

OFF-GRID RENEWABLES FEED AGRICULTURAL PRODUCTION

Photograph: IWM/Prashanth Vishwanathan

A farmer in India washes solar PV panels

Access to modern energy services is fundamental to improving livelihoods for over a billion people who lack electricity

In rural areas, agriculture and related agri-food activities are at the heart of the economy. Numerous households in developing countries derive their income from employment in harvesting, agro-processing, transporting and marketing produce, as well as subsistence farming.

However, rural communities often struggle with insufficient, costly resource access and are therefore limited to producing low-quality goods with little diversity. The high cost of energy, vulnerability to price fluctuations and lack of access to modern energy services can entrap rural economies in poverty, while also affecting wider food security.

**Off-grid renewables
support all stages of the
agri-food chain**

The number of people without access to electricity worldwide has been estimated at more than 1 billion. About 80% of those live in rural areas, which also host more than 70% of the world's poor – those who live on less than USD 1.25 a day. Decentralised renewable energy technologies are well suited to rural conditions, relatively easy to develop locally and increasingly affordable compared to other electricity solutions. Solar, wind and modern biomass facilities, built off the grid, therefore, offer an environmentally friendly and sustainable solution to end energy poverty.

Access to affordable, secure and environmentally sustainable energy along the different stages of the agri-food chain can support the development of rural communities, through job creation, poverty reduction, improved health, enhanced access to water and food, better livelihoods and gender equality.

Off-grid renewables can support productive activity at all stages of the agri-food chain. The installation of solar panels, a wind turbine or a biomass digester can transform a remote village, supporting irrigation (water pumping) and post-harvest activities including agro-processing and food preservation (drying, milling, pressing and cooling) for storage and transport. Modern renewable energy technologies also power sustainable food preparation and cooking.

These technologies produce heat from biomass, solar thermal and geothermal energy, as well as for food drying, cooling and cooking; water and wind mills that produce mechanical energy for agro-processing, with the option to simultaneously generate electricity. In addition, solar photovoltaic (PV), small hydropower and small wind and biomass installations can generate electricity for lighting and to power cooling appliances, processing equipment, computers and phones.

Along with the 1.1 billion people without electricity access, almost 2.8 billion people still relied on traditional, unsustainable biomass use for cooking and heating at the last estimate in 2012.

For many of these people, off-grid development could bring socio-economic benefits across the agri-food chain. These include economic benefits, such as savings on fuel spending; additional income generation; and job creation. Better food preservation

brings health benefits like preventing malnutrition and; reducing food and water contamination, in addition to the prevention of diseases related to indoor air pollution. Environmental benefits include lowering emissions, reducing deforestation and better waste management.

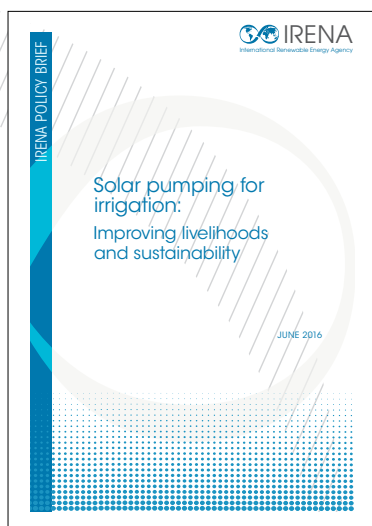
But technological solutions alone do not guarantee rural development. Realising the benefits also depends on:

- » effective policies and regulations;
- » co-ordination between the entities responsible for energy, agriculture, health, economic development and the environment;
- » capacity building and training to meet skills demand;
- » business and financial models; and
- » the nexus between food, energy and water



*IRENA's new digital publication, **Renewable Energy benefits: Decentralised Solutions in the Agri-food Chain**, analyses the benefits of introducing off-grid technologies to support agriculture.*

SOLAR PUMPING FOR IRRIGATION: IMPROVING LIVELIHOODS AND SUSTAINABILITY



Solar-based irrigation solutions can provide reliable, cost-effective and environmentally sustainable energy for decentralised irrigation services in a growing number of situations. The benefits include improved livelihoods, increased social welfare, and reduced spending on fossil fuel subsidies and centralised infrastructure.

The decision-making on energy options for irrigation lies at the heart of the water, energy and food nexus. This policy brief analyses the key drivers behind the adoption of solar pumping technology.

*For more information see **Solar pumping for irrigation: Improving livelihoods and sustainability***



EDF representative at a solar PV plant in rural Burkina Faso

PROJECT FINANCE HELPS ELECTRIFY RURAL COMMUNITIES

The government of Burkina Faso has set out to improve access to energy and increase national electrification within the next three years.

