



# 10 QUESTIONS TO ASK ABOUT DISTRIBUTED GENERATION

LILY ODARNO, SARAH MARTIN, AND CATALINA ANGEL

## THE 10 QUESTIONS TO ASK SERIES: FRAMEWORKS FOR DESIGNING GOOD ELECTRICITY POLICY

The 10 Questions to Ask Series, or the 10Qs Series, is an initiative of the World Resources Institute’s (WRI) Electricity Governance Initiative (EGI) and Prayas Energy Group. Each paper in the series asks a set of 10 questions relevant to a particular topic within the broader electricity sector. It aims to build the capacity of electricity sector stakeholders—government agencies, regulators, utilities, the private sector, civil society and others—to design and participate in policy-making and implementation processes. The series pays particular attention to public interests—interests in which society has a stake and that warrant government recognition, promotion, and protection. These interests may include decisions concerning public expenditures, affordability, service quality, and impact on local and global resources. We consider “good” electricity policies to be those designed to improve the effectiveness of public expenditures, reduce unnecessary costs, raise the quality of service, and minimize social and environmental impacts. “Good” also refers to “good governance” as laid out in EGI’s flagship publication, the “Electricity Governance Initiative Assessment Toolkit” (EGI Assessment Toolkit). (See Box 1.)

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*Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback and to influence ongoing debate on emerging issues. Most working papers are eventually published in another form and their content may be revised.*

**Suggested Citation:** Odarno, L., S. Martin, and C. Angel. 2015. “10 Questions to Ask about Distributed Generation.” Working Paper. Washington, DC: World Resources Institute. Available online at <http://www.wri.org/publication/xxxx>.

The questions raised in the 10Qs Series are relevant in a variety of policy-making contexts. Electricity-sector stakeholders can use the 10Qs to assess or review electricity policies. Civil-society groups can draw on the 10Qs as a guide to engaging with policymakers at public hearings or other consultations.

The questions posed are designed to help readers focus on issues affecting their country or region. The questions can be used to identify crucial gaps and challenges within a country's electricity sector; query decision-makers on plans to fill those gaps; and help to ensure that electricity policies represent public interests by keeping social, economic, and environmental considerations in mind. Each question is formulated to emphasize the active role that stakeholders can play in policy design and review processes, and is accompanied by an explanation of its relevance to the public interest. The order of the questions does not reflect relevance or importance in decision-making. Users should feel free to adapt the questions to the knowledge level of different types of stakeholders. For

example, pilot tests found that stakeholders wanting to build the capacity of consumers to participate in public hearings needed to adopt less technical language.

Additional resources are provided at the end of each question for readers who are interested in pursuing topics within that question in greater detail. Relevant page numbers within those sources are indicated, where applicable. Furthermore, supplemental "Action Questions" are provided at the end of each question. They are meant to highlight the main takeaways in each question as well as equip users with deeper analytic questions to explore the issues addressed in more detail, in their particular country contexts. A summary table is also provided at the end of the document. It features a tabulated list of the supplemental action questions identified under the 10 major questions. It also identifies key actors relevant to each question, who represent the proposed target audiences with whom Civil Society Organizations (CSOs) might choose to engage. This table can serve as a quick reference guide or can be used to steer stakeholder discussions.

## Box 1 | TAP-C: Key Principles of Good Governance

### THE ELECTRICITY GOVERNANCE INITIATIVE TOOLKIT Benchmarking Best Practice and Promoting Accountability in the Electricity Sector

**Transparency and Access to Information:** Transparency is the process of revealing actions and information so that they can be scrutinized by outsiders. Attributes of transparency include the comprehensiveness, timeliness, availability, and comprehensibility of information, and whether efforts are made to ensure that information reaches affected and vulnerable groups as appropriate.

**Accountability and Redress Mechanisms:** Access to justice and redress are necessary to hold governments and actors in the private and public sectors accountable. Accountability includes the extent to which there is clarity about the role of various institutions in sector decision-making; there is systematic monitoring of sector operations and processes; the basis for decisions is clear or justified; and legal systems are in place to uphold public interests.

**Participation:** Diverse and meaningful public input helps decision-makers to consider different issues, perspectives, and options when defining a problem. Elements of access to participation include formal space for participation in relevant forums, the use of appropriate or sufficient mechanisms to invite participation, the inclusiveness and openness of such processes, and the extent to which the gathered input is taken into account.

**Capacity:** Capacity refers to the government's social, educational, technological, legal, and institutional ability to practice good governance, and the ability of civil society to engage in decision-making. This includes the capacity of government and official institutions to act autonomously and independently, the availability of resources (both human and financial) to provide access, and the capacity of civil society (particularly NGOs and the media) to analyze the issues and participate effectively.

