Authors’ calculation, based on CAIT (2017).
49 Ibid.
51 Key informant interview.
54 Key informant interview.
56 Key informant interview. And: http://rea.gov.ng/projectdashboard/.
57 Another example is the Federal Ministry of Power that launched a solar park project in Jigawa in 2017. This is also serving as a research institute for innovation in the Nigerian solar energy technology market.

Pioneering Power - Country report
through platforms for Energizing Education, and Energizing Economies, for example). In addition, there are a number of government agencies claiming authority over national renewable energy policies, resulting in different targets and creating mixed signals for the sector.

It can be argued, though, that donors and private sector entrepreneurs are helping to lead the decentralised agenda in Nigeria. For example, GIZ has been working with the government on pilot solar PV mini-grid projects. Other players include the UK Department for International Development, International Finance Corporation, and Japanese and US governments, supporting off-grid solar activities. The Renewable Energy Association of Nigeria, a national trade association for developers and distributors, has also been instrumental, giving the industry a seat at the table to help the government develop the market and unlock financing. In 2017, the Nigerian Bank of Industry launched a $3.3 million (1 billion naira) fund for decentralised rooftop and mini-grid solar systems for micro-, small and medium-sized enterprises, supported by the United Nations Development Programme.

Companies in the decentralised renewable energy market include Lumos Nigeria and the telecom company MTN. Mini-grid companies include the leading indigenous company, GVE technologies, as well as SOSAI Renewables, Solarmate, Havenhill Energy and Vaya Energy and Rubitec Solar, while players in the SHS market include A-Stevens Solar, Arnergy, Blue Camel, Protergia Energy Creeds Energy and Solar-Centric Technologies.

Policy and implementation gaps persist. Developers are restricted in mini-grid developments by a one MW project capacity limit, after which developers are required to undergo licensing procedures; an inability to develop in municipal areas; the fact that project sites are not permitted to be within a distribution company’s (DISCO’s) five-year expansion plan (and if they are, the mini-grid operator must obtain permission from the DISCO to operate); and the necessity for operators to obtain support from local communities. Although projects remain risky, obtaining mini-grid permits reduces risks for the operator by guaranteeing private sector developers the bargaining power to engage with distribution companies (DISCOs), where DISCOs’ expansion plans overlap with mini-grid operation areas, and enabling them to negotiate favourable terms. Hence, as DISCOs decide to undertake rural electrification in the area, the risk of being sidelined or losing out is greatly reduced.

As of September 2017, the National Council on Power developed a policy enabling bilateral electricity trading (for larger-scale renewable energy). Policies were applied to embedded generation regulation, captive power regulation and mini-grid regulation. Captive or embedded power generation can now be sold directly to consumers, allowing negotiation with communities that are ready to purchase energy, where before it was sold to DISCOs.

Financing is not always readily available. Investors are concentrated on larger-scale project opportunities. At lower tiers of access, household solutions can be too costly and private sector investors need to enter the market to enable payments via pay-as-you-go schemes. Owner equity

58 Key informant interview.
59 Ibid.
60 http://www.offgridnigeria.com/new-era-nigerias-decentralized-renewable-energy/
61 Key informant interview.
62 Key informant interview.
63 Ibid.
64 Ibid.
65 Electricity generation that is connected to a decentralised distribution network.
66 Electricity generation that is set up to generate electricity for personal use (e.g. by a business, community).
67 Key informant interview.
68 Ibid.
69 Ibid.

Pioneering Power - Country report
financing remains the dominant form of financing for decentralised electricity solutions (at Tiers 1–3). More generally, local financing is also needed to match international financing, to make it cheaper for borrowers and reduce exchange risks. Stringent banking regulations limit mobile money providers, seeking operation outside or in the grey areas of regulatory space. Incumbent banks therefore monopolise banking services and mobile money. Despite this, mobile money penetration remains low (at one per cent of mobile users). Multilateral development banks, such as the African Development Bank, also provide funding, though the conditions can often be too stringent for local entrepreneurs. There is also a growing appetite among bilateral donors and philanthropic organisations towards the financing of decentralised electricity solutions (Tiers 1–3).