This is a key component of the country's development plans. Electrification rates are only 3-4% in underserved areas like Hauts-Bassins and Boucle du Mouhoun. To start improving the picture, IRENA has recommended a 3.6 megawatt (MW) rural electrification project in these two areas for concessional loan funding by the Abu Dhabi Fund for Development (ADFD). The project involves solar photovoltaic (PV) systems, PV/diesel and power distribution mini-grids.

The project coordinator is the Electrification Development Funds (FDE), a government funding and implementing body that has carried out similar projects with other multilateral development funds and banks.

The project targets 42 rural localities (30 in Hauts-Bassins and 12 in Boucle du Mouhoun), which include about 12 000 households, businesses, health and education facilities and community centres, with mini-grids, grid extensions and solar home system technologies.



This clinic manager stores medicines safely with the help of solar energy

The project identifies the most suitable and cost-effective technology for each user. In rural trading localities where populations are sufficiently dense, mini-grids can offer a competitive advantage, over either grid connection or installing individual solar kits. In sparsely populated areas, in contrast, households are best served with their own solar kits.

Giving villages electricity will transform people's lives and enable communities to move up the socio-economic development ladder. With the right infrastructure and conditions in place, solar PV can be cheaper than diesel-powered generator sets.

The project will allow the set-up of small enterprises and allow more people to earn income. Making clean, renewable power available can also contribute to an emissions reduction of 2 500 tonnes of carbon dioxide (tCO₂) each year, as well as improving local air quality.

"The IRENA/ADFD Project Facility is a pioneering partnership to fund renewable energy projects in developing countries around the world," said Adnan Z. Amin, Director-General of IRENA "These projects are improving the lives of hundreds of thousands of people by facilitating sustainable economic growth, bolstering energy security and expanding energy access."

For information on how to apply for funds through the **IRENA/ADFD Project Facility** as an applicant for funding, or how to participate as an expert or co-financier, please contact Seleha Lockwood, Programme Officer: slockwood@irena.org



Photograph: Energy for Development Network

RENEWABLE MINI-GRIDS LIGHT UP AFRICA

In Kenya, Tanzania and Uganda, companies and private investors are increasingly active in the expansion of access to modern, affordable electricity. M-KOPA Solar, a firm from Kenya, has connected more than 375,000 homes in the three countries to solar power, with over 550 new homes being added every day.

M-KOPA Solar uses a pay-as-you-go model. Buyers pay an initial deposit of USD 35 for the system. They then make 365 daily payments of USD 0.43 through M-Pesa, a mobile money system.

With 15% of the world's people living without electricity and many more dealing with unreliable access, off-grid solutions offer a cost-effective, environmentally sustainable way to extend electricity to unconnected areas.

The opportunity at hand is immense. But creating an enabling environment requires more than one building block. Technology must be adapted and made accessible for rural, un-electrified populations and combined with innovation in business and financing models. Policies and regulations shape the conditions for private sector involvement.

When all of these elements come together, they can spur rapid growth. The off-grid sector is inherently fragmented. Private companies are essential for the transition from a project-by-project to a market-based approach at a large scale. Yet co-operation is essential at this crucial stage for the market. Sharing experience from both the private and public sectors about the design and implementation of policies, financing schemes, business models and technology applications with help to drive costs down further.



IOREC is the global platform for sharing experience and best practices about design and implementation of enabling policies, tailored financing schemes, innovative business models and technology applications for stand-alone and mini-grid systems.

IRENA, in partnership with the Kenyan Ministry of Energy and Petroleum and the Alliance for Rural Electrification, organised the third IOREC, held in Nairobi between 30 September and 1 October.

The conference brought together over 550 stakeholders from across the off-grid renewable energy value chain, including representatives from rural electrification agencies, ministries in charge of renewable energy development, the private sector, academia, financing institutions and international organisations.



A solar mini-grid in a remote village in Nepal

RENEWABLE MINI-GRIDS: POLICY AND REGULATION

Off-grid solutions are estimated to supply nearly 60% of the additional generation needed to achieve universal electricity access; mini-grids will account for the majority. The business case for renewable energy mini-grids has never been stronger. Costs have fallen dramatically – over 80% since 2010 for solar photovoltaics (PV) – while technologies have continued improving.

Renewable energy mini-grids have a proven track record of delivering cost-competitive electricity services in rural areas. Traditional deployment models led by public utilities, non-governmental organisations and communities, are being complemented with private sector approaches. From local entrepreneurs to large international utilities, interest in the development, financing and operation of mini-grids is growing.