*Source:* Dixit, S., N.K. Dubash, C. Maurer, and S. Nakhoda. 2007. "The Electricity Governance Initiative Toolkit—Benchmarking Best Practices and Promoting Accountability in the Electricity Sector." Washington, D.C. and Pune: EGI and Prayas Energy Group.

The 10Qs Series builds on the EGI Assessment Toolkit (EGI Toolkit), which provides a set of good governance indicators customized for policy and regulatory processes in the electricity sector. The EGI Toolkit highlights the good governance principles of transparency, accountability, and participation (TAP), which correspond to the principles of access to information, decision-making, and justice in Principle 10 of the 1992 Rio Declaration on Environment and Development (UNEP 1992). The EGI Toolkit adds a fourth principle of capacity (TAP-C) (see Box 1). Indicators from the EGI Toolkit may be used to supplement the 10Qs to assess procedural aspects of governance.

To date, the 10Q Series includes:

- 10 Questions to Ask about Electricity Tariffs
- 10 Questions to Ask about Integrated Resources Planning
- 10 Questions to Ask about Scaling On-Grid Renewable Energy
- 10 Questions to Ask about Distributed Generation

## INTRODUCTION TO DISTRIBUTED GENERATION

Electrification planning in many developing countries has for a long time focused on centralized large-scale generation in combination with grid extension. The gaps in electricity access in many parts of the developing world today, however, point to the insufficiency of this approach alone. Some 1.3 billion people are still without access to electricity, about 80 percent of whom live in rural locations in Sub-Saharan Africa and developing Asia (IEA 2011). In Sub-Saharan Africa, the number of people without access to electricity is expected to grow by 10 percent (from 585 million to 645 million) by 2030 (IEA 2011), largely because electrification efforts are failing to keep up with population growth (IEA 2011). It is projected that the majority of people lacking access by 2030 will still be living in rural areas. The high costs associated with the extension of the central grid to these usually remote locations have served as a major barrier to the delivery of energy services in such areas. Even for communities that are connected to the grid, inadequate and unreliable supply makes electricity almost inaccessible.

There is now a growing interest in the role of distributed generation (DG) options in filling the energy access gap. The IEA has projected that universal access to electricity by 2030 will require the adoption of approaches

### Box 2 | Distributed Generation

The term “distributed generation” (DG) used in this framework refers to electricity generation systems with capacities of about 200 watts through to a few megawatts (~10MW). These systems include isolated and grid-connected home systems (for example, systems with capacities in the hundreds of watts range, able to support refrigeration and food processing) (Bhatia and Angelou 2014) as well as micro- and mini-grids (islanded or grid-connected). Very small capacity devices, such as those for task lighting, are not considered here. While we recognize the relevance of these smaller devices in meeting household lighting and other basic needs, the markets for these products are quite different from those of larger capacity home systems and mini-grids and are less relevant to the policy, regulatory, and planning frameworks discussed in this framework.

that integrate both conventional grid and distributed generation options. It is estimated that nearly half (45.5 percent) of rural areas lacking electricity will be connected by mini-grids, and a quarter (24.5 percent) of rural areas will rely on small, stand-alone solutions such as solar home systems for first-time electricity access by 2030 (IEA 2013). In line with this, global initiatives such as Sustainable Energy for All (SE4ALL) have identified distributed solutions such as mini-grids as a High Impact Opportunity—an action category with great potential for advancing the objectives of the global energy access initiative.

Like conventional grids, the success of distributed generation options will depend largely on the creation of enabling environments that promote their development and scale-up and attract investment. Because of their smaller system sizes and different engineering and market requirements, the development of a supportive framework for the expansion of DG will raise new questions and present a new set of challenges to stakeholders such as planners, policymakers, entrepreneurs, investors, and civil-society groups. For national- and local-level planners, this could involve the challenge of developing new planning approaches that capture the role of distributed generation in national electrification efforts. For investors and entrepreneurs, the complexity created by the changing landscape of electricity markets can generate questions relating to the financial viability of the DG sector and related concerns about the fate of DG options if and when a central grid should arrive. Civil-society organizations also have to navigate a new energy-supply landscape and

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position themselves appropriately to work together with both the private and public sectors to create or facilitate the creation of the conditions that allow distributed electricity options to thrive and scale up.

The 10 Questions to Ask about Distributed Generation provides a framework for stakeholder engagement around the common questions and challenges that arise in the context of planning for and implementing DG options to address the electricity access gap. The 10 questions addressed in this framework shed light on the key considerations necessary for the long-term sustainability of DG projects (Figure 1). The key considerations are presented as questions with short explanations of their relevance.

