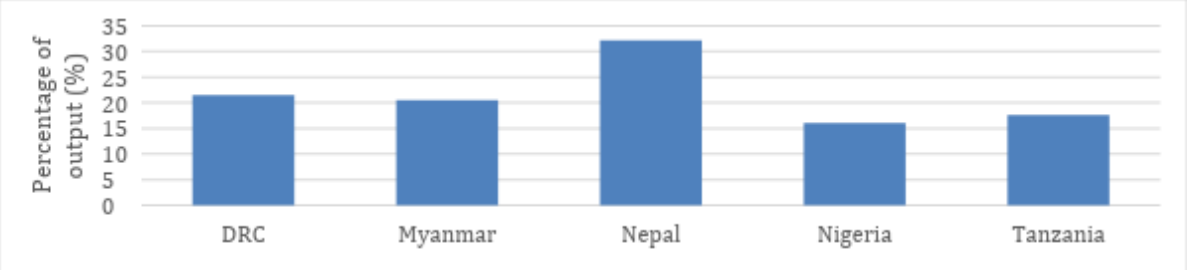
## Nepal

### Current state of play

The IEA estimate that 77 per cent of Nepal's population had access to electricity in 2016.[1] The Global Tracking Framework (GTF) estimate, for 2014, is higher at 85 per cent.[2] The latter takes more account of off-grid access. The level of access in urban areas is higher than in rural areas: 97 per cent according to the IEA and 85 per cent according to the GTF. In rural areas, where most of the population live, the level of access is 72 per cent or 82 per cent, according to the IEA or GTF, respectively.[3]

Electricity production in Nepal is almost entirely by hydropower (99.8 per cent in 2015).[4] However, the country's electricity system is unreliable, experiencing frequent load shedding (up to 12 hours a day).[5] Almost a third of the electricity supply is imported and a quarter is lost in transmission.[6] World Bank data places system losses as even higher (32 per cent of electricity output), and the highest when compared with the other countries in this study (averaging 19 per cent) (see Figure 4). Investments in the transmission and distribution infrastructure are required to reduce such system losses.

**Figure 4 Transmission and distribution losses in select countries (2014)**




Source: World Bank (2017) *World Development Indicators.*

Nepal has abundant renewable resources and 15 per cent of the population has access to renewable energy services (excluding large hydro).[7] Micro-hydropower development has been a pivotal energy development pillar since the 1960s.[8] As of 2017, 30 MW of micro-hydropower had been deployed and 20 MW of decentralised solar solutions, in particular solar home systems. Under the Scaling Up Renewable Programme this includes solar-wind hybrid mini-grids.[9] By 2012, the government's Alternative Energy Promotion Centre (AEPC) had provided 229,000 solar home systems. These dominate the market, compared with solar lamps, because of a high level of subsidy.[10] Since then,

1 IEA (2017) IEA Energy Access Statistics. IEA website.

2 http://gtf.esmap.org/country/nepal

3 IEA (2017) Op. cit.; IEA and World Bank (2017) Op. cit.

4 IEA Statistics.

5 Dhital, R.P. (2017) National Energy Access Policies and Plans: Government Plans. Alternative Energy Promotion Center. And: SREP. (2017) Upscaling Mini-grids for Least Cost and Timely Access to Electricity Services. SREP round table [NEPAL], Myanmar, Feb 6, 2017. And: World Bank. (2017) SUMMARY. Nepal: Scaling Up Electricity Access through Mini and Micro Hydropower Applications. A strategic stock-taking and developing a future roadmap. Washington DC: World Bank Group.

6 IEA Statistics.

7 SREP (2017) Op. cit.

8 Deshmukh (2013)

9 SREP (2017) Op. cit.

10 Lighting Asia (2012) Lighting Asia: Solar Off-Grid Lighting. India, Bangladesh, Nepal, Pakistan, Indonesia, Cambodia and Philippines. Washington DC: International Finance Corporation.

more than 200,000 more SHS have been installed by the AEPC. GOGLA reported sales of 36,162 Lighting Global-certified solar lamps and SHS in 2016.[11]

> '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

### Cost-effectiveness of decentralised renewables

The levelised costs of renewable energy options demonstrate that Nepal is relatively cost-competitive, in particular in the small-hydropower market, when compared with other developing countries (see Box 1 above). The cost of electricity delivered in Nepal's rural hills through the central grid averages $0.17–0.25 kWh, compared with $0.09–0.15 through a local micro-hydropower plant connection (of 50–100 kW).[12] This may be in part due to the difficult topology of Nepal's remote regions.[13]