From a fiscal perspective, while zero tariffs exist on solar panels, these rise to 35 per cent for batteries. A key informant has noted that this was in part the result of lobbying by actors with an interest in promoting diesel generators in the Nigerian energy market. In addition, solar lanterns and home systems are difficult for customs officers to categorise (as either renewable energy components or complete products, which have different tax implications). The result is a large fiscal burden, which is placed on distributors of such technology solutions.

---

71 Key informant interview.
74 Key informant interview.
76 Key informant interview.

Pioneering Power - Country report
Table 10 Energy sector governance and policy in Nigeria

<table>
<thead>
<tr>
<th>Governance</th>
<th>Generation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In 2013, the public utility, the Power Holding Company, was fully privatised, with generation activities handed over to six generation companies (GENCOs), which operate the power plants.</td>
<td></td>
</tr>
</tbody>
</table>

| Transmission      | The state-owned Transmission Company of Nigeria is responsible for transmission activities. There is a single control centre in Oshogbo. The government set up an agency, the Nigerian Bulk Electricity Trading Ltd, to buy electricity from GENCOs and sell it to DISCOs. They are the operators of the Nigerian Electricity Market, and are responsible for the wholesale market and payment settlements within the Nigerian electricity industry. |   |

| Distribution      | During the privatisation process, distribution activities were handed over to 11 distributed energy companies (DISCOs). Severe financial problems have pushed certain DISCOs to the point of bankruptcy, while also worsening electricity supply. |   |

| Regulator         | The Nigerian Electricity Regulatory Authority regulates the sector. Other supportive regulatory oversight roles are performed by the Nigerian Bulk Electricity Trading Ltd, Nigerian Electricity Management Services Agency and National Power Training Institute of Nigeria. |   |

Note: The Federal Ministry of Power is in charge of policy setting and the Rural Electrification Agency is responsible for the coordination of rural electrification. Source: Emodi (2016); GIZ (2015); key informant interviews.
### Policy issues and recommendations for Nigeria

<table>
<thead>
<tr>
<th><strong>Policy barrier</strong></th>
<th><strong>Challenges and opportunities</strong></th>
<th><strong>Potential policy actions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy framework and implementation</strong></td>
<td>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. Recent positive decentralised energy policy progress has also been achieved at the state level (eg Plateau state). Governance overlaps persist, with energy mandates 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).</td>
<td>Demonstrate political will by increasing the emphasis on cost-effective decentralised renewable energy solutions in energy policy, and clear pathways of commitment. In particular, encourage investment in renewable energy-based mini-grids (under the Mini-Grid Policy) by reducing restrictions on mini-grid development. Improve coordination on renewable energy policies and targets across relevant government agencies. Empower the Rural Electrification Agency to oversee renewable energy plans, policies and targets, in particular decentralised energy services. Encourage effective governance in agencies responsible for electricity generation, transmission, distribution and regulation.</td>
</tr>
<tr>
<td><strong>Access to finance</strong></td>
<td>High interest rates and very low levels of access to banks affect finance for SMEs and rural area consumers. This is largely because the renewable energy sector is seen as high-risk.</td>
<td>Facilitate access to finance for actors across the value chain, in particular SMEs and rural consumers. This should include low-interest loans and pay-as-you-go schemes, in cooperation with financial institutions and other funding organisations. Take measures to reduce the perception of risk in the renewable energy sector and to attract investment, patient capital and venture capital (eg credit guarantees and first-loss facilities).</td>
</tr>
<tr>
<td><strong>Fiscal barriers</strong></td>
<td>Zero tariffs exist for solar panels, but high-cost tariffs remain for the import of solar batteries, inverters, charge controllers, SHS and other renewable energy system components. This reduces their cost-competitiveness.</td>
<td>Apply measures to reduce import duties for solar batteries, lanterns and SHS and other system components (ie tax incentives). Train relevant agencies such as the Customs and Standards Organisation of Nigeria in implementing standards.</td>
</tr>
</tbody>
</table>