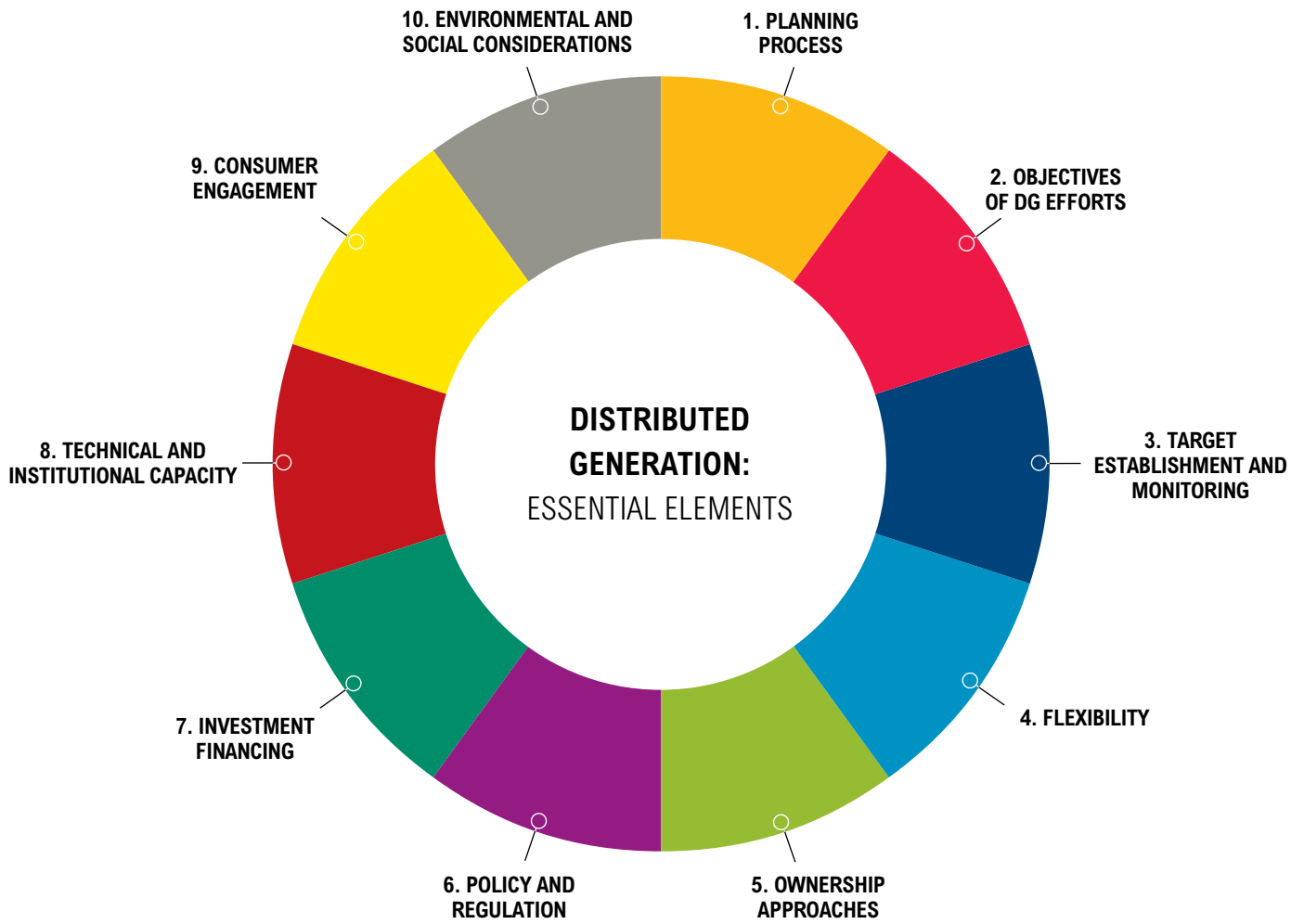
The 10Qs on Distributed Generation can be used in the following ways:

- As a stand-alone capacity-building framework for stakeholders involved in the implementation of DG projects or the development of enabling environments for DG options on national, sub-national, and local levels;
- As a framework for stakeholders to share information on how key issues will be addressed;
- As a framework for civil society to ask on-point questions of policymakers and planners;
- As a framework for identifying gaps and developing shared research agendas.

This framework can also be used to complement others developed by EGI and other institutions. The framework complements EGI's [10 Questions to Ask about Integrated Resource Planning](#) by clarifying the role of DG in an integrated electricity-planning approach. It can also be used in conjunction with frameworks that are emerging from global energy access initiatives. These initiatives are arising to help governments create holistic enabling environments for energy access that incorporate DG as part of a full range of applicable options. For example, the World Bank's Readiness for Investment in Sustainable Energy Indicators (RISE) is a Bank input into the SE4ALL process, which compares investment climates of countries across the three SE4ALL thematic areas on the basis of specified indicators. The 10Qs on Distributed Generation can provide a framework for planners and policymakers to think through the decisions and the practical actions they can take to promote viable investment climates for energy access in their countries per the RISE indicators.