From the decentralised perspective, the unit costs of SHS ranged from $50–70 for small systems (3–5 Wp), $220 for medium systems (20 Wp) – both providing Tier 1 access – and $565 for larger Tier 2 systems (60 Wp) (2012 data).[14] For the Scaling Up Renewable Energy Programme (2011), a medium solar home system (20 Wp) is estimated to cost $250, while a micro-hydropower project is estimated to cost $4,444 per kW.[15] However, these cost estimates predate large falls in the costs of solar. More recent LCOE estimates by the World Bank place costs for a medium solar home system (20 kW) at $0.55 per kW, a micro-hydropower plant (20 kW) at $0.24 per kWh, and a diesel generator set (20 kW) at $0.60 per kWh.[16]

### Contributions to the SDGs

#### SDG 3 Healthy lives

One third of rural health centres in Nepal lack access to reliable power.[17] Power cuts in rural Nepal can last nine hours, putting patients' lives at risk from an absence of lighting or the failure of oxygen machines. Following the installation of solar systems in six clinics, medical staff were able to deliver babies during the night, using solar-powered illumination (where they had previously relied on torches or costly diesel generators).[18] Following installation of solar units – called 'suitcases' – in Pandavkhani, maternal and child deaths were reduced to zero.[19]

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11 GOGLA, Lighting Global, World Bank Group and Berenschot. (2016) Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data. And: GOGLA (2017a): Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, July-December 2016. And: GOGLA (2017b): Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, January - June 2017, Public Report.

12 These cost estimates adopt the exchange rates in the study by World Bank (2017) Op. cit.

13 Deshmukh, R., Carvallo, J.P. and Gambhir, A. (2013) Sustainable Development of Renewable Energy Mini-grids for Energy Access: A Framework for Policy Design. Lawrence Berkeley National Laboratory, University of California Berkeley and Prayas Energy Group Pune.

14 Lighting Asia. (2012) Op. cit.

15 SREP (2011) Scaling up renewable energy program investment plan for Nepal. Scaling up Renewable Energy Program.

16 World Bank. (2017) Op. cit.

17 Wheeler, (2017) Op. cit.

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

19 Wheeler (2017) Op. cit.

There was also a notable role for decentralised solar systems in the aftermath of the Kathmandu earthquake in 2015. For example, Gham Power crowd-sourced financing for distributed solar systems, providing them to relief workers for healthcare purposes. This reduced the reliance on expensive diesel generators or kerosene and candles, the latter presenting a fire hazard.[20] SunFarmer also funded, alongside other NGOs, distributed solar-powered water purifiers and other systems to remote rural regions following the earthquake.[21]

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.'

## SDG 4 Inclusive and equitable education

Access to decentralised electricity solutions can create opportunities for improved education. The company SunFarmer found access to such electricity can improve school attendance and enhance literacy rates and study habits.[22] The impact of electricity on education is perceived differently according to the technological solution adopted, and decentralised solutions may have a greater impact on education.

In Kavre and Sindhuli, regions to the southeast of Kathmandu, 82 per cent of respondents in a survey agreed that grids have had a positive impact on child education, compared with 98 per cent for micro-grids and 97 per cent for stand-alone solar solutions.[23] The role of decentralised solar is also noted in the electrification in schools that are distant from the national grid. In Matela, decentralised solar is being used to electrify two schools, to offer night-time classes and launch computer classes. This enables the schools to provide night-time education for children and adults who are engaged in care or business activities during the day. SHSs are also being adopted to enable children to study at night in their homes.[24]

## SDG 5 Gender equality

Decentralised electricity solutions can provide job opportunities for women. For example, Empower Generation – operating in the districts of Bardiya, Rupandehi, Chitwan and Siraha – is run by 23 female chief executive officers (CEOs). These CEOs receive financial and managerial training. In addition, the CEOs employ up to 170 agents, male and female, which distribute solar lamps and home systems, as well as clean cookstoves and water filters. The agents receive sales and marketing training to distribute their products. By 2020, the aim is to empower 100 female CEOs and 1,000 sales agents.[25]

Other evidence points to the role of electricity services in reducing time spent on cooking, though not a direct focus of this study. Anecdotally, small hydro can create opportunities for rice cooking, which has high energy requirements, or the powering of mills, which reduces the burden of grounding flour, for example.[26]

20 Lohan, T. (2015) How Solar is Lighting the Way for Recovery in Nepal. The American Prospect website.

21 Tweed, K. (2015) How Solar is Playing a Role in Nepal's Disaster Relief. GreenTech Media website

22 http://www.sunfarmer.org/blog-full/the-challenges-and-opportunities-of-electricity-access-in-nepal

23 https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2015/06/Anjana_Minigrid.pdf

24 http://www.globalelectricity.org/upload/File/the_nepal_energy_for_education_project_publication.pdf

25 Purvis, K. (2017) Woman led company wins award for lighting up Nepal. The Third Pole Website.

26 Key informant interview.

**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 she that 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.'

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

As seen in the SDG 5 section above, distributed technologies can create economic opportunities for women, as well as men. Anecdotally, solar systems in the Chitwan National Park enabled tourists to stay overnight, providing further income opportunities in the tourism sector. Rangers were also able to stay in touch with park authorities and power spotlights using solar power.[27] A key informant interviewed also outlined the role of decentralised renewables in creating additional rural industries. For example, hydroelectricity opens up opportunities in carpentry workshops, for manufacturing household goods.[28]

27 PennEnergy. (2017) Solar Energy Empowers Villagers and Saves Wildlife in Nepal. Renewable Energy World Website.

28 Key informant interview.

'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.