Governments have an important role in facilitating private sector participation. Mini-grid development is closely tied to national policy decisions and regulatory frameworks. Supporting mini-grids requires an adaptation of the power system framework, traditionally based on a centralised model. Mini-grid solutions are diverse, and so are the accompanying business and financing models. In recognition of these specificities, a number of countries are turning to dedicated policies and regulations that cater specifically to mini-grid development.

The policy and regulatory landscape for mini-grids is highly dynamic as governments introduce dedicated measures, gain experience and incorporate learning towards a more effective

framework for mini-grid development. Capturing country experience and facilitating sharing of best practices and lessons learnt in policy design and implementation is a key pillar of IRENA's workstream on energy access.

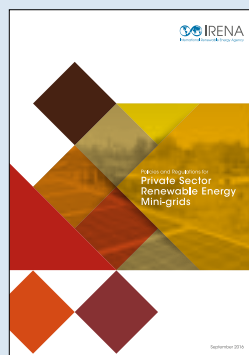
Policies and regulations for private sector renewable energy mini-grids is one of IRENA's releases for IOREC 2016, the third International Off-grid Renewable Energy Conference.

About the report

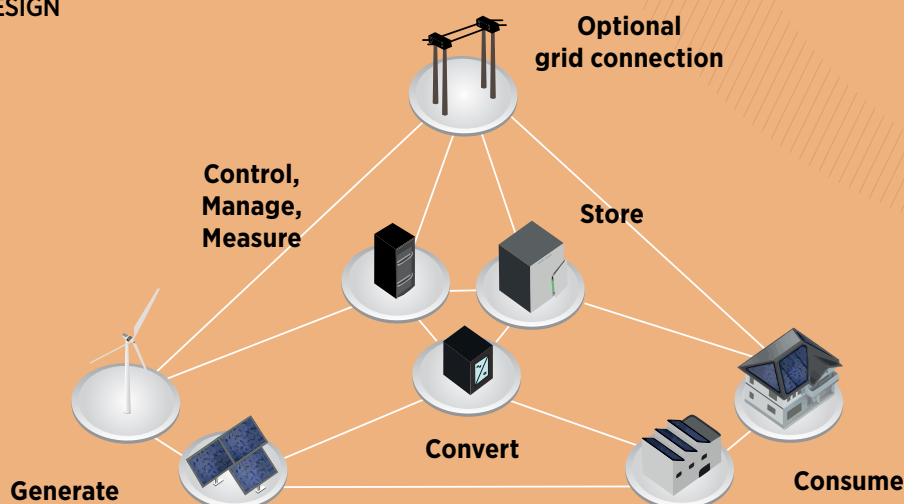
IRENA's latest policy report aims to support policy makers in the design of enabling frameworks for mini-grids. The report examines licencing, tariff regulation, risks related to main-grid arrival, and access to finance – the key factors investors in mini-grids consider.

The report finds that mini-grid configurations respond differently to policy and regulatory conditions. It analyses the specificities for mini-

grids based on solar, biomass, wind and small hydropower, or a combination of these with other energy sources. These need to be fully understood to develop the right policy mix.



MINI-GRIDS DESIGN



INNOVATION NEEDED TO MAKE MINI-GRIDS CHEAPER

Ground-breaking improvements are underway for the future of renewable mini-grids, not only in components, but in system integration, controllability and flexibility.

Renewable mini-grids continue to gain momentum as a sustainable energy solution, especially where grid extension is not cost effective. Existing diesel mini-grids have been progressively retrofitted with renewable energy technologies, reducing exposure to oil price volatility along with environmental damage and financial or economic costs.

Variable renewable energy, such as solar photovoltaic (PV) and small scale wind power, is being increasingly integrated into mini-grids, with energy storage solutions also incorporated to ensure stable output.

Mini-grids connect power generation and storage to a limited distribution network. Planning and design take these functions into consideration, as well as control,

management and measurement, conversion and consumption before construction starts. Mini-grids can supply different levels of service, from basic lighting to commercial needs and can be added eventually to the main grid or remain fully autonomous.

In a dynamic power sector, mini-grids have enormous potential:

- » **Energy Storage:** Lithium-ion, organic flow and other chemistry types will drive down the cost of batteries. Phase-change and thermochemical materials will allow increased use of thermal storage over long periods.
- » **Control, Management and Measuring:** Internet of Things technologies enable more intelligent use and control of electricity by allowing interconnection and intercommunication among conventional appliances.
- » **Conversion:** Nanomaterial semiconductors, such as carbon nanotubes, will have dual mode inverters that can operate even when the rest of the grid is down.