Each of the 10 questions is accompanied by a set of supplementary "Action Questions" provided to equip stakeholders with a deeper set of analytical questions that serve as a guide for more context-specific discussions around the identified key elements. A few examples are also presented, not as prescriptions for best practice but to enable users of this framework to think broadly about what has or has not worked in some specific contexts.

Figure 1 | **Ten Essential Elements for Distributed Generation**



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## 10 QUESTIONS TO ASK ABOUT DISTRIBUTED GENERATION

### Q1: HOW IS DG BEING INTEGRATED INTO NATIONAL POWER-SECTOR PLANNING?

DG can play an increasingly important role in meeting national electrification needs. A holistic planning framework that carves out well-defined spaces for DG in meeting electrification targets and establishes a process for its implementation can help in establishing DG options as electrification options that are recognized by planners and policymakers. This might require a shift toward a planning approach that integrates grid extension with distributed generation to meet electricity access needs in places where such an integrated approach does not currently exist. Institutional arrangements for this integrated planning process differ from country to country but typically involve both national- and local-level planning efforts and agencies. Agencies responsible for distributed generation planning can include national ministries, national planning commissions, or local-level institutions, such as rural electrification agencies (REAs) that may be tasked with implementing electrification initiatives in local spaces. India's Ministry of New and Renewable Energy, a national ministry, oversees state-level RE agencies tasked with DG planning. Tanzania's REA provides guidance and support for rural electrification efforts, including projects with off-grid components (World Bank 2012).

A clear understanding of a country's electrification needs is crucial for effective planning for DG supply options. Understanding where the central grid can play a role and where it cannot over a given timeframe, as well as where markets exist for DG options, will be important in establishing where and how DG can play a role in energy access. In places where potential for DG is recognized, local-level planning can be critical in helping to determine which DG options are best suited to meeting electricity needs in these spaces: home systems, micro- or mini-grids. Spatial factors such as population density, size of human settlements, and distance from load centers are key elements that influence the choice of DG options. Planning for dis-

tributed generation, even if initiated at the national level, will thus benefit immensely from local-level demand and supply analysis to ensure that energy needs, as well as the range of available local options for meeting those needs, are well understood. A clearly defined process for community engagement in the characterization of energy needs, which also states exactly how the identified needs will be integrated into national- and local-level planning, can ensure that electricity planning responds to local electricity needs. (See Q4 for more on planning to meet changing demand over time.)

A national planning framework can also establish whether distributed generation is carried out by existing national utilities, private-sector actors, community cooperatives, or by some combination of these actors. Understanding questions relating to how distributed generation projects will be financed, who is responsible for regulating DG, and what the regulatory process entails, will be important in the planning process. (See Q6 and Q7 for more on regulation and financing.)

Establishing clear avenues for stakeholder engagement can help to promote a transparent and inclusive planning process. Comprehensive, transparent, and publicly available electrification plans, as well as a clear articulation of the composition, roles, and responsibilities of relevant actors, can foster effective stakeholder participation. Establishing clear processes that coordinate the work of local stakeholders, the implementing agency, the regulator, and relevant government ministries can help to promote effective deployment of distributed generation projects.

## Q1. Action Questions

- How effectively does your national electricity planning framework integrate both on-grid and off-grid options?
- How publicly accessible are national-planning frameworks?
- How well integrated are long-term national priorities with short- or medium-term electrification planning goals?
- How clear are the roles and responsibilities of actors in DG implementation (national utilities, independent power producers, and communities)?
- How inclusive, transparent, and effective is the process for stakeholder participation in the planning process?

## Additional Resources

## Pages

Toward Universal Energy Access: Designing a New Household Electrification Strategy for South Africa .....	All
Sustainable Development of Renewable Energy Mini-Grids For Energy Access: A Framework For Policy Design .....	11-17
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## Q2: HOW ARE THE OBJECTIVES OF DG EFFORTS BEING ESTABLISHED?

Objectives that steer DG efforts can be directly or indirectly related to electrification efforts, can be bound by short-, medium-, or long-term goals, and can involve energy only or larger national development priorities. For this reason, it is important that the objectives of distributed generation efforts be clearly identified and stated in DG planning efforts. Well-defined objectives can help to focus monitoring and evaluation processes to track whether objectives are being achieved. (See Q3 for more on monitoring and evaluation.) (Wood et al. 2014.)