## SDG 13 Tackling climate change

Domestic emissions were equivalent to 44.06 million tonnes of $CO_{2e}$ in 2014.[29] The replacement of traditional fuels, such as kerosene, and diesel can create emissions savings domestically. In 2007–2014, 400 micro run-of-river hydropower plants[30] were built, which are estimated to have abated 66,345 tonnes of carbon dioxide (the equivalent of taking 14,000 passenger vehicles off the road for one year).[31] Despite this, Nepal is not a significant contributor to global emissions.[32] As with Myanmar, a reliance on hydroelectricity results in a vulnerability to climate change impacts, with possible implications for security of supply.

### Political economy of decentralised renewables

An overview of Nepal's energy sector governance and major political economy findings is presented in Tables 8 and 9. According to the World Bank RISE indicators, Nepal's policy environment for energy access and renewable energy is scored at 43 per cent and 45 per cent, respectively.[33] According to one key informant, one of the largest obstacles for the country's energy policies is their implementation. It was mentioned that such policies have been developed in a 'vague manner', allowing for government interpretation, bureaucratic impediments and misaligned incentives.[34] Renewable energy policy has also suffered from an 'identity crisis' – where renewables (excluding hydropower) have been viewed as a solution to rural energy access, but now are increasingly seen as an option for on-grid solutions also.[35]

A number of actors oversee energy governance. The government and donor communities' focus has largely been on on-grid hydroelectricity opportunities. The government perspective on the decentralised opportunity is seen as an interim solution, until the grid arrives.[36] It follows that the state-owned electricity utility, the Nepal Electricity Authority's, project pipeline is exclusively large-scale projects. The exception is the Alternative Energy Promotion Centre, focused on small-scale renewables in rural centres, including micro- and pico-sized electricity solutions (eg solar).[37] Notably, interviewees commented there is very little private sector involvement, despite the fact that policies are trying to promote private sector inclusion. This is in part due to cumbersome bureaucratic procedures.

29 WRI CAIT (2017) Op. cit.

30 Run-of-the-river hydropower plants rely on little to no water storage, instead relying on the movement of water to generate electricity.

31 World Bank. (2015b) Micro-Hydros Earn First Carbon Revenue in Nepal. Washington DC: World Bank.

32

33 ESMAP (2017) Op. cit.

34 Key informant interview.

35 Ibid.

36 Ibid.

37 Ibid.

A private sector stakeholder interviewed identified the need to address how decentralised solutions will integrate with the national grid, when it arrives.[38] For larger infrastructure, such as schools, electricity generated during weekends and holidays creates opportunities for selling electricity back to the grid. However, it is unclear whether this is a viable option for smaller buildings, such as households.[39] Although solar played a strong role in urban centres facing unreliable grid electricity supply, it is also unclear how improvements in the grid-connected electricity supply in cities will impact the urban solar market.

The absence of decentralised energy governance leads to an absence of integrated planning.[40] Focusing on the project level, project development is relatively cumbersome and developers need to obtain a licence to survey, followed by a power purchase agreement, and a licence for building to commence. It has been known for private sector developers to proceed without getting the necessary approvals,[41] given the lengthy process. Another barrier is bureaucratic impediments. It is rumoured that the private sector has in the past provided incentives to the Nepal Electricity Authority to speed up approval processes. The lack of reliable hydrological data offers some 'room for manoeuvre' when private sector and government project negotiations take place.[42] This is understood as the ability for government to provide undue influence.

Despite these challenges, governance opportunities are emerging. Recently, the Nepalese government held state-level elections, with plans to also carry out provincial or local-level government elections. If adequately implemented, this would decentralise political decision-making from the central government elite in Kathmandu to the local level.[43] This creates an opportunity for stakeholders to influence local municipalities, in particular towards the role of decentralised renewables in energy access (and particularly in rural areas).

From a technological perspective, baseline energy technologies in Nepal remain seven to eight years behind the global frontier, according to a key informant interviewed. From a financial perspective, the private sector has been crowded out by government and donor funding. When public financing dries up, the sector therefore becomes idle. In addition, the political narrative that decentralised solutions act as an interim for grid connection negatively impacts the investment climate.[44] As an example, Alternative Energy Promotion Centre projects are largely reliant on external and government funding.[45] Diversifying the sources of investment will hence be necessary for the long-term success of the decentralised renewable sector.