Further innovations in technology will help accelerate the uptake of renewables. By 2035 the typical mini-grid could be nearly 100% renewable.

Renewable mini-grids continue to gain momentum, especially where grid extension is not cost effective

Innovation Outlook: Renewable Mini-grids highlights the most promising technological developments to expect over the next two decades.



Photograph: Abbey Taylor-Smith / Panos Pictures / DfID

Off-grid renewables are essential to extend energy access worldwide by 2030

OFF-GRID KEY TO GLOBAL SCALE-UP OF RENEWABLES

Global power capacity from off-grid renewables could exceed 160 gigawatts (GW) by 2030 – similar to the total generating capacity in ASEAN (the Association of Southeast Asian Nations) countries or in Germany today. About 40% would come from solar photovoltaic (PV), if the right plans and policies are put in place without delay.

New technologies like pico-PV systems, typically below 10 watt-peak (Wp) and mostly with a voltage not above 12 volts can bring power to the poorest, most remote communities. Pico-PV systems can replace kerosene for lighting, or charge mobile phones. Off-grid telecom towers and water pumping stations can be powered by renewables instead of diesel generators, for instance, India has at least a gigawatt of telecom base stations, and Africa has nearly as much. Small-scale wind turbines (<500 kilowatt (kW)) can be used in villages, mostly installed in low-voltage grids, while micro-turbines (< 1 kW) can be installed on residential rooftops.

Accelerating rural electrification through renewable energy will require more effort from both project developers and governments. Governments need to provide dedicated policies for off-grid renewable solutions and mini-grids, as well as providing clarity on the long term rural electrification strategy.

Subsidies on energy prices and grid access can distort the market impeding the deployment of renewable energy. Data-collection and country statistics will need to be improved for target setting and policy analysis, complemented with regular monitoring.

The private sector role is also important. Companies need to engage with local communities to

demonstrate renewable energy solutions and develop. Training people to install, operate, and maintain systems is also critical to ensure off-grid projects are scalable and sustainable. Vendors need to reduce consumer risk with good after sales service.

IRENA's global renewable energy roadmap (REmap) evaluates pathways to double renewables in the global energy mix by 2030. REmap shows that off-grid systems can make an important contribution to climate change mitigation, taking care of about a quarter of the global carbon dioxide emission reductions needed in the power sector. This equates to 0.5-0.6 gigatonnes (Gt) per year by 2030.

Off-grid solutions call for dedicated policies

About half of all final renewable energy use in the global energy mix could be by way of electricity. Renewable electricity consumption would total 16 700 terawatt-hours (TWh), with roughly 1000 TWh of this related to extending modern energy access to unserved communities. Much of this would be through distributed generation, with off-grid systems playing a major role.

These technologies could include rooftop solar PV, small wind turbines connected to low-voltage networks or deployed in off-grid systems, small hydropower and other decentralised renewable power technologies.

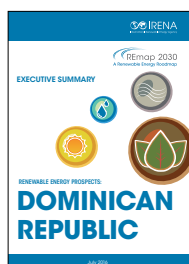
For more information on REmap, see: www.irena.org/remap

Recent publications



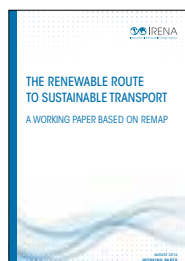
Solar PV in Africa: Costs and markets

This report shows installed costs for power generated by utility-scale solar PV projects in Africa have decreased as much as 61% since 2012. It further discusses challenges in policy making and proposes a co-ordinated effort to collect data on the installed costs of solar PV in Africa, across all market segments.



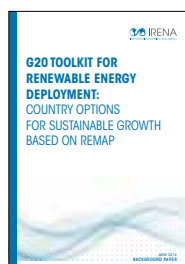
Renewable Energy Prospects: Dominican Republic

This country study highlights the potential to increase the share of renewable power generation in the Dominican Republic to as much as 44% by 2030, based largely on solar photovoltaics (PV), wind and bioenergy. The full report (to be released soon) provides a more detailed analysis of the power system and the challenges



The Renewable Route to Sustainable Transport: A working paper based on REmap

Energy use in transport accounts for around one-third of global final energy consumption, and demand is growing rapidly, at about 1% annually. The paper also proposes an action agenda to help boost renewable energy use in transport and improve the overall sustainability of the sector.



G20 Toolkit for Renewable Energy Deployment: Country options for sustainable growth based on REmap

The Group of Twenty (G20) has a leading role in accelerating renewable energy deployment. This background paper summarises the results, identifies action areas for G20 policy makers and proposes the next steps of a “REmap G20 process”.

www.irena.org/publications

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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