Most distributed generation efforts in developing countries are focused primarily on meeting national electrification targets by providing a number of communities, households, and/or businesses with a defined set of energy services over a specified period of time. However, they can offer additional benefits and fulfill other objectives. For instance, they might help to reduce adverse fire and health impacts of traditional biomass and kerosene usage, and lower energy costs (especially in remote areas, where electricity generation options such as car batteries can be expensive) (Tenenbaum et al. 2014: 188, 201). Distributed generation systems might also satisfy other objectives, such as improving the reliability of the central grid or reducing peak power requirements, CO<sub>2</sub> emissions, and vulnerability to natural disasters (Bhattacharya 2013; FERC 2007).<sup>1</sup> Common mini-grid applications in developed countries include the provision of backup power for military bases, campuses, and hospitals (St. John 2013). Lower-capacity home systems, meanwhile, can be utilized for a variety of reasons, including low-carbon generation and reduction of utility costs (USEPA 2014).

As with on-grid electrification, any distributed-generation initiative must be mindful of its linkages with other development sectors, particularly rural development, livelihood development, and agriculture (Bhattacharya 2013: 33, 287). Indirect objectives should be considered and included in monitoring and evaluation processes. For example, expanding distributed generation could have downstream employment effects, through its operations and maintenance requirements. In areas where

the electricity source is capable of supporting productive activities, the use of equipment (for example, agricultural machinery) can further contribute to enhanced downstream economic benefits for local industries. Existing plans for other sectors can, in turn, affect the distributed generation initiative as well. For example, telecommunication companies with mobile phone towers in a particular area could serve as “anchor customers,” creating reliable demand for the power generated from a mini-grid, and potentially promoting the financial viability of a mini-grid business (Tenenbaum et al. 2014: 12). It is thus necessary to consider how existing plans for related sectors stand both to impact and be impacted by distributed-generation initiatives, and how synergies can be created among these related sectors.

Setting clear objectives for distributed generation can help planners to align local electrification efforts to meet these objectives. For example, if the aim of a program is to expand access to electricity for the satisfaction of lower-tier (Bhatia and Angelou 2014: 1-8) energy needs, such as refrigeration, then home systems with capacities in the hundreds of watts range would suffice.<sup>2</sup> However, if maximizing economic benefits of electricity access is the objective, plans will have to be made for the development of mini-grid systems with larger capacities that are able to support productive uses such as powering local industries.

Planning a distributed-generation system installment might require balancing competing objectives. For example, a hybrid system (such as diesel-solar) might be more cost-effective than a wholly renewable system, depending on the area’s resource endowment (Tenenbaum et al. 2014: 34). In this case, electrification planners would need to balance carbon-emissions reduction with electrification and affordability priorities. Affordability of energy services is a critical consideration for poor non-electrified communities. The identification of such competing objectives, as well as decisions regarding the prioritization of objectives, can benefit from an inclusive process that allows local communities to engage in decision-making.



## Q2. Action Questions

- How clearly articulated are the direct and indirect objectives of the distributed-generation effort?
- How clear are the links between distributed-generation efforts and other development goals?
- How are choices made between competing priorities?
- How inclusive, transparent, and effective is the process for stakeholder participation in the identification of objectives?

## Additional Resources

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Rural Electrification through Decentralised Off-Grid Systems in Developing Countries .....	33, 287, 293
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### Q3. HOW ARE DG TARGETS BEING ESTABLISHED AND MONITORED OVER TIME?

Once the role of distributed generation in meeting electricity access needs has been established, specific targets for DG can be set. Setting appropriate targets for DG first requires an understanding of the electricity-service needs to be addressed. It is important that DG project developers, whether public or private entities, work closely with local communities to characterize demand. Such demand characterization will enable an understanding of who needs electricity, how much is needed, and for what.

The World Bank/ESMAP Program has developed a multi-tier framework for energy access as an input into the SE4ALL Global Tracking Framework.<sup>3</sup> (See Table 1.) The multi-tier framework proposes an approach to classifying levels of energy access that focuses on eight performance characteristics of energy supply: quantity, quality, availability of supply, affordability, reliability, legality, convenience, and health and safety. Tiers of energy access are determined on the basis of the specific combinations of these attributes reflected in energy-supply systems.

Together with local communities, DG project developers can decide on the level of electricity service needed by communities. The multi-tier framework can thus be adopted for the development of country- or region-specific energy-service targets that focus on the performance characteristics of energy-supply systems. More guidance on the use of the multi-tier framework for setting energy-access targets can be found in the World Bank's Open Knowledge Repository (Capturing the Multidimensionality

of Energy Access) (World Bank 2015) and Practical Action's 2013 Poor People's Energy Outlook (Practical Action 2013).

Once the minimum desired energy-service levels are established, appropriate targets regarding the DG technologies and capacities can be set. An understanding of locally available energy resources such as solar irradiation, biomass resources, wind and hydro resources can help to identify potential DG technologies that can be adopted in a region. Technical considerations regarding the commercial availability and feasibility of implementing particular technologies in specific areas are also important. Even though some technologies might be commercially available, not all communities will have the capacity to accommodate and manage the complexity of these technologies.