**Table 11 Policy issues and recommendations for Nigeria**
| Consumer protection and quality assurance | There is non-existent consumer protection or quality assurance for decentralised renewable energy, including solar products. This may already have caused poor reputation and market spoilage. | Adopt international quality standards for renewable energy products to reduce market spoilage (applied by the Customs and Standards Organisation of Nigeria, and during energy contract bids). Protect consumers’ rights by ensuring providers of decentralised renewable products are accountable through legal provisions. |
| Level playing field | Very high subsidies are provided to kerosene and petrol fuels. This is seen as a welfare measure and is highly supported by Nigerians. | Review subsidies for kerosene and petrol fuels, or apply the waivers and incentives for fossil fuels to renewable energy technologies. Tackle the perception of these being a welfare measure through awareness campaigns (eg earmarking fiscal savings for other social goods, such as health or education). |
| Consumer awareness | Low levels of awareness, with up to 40% of population unaware of the advantages of decentralised renewable energy. A poor existing reputation is evident in certain areas, due to previous failed solar programmes. | Develop a government narrative on the transition to renewable energy. Create citizen buy-in through raising awareness of the benefits of renewable energy technologies, including job creation opportunities (eg national awareness campaigns through the media, civil society advocacy etc). Adopt best practice models to improve the reputation of decentralised renewable energy projects, in particular solar projects. |
| Consumer financing | Very low access to finance for SMEs and the rural population. Only 0.1% of Nigerians have access to mobile financing. | Improve access to consumer finance, especially for SMEs and the rural population (eg mobile pay-as-you-go schemes and micro-finance). Relax stringent banking regulations that limit mobile money providers. Ease the stringent conditions of development banks for local entrepreneurs. Increase ease of borrowing and lower exchange rate risks by enabling local financing to match international financing. |
| Level of local skills | Skilled renewable energy technicians are rare due to low national experience in solar PV systems and concentrated solar power. | Increase domestic value creation by building a qualified workforce for the renewable energy sector, especially technicians for solar PV systems and concentrated solar power. Focus efforts in rural, decentralised regions. Earmark public financing for current renewable energy training programmes and technician certification schemes. |

Source: Various references op. cit. and key informant interviews.
CONCLUSIONS

Historically, access to electricity in most countries has been achieved by extending a grid that is connected to centralised, large-scale thermal or hydropower plants. In 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.

Although the attractiveness of decentralised electricity options is increasing, they are not always integral to policies and plans for the development of the electricity sector. 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 solution until the government or utility can extend the grid to all households and businesses. This is implicit recognition that investments in grid extension can entail very long lead-times, while the distribution and installation of solar lamps and home systems may take only a few weeks.

For those living in energy poverty in rural areas, delays in access to electricity hinder opportunities for development gains through access to modern energy services. 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. For example, the use of solar lamps has been shown in some 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 thus avoids associated negative health impacts (burns and respiratory illnesses) and climate change effects. Although evidence for the impact of solar lamps and SHS on productivity and production is mixed, there is evidence of increased hours of operation of retail businesses.

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. However, robust and comparable cost information is not readily available everywhere (eg the LCOE for solar off-grid in DRC and Nigeria). As the grid is extended to remote communities and thinly populated rural areas, the average investment cost of a grid connection will increase. In Myanmar, for example, grid connections are now estimated to cost approximately $1,000. Such connection costs may be prohibitive for consumers, and the revenue from new connections to low-income households unattractive for utility companies. In contrast, for solar lamp and SHS purchasers, the savings on avoided kerosene and battery expenditure can often exceed the purchase cost within a short period.

The evidence from the five countries reviewed in this study highlights several other barriers to the adoption of off-grid renewable electricity. One of the most notable of these is the overall business environment and the extent to which this discourages private investment, particularly in solar off-grid markets. In Myanmar, Nepal and Tanzania, for example, the levels of public subsidy for electrification – on and off the grid – provide limited opportunities and incentives. Bureaucratic procedures and the limited capacity of government institutions can also be a challenge. This can affect the availability of finance for consumers and businesses, and the application of product standards to protect consumers.