38 Ibid.

39 Key informant interview.

40 Ibid.

41 Ibid.

42 Ibid.

43 Ibid.

44 Ibid.

45 Ibid.

**Table 8 Energy sector governance in Nepal**

| | | |
|---|---|---|
| **Governance** | **Generation** | The Nepal Electricity Authority (NEA) – the state-owned energy utility incumbent – is responsible for power generation, both on-grid and off-grid. The government plans to unbundle the NEA. The Alternative Energy Promotion Centre (AEPC) is a state-owned energy body responsible for renewable/alternative energy generation. |
| | **Transmission** | The NEA is responsible for the transmission of electricity. |
| | **Distribution** | The NEA is responsible for the distribution of electricity. The AEPC is also responsible for distributed renewable energy solutions. |
| | **Regulator** | The Nepal Electricity Regulatory Commission is mandated to regulate the power sector. This follows the Electricity Regulatory Commission Bill 2017, approved by Parliament in August 2017. |

Source: Nepal Electricity Authority and Alternative Energy Promotion Centre websites; SARI (2013); Kathmandu Post (2017)

Table 9 Policy issues and recommendations for Nepal

| Policy barrier | Challenges and opportunities | Potential policy actions |
|---|---|---|
| **Policy framework and implementation** | The government focus is on on-grid hydroelectricity. The decentralised opportunity is seen as an interim solution until the grid arrives.<br><br>Implementation of national energy policies is a key barrier as policies have been developed with 'vague wording'.<br><br>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.<br><br>Cumbersome bureaucratic procedures restrict private sector involvement.<br><br>This is against a backdrop of government plans to decentralise political representation through provincial elections. | Increase the role of decentralised energy solutions in future energy policy, in particular in rural regions (including cost-effective solar lamps, SHS and mini-grids). Policy standards should ensure mini-grids can be connected to the grid in the future.<br><br>Government efforts should also focus on strategic and coordinated implementation of energy policy.<br><br>Promote policies to incentivise private sector investment in decentralised energy. Encourage technological advances in these technologies, and the simplification of bureaucratic procedures for project development. Facilitate private sector and civil society investment in distributed solar systems in humanitarian situations (eg earthquakes and flooding). |
| **Access to finance** | Off-grid financing facilities exist. Complex procedures and high rates, however, reduce lending to lower income households and SMEs. Donor and government financing can crowd out private financing to decentralised energy projects. | Mobilise access to finance for actors across the value chain, in cooperation with financial institutions and other funding organisations. Review the high interest rates applied to lower income households and SMEs. Explore ways to reduce public financing crowding out private financing (eg public-private partnerships). |
| **Fiscal barriers** | Duty exemptions are applied to mini-grid generators/systems and their storage, as well as distributors. Tax exemptions for stand-alone systems are not apparent. | Apply tax exemptions and other measures for stand-alone renewable energy systems. |
| **Consumer protection and quality assurance** | Quality standards are applied to stand-alone systems (eg pico-solar products). Government certification is applied to mini-grid equipment. | Protect consumers' rights by ensuring solar off-grid and mini-grid system providers are accountable through legal provisions and internationally recognised quality standards. |

| | | |
|---|---|---|
| **Level playing field** | Subsidies are provided to mini-grid generators, as well as stand-alone solutions. Subsidies are also provided for diesel and kerosene. | Review subsidies for kerosene and diesel and their potential elimination (eg reallocate subsidies to other social sectors, such as health or education). |
| **Consumer awareness** | There is relatively small growth in the Nepal solar market, which is dominated by SHS. | Raise consumer awareness about the benefits of decentralised renewable solutions (eg solar lamps, renewable based mini-grids) to encourage market growth. |
| **Consumer financing** | [No specific information available.] | |
| **Level of local skills** | [No specific information available.] | |

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.

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 (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, 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 (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 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 (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, strengthen coordination of energy policy implementation (eg by making project information available across agencies), and remove uncertainty.

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References are included as footnotes. The below references are for tables, figures and boxes:


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## 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**

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

Sources: Scott (2017) (and based on Bhatia and Angelou (2015) and ADB (2015))

## Appendix 3. Table of barriers and opportunities in the enabling environment

**Table 15. Major findings from the country secondary literature and key informant interviews**

| Democratic Republic of 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.<br><br>Poor energy governance, including slow progress to privatise the electricity sector, means that the business climate remains hostile and negatively impacts investment.<br><br>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). Even these projects can struggle to attract financing though. |
| **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.<br><br>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. |

| 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.<br><br>Cumbersome bureaucratic procedures restrict private sector involvement.<br>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. |

| 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.<br><br>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 systems. |

| 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.<br><br>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.<br><br>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 (i.e. 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. |

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