An economic-potential assessment can determine the maximum capacity of distributed generation that can be deployed cost-effectively, given the available capital as well as other incentives such as government subsidies. A sound demand-side analysis enables decisions to be made as to whether viable markets exist for specific DG technologies and whether consumers are willing to pay for these services. This is pertinent for the long-term sustainability of DG efforts. An understanding of present and future energy needs helps in setting targets that are well aligned with present and projected energy needs. Economic assessments should also take into consideration future plans for central grid extension. This allows decisions to

#### Box 3 | Monitoring and Evaluating DG Efforts

Monitoring and evaluation of DG projects is usually carried out by national- and local-level government regulatory authorities that can define quality of service criteria for DG project developers. As markets for DG expand, capacity constraints within government regulatory agencies can prevent these agencies from effectively monitoring the many DG projects as they come online. Non-traditional actors such as civil-society actors

and/or community-based organizations can play a significant role in performing some of these monitoring and evaluation functions. With the private sector playing a significant role in the development of DG options, the creation of partnerships between the private sector and civil-society organizations could facilitate effective monitoring and evaluation. Establishing platforms for private-public engagement around distributed generation

could facilitate the positioning of CSOs and other community groups as honest brokers in DG projects. CSOs and community-based organizations can ensure that entrepreneurs provide quality products and services. They can also promote community acceptance of projects and provide the intelligence needed by private-sector actors to make informed decisions about their potential markets and effectively respond to consumer needs.

Table 1 | SE4ALL Multi-Tier Matrix for Access to Household Electricity Supply

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
<b>Typical applications of household electricity services</b>		None	Radio, task-lighting	<b>Tier 1+</b> General lighting, TV, light office needs	<b>Tier 2+</b> Air-cooling, food-processing. Task-oriented food preparation	<b>Tier 3+</b> Refrigeration, water-heating, pumps, expanded food preparation	<b>Tier 4+</b> Air conditions, space heating
<b>ATTRIBUTE 1: Peak Capacity</b>	Power		Very Low Power: Min. 3W	Low Power: Min. 50W	Medium Power: Min. 200W	High Power: Min. 800W	Very High Power: Min. 2kW
	Daily Capacity		Min. 12Wh	Min. 200Wh	Min. 1.0 KWh	Min 3.4 KWh	Min 8.2 KWh
	Or Services		Lighting of 1,000 lumen-hours per day	Electrical lighting, air circulation, television, and phone- charging are possible			
<b>ATTRIBUTE 2: Duration</b>	Hours per day		Min. 4hrs	Min. 4hrs	Min. 8hrs	Min. 16hrs	Min. 23hrs
	Hours per evening		Min. 1hr	Min. 2hrs	Min. 3hrs	Min. 4hrs	Min. 4hrs
<b>ATTRIBUTE 3: Reliability</b>					Max. three disruptions per day	Max. seven disruptions per week	Max. three disruptions per week of total duration <2hrs
<b>ATTRIBUTE 4: Affordability</b>					Cost of a standard consumption package of 365 kWh per annum is less than five percent of household income		
<b>ATTRIBUTE 5: Legality</b>					Bill is paid to the utility/pre-paid card seller/authorized representative		
<b>ATTRIBUTE 6: Health and Safety</b>					Absence of past accidents and perception of high risk in the future		
<b>ATTRIBUTE 7: Quality</b>					Voltage problems do not affect use of desired appliances		

Source: International Energy Agency (IEA) and The World Bank. 2015. "Progress towards sustainable energy 2015: Global tracking framework report." Washington, D.C.: World Bank. Online at: <http://trackingenergy4all.worldbank.org/~media/GIAWB/GTF/Documents/GTF-2105-Full-Report.pdf>

be made as to whether grid extension, distributed generation, or some combination of the two will be necessary to meet electrification needs.

Environmental and social impact assessments help to make clear the external impacts of distributed generation. These are important when deciding on the scale of DG options. For instance, in deciding on system sizes for small hydro plants, it is important that impacts on aquatic life be considered. In setting targets for biomass-based DG options, impacts on plant life as well as land-use patterns should be considered when determining an appropriate scale of operation. (See Q10 on Environmental and Social Impacts.)

Continuous monitoring and evaluation can help to ensure that set targets are met. Clear baselines as well as indicators of progress should be established for this purpose. For instance, if it is determined that a community requires a Tier 3 level of electricity service, indicators of progress can measure the capacity of electricity provided, the number of hours of service, the quality of the electricity produced etc. Civil-society organizations can play a critical role in monitoring and evaluating DG efforts.

The process for setting targets, the criteria for selecting particular DG technologies as the options of choice, and information about indicators of progress should be clear and publicly available, so that stakeholders can be well informed about the basis of decision-making.

### Q3. Action Questions

- How are DG targets established?
- How well do targets reflect supply conditions, as well as present and future energy demand profiles?
- What baselines and indicators are used to track progress toward stated targets?
- How effective is the process for monitoring and evaluating stated targets?
- How inclusive, transparent, and effective is the process for stakeholder participation in monitoring and evaluation?