Pioneering Power - Country report
With the exception of Tanzania, there is a skills deficit for the off-grid renewables market. Investment in technician skills for the installation, maintenance and repair of solar lamps and SHS will be necessary. Expertise for mini-grid design, implementation and operation is also in short supply.
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’ that 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 (e.g. 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, as well as giving guidance for key actors such as 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 (e.g. 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)

Pioneering Power - Country report
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 for 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 instalments
- 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 in 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.
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 (e.g. 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, strengthen coordination of energy policy implementation (e.g. by making project information available across agencies), and remove uncertainty.
References
References are included as footnotes. The below references are for tables, figures and boxes:


Scott, A. (2017) Why Wait? Seizing the energy access dividend. SEForAll and PowerForAll.


UNDP, MEHR and GEF. (2013) Project document: Promotion of mini- and micro-hydropower plants in DRC.


Appendix 1. Glossary

Decentralised electricity: Electricity that is generated by small generation units, which may be connected to a transmission network or serve individual premises.

Electricity access: The availability of an electricity supply to a household (or business), at any tier of access (see Multi-Tier Framework, defined below). This may be distinguished from connection to an electricity grid (or mini-grid) by its focus on the actual supply of electricity, and therefore implies that electricity is used by the household.

Energy poverty: Lack of access to modern energy services (ie electricity and clean cooking fuels and technologies).

Energy service: The service that electricity enables to be delivered to the consumer, including lighting, heating, cooling, communications and motive power.

Levelised cost of energy: The cost per unit of energy produced (eg kilowatt hours) over the lifetime of the plant, including all fixed capital and operating costs. Costs are discounted to reflect the time value of money.

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

Multi-Tier Framework: To measure the quality of the 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 Multi-Tier Framework developed by the World Bank and supported by SEforALL (Bhatia and Angelou, 2015).

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

Solar home system: A stand-alone photovoltaic system, comprising a solar panel or array connected to a charge controller, inverter and battery, which can supply appliances as well as multiple lights.

Solar light: A single light (lightbulb) powered by a solar photovoltaic cell. Some solar lights also have a socket that enables the recharge of mobile phone batteries.

Tier of access to electricity: The level of access to electricity, as defined by the Multi-Tier Framework in terms of capacity, hours of service and qualitative attributes. There are five tiers of access, from Tier 1, the lowest, to Tier 5, the highest.
**Appendix 2. Energy tiers and the Multi-Tier Framework**

The Multi-Tier Framework (MTF) was developed by the World Bank to measure the range of energy access levels, or tiers (Bhatia and Angelou, 2015). The capacity of the electricity supply determines which of these services and how much of a particular service is available to a household (see Table A2 for details). Decentralised electricity solutions, which are the focus of this report, provide access at Tier 0 through Tier 3.

Table A2. Multi-Tier Framework: services and consumption levels at different tiers of electricity access

<table>
<thead>
<tr>
<th></th>
<th>Tier 0</th>
<th>Tier 1</th>
<th>Tier 3</th>
<th>Tier 4</th>
<th>Tier 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power capacity</td>
<td>&lt; 3 W</td>
<td>3-49 W</td>
<td>50-199 W</td>
<td>200-799 W</td>
<td>0.8-1.9 kW</td>
</tr>
<tr>
<td>Daily consumption capacity</td>
<td>&lt; 12 Wh</td>
<td>12-199 Wh</td>
<td>0.2-0.9 kWh</td>
<td>1.0-3.3 kWh</td>
<td>3.4-8.1 kWh</td>
</tr>
<tr>
<td>Annual consumption capacity</td>
<td>&lt; 4.5 kWh</td>
<td>4.5–72 kWh</td>
<td>73–364 kWh</td>
<td>365–1,249 kWh</td>
<td>1,250–2,999 kWh</td>
</tr>
<tr>
<td>Services provided</td>
<td>Task lighting</td>
<td>Task lighting</td>
<td>General lighting</td>
<td>General lighting</td>
<td>General lighting</td>
</tr>
<tr>
<td></td>
<td>Phone charging</td>
<td>Phone charging</td>
<td>Television</td>
<td>Phone charging</td>
<td>Phone charging</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fan</td>
<td></td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium-power appliances</td>
<td></td>
<td>Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>General lighting</td>
<td>Medium-power appliances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Phone charging</td>
<td>TV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Television</td>
<td>Refrigerator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fan</td>
<td>Refrigerator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multi-point</td>
<td>Medium-power appliances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>general lighting</td>
<td>appliances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Phone charger</td>
<td>Radio</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Television</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Computer and printer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Air cooler</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Refrigerator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Food processor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rice cooker</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Iron</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hairdryer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Toaster</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Microwave</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Scott (2017) (and based on Bhatia and Angelou (2015) and ADB (2015))
### Table 15. Major findings from the country secondary literature and key informant interviews