### Additional Resources

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Progress Towards Sustainable Energy 2015: Global Tracking Framework Report.....	All
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Poor People's Energy Outlook 2013: Energy for Community Services .....	26-33
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## Q4: HOW FLEXIBLE AND RESPONSIVE IS DG PLANNING TO CHANGING CONDITIONS IN YOUR COUNTRY?

Distributed generation exists in a constantly changing landscape; there might be advances in technologies, changes in prices, the central grid might arrive at previously non-electrified areas, and energy demand dynamics can change. It is important that these changes are anticipated and planned for early in the process.

The question regarding the fate of DG options when the central grid arrives has been of particular interest to mini- and micro-grid developers in rural areas. For instance, within weeks of setting up a mini-grid in the Northern Indian Village of Dharnai, the government utility extended the grid to the village, threatening to put the mini-grid out of business (Obiko Person 2014). To mitigate this uncertainty, it is important that the regulatory process clearly define contingency measures in the event of central grid arrival. Regulation should clearly state whether mini-grid operators are to continue generating as isolated power producers, connect to and sell power to the national utility under well-defined power-purchase agreements, discontinue generation and act as distributors of wholesale power from the central utility, or cease operation entirely (Tenenbaum et al. 2014). A regulatory framework that establishes such contingency provisions helps to create an environment of certainty for investors that guarantees them returns on their investments. Tanzania's 2014 Electricity Act (CAP 131) for the Development of Small Power Projects outlines specific provisions for the arrival of the central grid. The act specifies rules for the interconnection of mini-grids to the central grid and for mini-grid operators to act as wholesale distributors once the grid arrives (EWURA 2014).

DG planning must also make arrangements for changes in energy-demand dynamics. Plans for future income-generation activities such as manufacturing will lead to an increase in load demand. Solar home systems which provide electricity for refrigeration and other basic household duties might not be sufficient to support the energy services needed by communities as they move up the energy ladder. In the Indian state of Chhattisgarh, the Chhattisgarh Renewable Energy Development Agency (CREDA), with the support of the central government's Ministry of New and Renewable Energy, initiated a renewable-energy program to provide lighting to remote communities using solar PV micro grids. The electrification program—which was seen as a temporary measure to provide lighting to the remote communities before the arrival of the central grid—designed its solar micro-grids to support lighting loads only. However, after the installation of the units, local community members began to acquire televisions and fans and energy needs in the communities changed. As demand exceeded supply, the micro-grids became overloaded, leading to the eventual shutdown of some systems (Schnitzer et al. 2014: 35). This example highlights how demand can change over time when electricity services are provided, requiring DG project developers to be adaptive to these dynamics and devise scale-up strategies early in the planning process, or plan for the adoption of technologies able to support larger load sizes.

Developments in technologies and markets can also lead to variations in the cost of power production from various DG options. In the case of biomass-based systems, for example, seasonal variations in the availability and cost of

### Box 4 | Flexibility in Determining Tariff Structures

The financial viability of a DG system is often dependent on the tariff structure upon which rates are based. Tariffs need to be high enough to cover O&M and capital costs, while simultaneously keeping consumer interests in mind. Considering the variety of

tariff structures that exist can help determine which cost structure is most financially viable and equitable. Such structures include: uniform national tariffs, avoided cost tariffs, and cost reflective tariffs (Tenenbaum et al. 2014). No one tariff structure is preferable to

another. Tariff structures can be combined or designed to respond to context-specific needs (for more information on tariff-setting processes, see 10 Questions to Ask about Tariff Setting).

feedstock can affect the cost of power generation at different times of the year. Tariffs can be reviewed periodically to account for these variations in generation and operation costs as applicable. It is important that such tariff review processes be transparent and inclusive to ensure that tariffs are affordable for consumers on the one hand and do not undermine the financial viability of DG projects on the other. (See Box 4: Flexibility in Determining Tariff Structures.) It might even be necessary to shift to different distributed-generation technologies as they become more commercially available and cheaper than existing ones.

Changes in the policy environment can have huge implications for the financial viability of a distributed-generation system. For example, discontinuing subsidies or lowering feed-in tariffs (for grid-connected DG systems) can threaten the financial viability of DG businesses. It is important to establish safeguards to protect DG project developers against any unanticipated policy and regulatory changes.

#### Q4. Action Questions

- What mechanisms are in place to monitor and respond to changes in energy demand over time?
- How clear and effective are policies for transitioning from DG if the central grid arrives?
- How effective are processes for the periodic review of tariffs?
- What safeguards against unanticipated policy and regulatory changes exist?