#### Democratic Republic of Congo

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy framework</strong></td>
<td>Energy access and rural electrification targets exist. The government focus is on on-grid solutions, in particular, large-scale hydropower for export.</td>
</tr>
<tr>
<td></td>
<td>Poor energy governance, including slow progress to privatise the electricity sector, means that the business climate remains hostile and negatively impacts investment.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Access to finance</strong></td>
<td>Off-grid financing facilities are not readily available. Large-scale hydropower projects attract the majority of financing (eg by development banks). Even these projects can struggle to attract financing though.</td>
</tr>
<tr>
<td><strong>Fiscal barriers</strong></td>
<td>Tax levies are exonerated for renewable energy projects. These are not necessarily implemented at sub-national levels (eg provincial taxation can occur).</td>
</tr>
<tr>
<td><strong>Consumer protection and quality assurance</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Level playing field</strong></td>
<td>Available evidence suggests subsidies are not consistently applied to kerosene or diesel at the national level.</td>
</tr>
<tr>
<td><strong>Consumer awareness</strong></td>
<td>The DRC off-grid market is fledgling. There is growing awareness of solar products in certain regions.</td>
</tr>
<tr>
<td><strong>Consumer financing</strong></td>
<td>Pay-as-you-go schemes and long-term leases are made available to consumers. Such solutions are still in their early stages.</td>
</tr>
<tr>
<td><strong>Level of local skills</strong></td>
<td>Few local skills in rural areas are built through on-the-job training.</td>
</tr>
</tbody>
</table>
### 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. |
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.

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.

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.

Quality standards are applied to stand-alone systems (e.g., small solar products). Government certification is applied to mini-grid equipment.

Subsidies are provided to mini-grid generators, as well as stand-alone (decentralised) solutions. Subsidies are provided for diesel and kerosene.

There is relatively little growth in the Nepalese solar market, which is dominated by SHSs. Awareness-raising could help increase market growth.
<table>
<thead>
<tr>
<th>Nigeria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy framework</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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 (e.g. restrictions on the development of mini-grids).</td>
</tr>
<tr>
<td><strong>Access to finance</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>Fiscal barriers</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>Consumer protection and quality assurance</strong></td>
</tr>
<tr>
<td>Non-existent consumer protection or quality assurance for solar products. This may already have caused a poor reputation and market spoilage.</td>
</tr>
<tr>
<td><strong>Level playing field</strong></td>
</tr>
<tr>
<td>Very high subsidies on kerosene and petrol. This is seen as a welfare measure and is greatly supported by Nigerians.</td>
</tr>
<tr>
<td><strong>Consumer awareness</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>Consumer financing</strong></td>
</tr>
<tr>
<td>Very low access to finance for SMEs and the rural population. Only 0.1% of Nigerians have access to mobile financing.</td>
</tr>
<tr>
<td><strong>Level of local skills</strong></td>
</tr>
<tr>
<td>Skilled renewable energy technicians are rare due to low national experience in solar PV and CSP systems.</td>
</tr>
<tr>
<td>Tanzania</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td><strong>Policy framework</strong></td>
</tr>
<tr>
<td><strong>Access to finance</strong></td>
</tr>
<tr>
<td><strong>Fiscal barriers</strong></td>
</tr>
<tr>
<td><strong>Consumer protection and quality assurance</strong></td>
</tr>
<tr>
<td><strong>Level playing field</strong></td>
</tr>
<tr>
<td><strong>Consumer awareness</strong></td>
</tr>
<tr>
<td><strong>Consumer financing</strong></td>
</tr>
<tr>
<td><strong>Level of local skills</strong></td>
</tr>
</tbody>
</table>

Source: Various (reports and websites reviewed for the country studies).