#### Additional Resources

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## Q5. WHAT OWNERSHIP APPROACHES CAN BE USED SUCCESSFULLY FOR DG IMPLEMENTATION IN YOUR COUNTRY?

A variety of ownership models can be applied both at the isolated-systems level and at the mini-grid level, and each model carries implications for the sustainability and financial viability of the project. DG systems can be owned by governments (including public utilities), communities, the private sector, individuals, or by some combination of these actors, and at multiple levels. Governments may own systems at municipal, state, or central level. Municipal ownership of mini-hydro grids has been employed in Bolivia, while state-level ownership of diesel mini-grids and solar home systems has been employed in Cambodia and Mexico, respectively. Nongovernmental ownership, meanwhile, can take the form of individual, cooperative, or community ownership of distributed-generation assets. In India, while many publicly supported mini-grid projects are promoted by the central Ministry of New and Renewable Energy, most are structured around a Village Energy Committee or Rural Electric Co-operative model (Palit and Sarangi 2014).

Table 2 highlights commonly used models for home systems and mini-grid, and identifies some advantages and disadvantages of those systems. When planning decentralized electrification, it is necessary to consider the types of ownership models available under the regulatory framework, and which is most appropriate given the particular implementation context.

Local conditions will determine which model is optimal. For example, a dealer model might be more appropriate for a solar-home-systems market that is competitive and economically attractive, while a Fee-for service (FFS) model might be superior where the market is less attractive on purely commercial terms (for example, low-density, low-income communities, which are commonly targeted by rural electrification efforts).

The model adopted is sometimes dependent on the existing level of government support. Private-sector actors, for instance, might be more inclined to engage in electrification efforts where effective government support exists, whether in the form of appropriate policies (for example, those that encourage independent power production) or the provision of incentives such as long-term concessions or output-based subsidies. Poorly designed government support programs can deter investments as well. (See Q6 and 7 for more on government incentives.)

In some countries, the national utility has an exclusive service territory, for areas that are not reached by the national grid. In this case, concessions are granted by the utility to concessionaires, allowing them to provide service within the utility's territory. This approach is used in Senegal where rural electrification is promoted through a public/private concessionaire approach. The country is divided into ten concession areas allotted to private operators through a competitive bidding process. Concessions are awarded for a minimum of 25 years and are technology-neutral, permitting each concessionaire to decide on the most appropriate technology given the prevailing local circumstances and market structures (Mawhood and Gross 2014; Senegalese Agency for Rural Electrification 2006). DG project developers should determine whether obtaining a concession should be a mandatory requirement in order to produce electricity. If so, transparency regarding the parameters by which concessions are determined, as well as processes that take into account investor needs and constraints, can help minimize the selection of inefficient projects that will under-deliver. For example, concessions can be granted to the operator offering the highest number of new connections in a specified amount of time, the lowest tariff levels, the lowest connection charges and the lowest required subsidy to achieve financial viability (World Bank 2008).



Table 2 | **Ownership Models for DG Options<sup>4</sup>**

Ownership Model	Description	Advantages	Disadvantages
<b>HOME SYSTEM</b>			
Third party lease/ Dealer	Customers sign a contract/lease and pay for the system over a set period of time (rather than paying for the power produced); leases can be structured so that customers pay none or some of the upfront costs before the lease term	Customer owns system after the lease period; no direct electricity costs	Customer responsible for operation and maintenance (O&M); potentially high upfront costs
Third party Power Purchase Agreement (PPA)	Customers sign a PPA to have a system built on the customer's property at no cost; through the PPA, a specific rate for the electricity generated (per kWh) each month is established	Customer avoids upfront cost of system; customer not responsible for O&M	Unless a service agreement or third party verifier exists to ensure quality of service, sub-standard services may be provided after PPA is signed
Fee-for service (FFS)	Developer retains ownership of the systems and provides electricity services for a fee; in some cases, a user may eventually become the system owner after paying the fee for a fixed amount of time	Customer not responsible for O&M; service tailored to energy needs	Developer owns system; price for service is determined by developer
<b>MINI-GRID</b>			
Private	Private entrepreneur or investor finances the construction, operation and management of the project, and provides service to consumers	Efficient O&M; not driven by political agendas	Profit-driven, not community-driven; customers unwilling to participate in electrification efforts in remote areas without adequate government support
Utility	Ownership of the mini-grid lies with utilities, which are usually publicly owned in most developing countries	Experienced entities with existing technical capacity and access to finance	Usually driven by political agendas; community engagement sometimes poor
Hybrid model	Usually involves multiple actors working together; for example, a mini-grid can be built and owned by a utility, and managed by a community based organization, while technical maintenance is handled by a private entity	Can involve diverse set of owners who can make up for each other's capacity constraints	Diversity of actors can complicate project development; high transaction costs

## Q5. Action Questions

- What kinds of DG ownership models have been used successfully in the project context?
- What are the advantages and disadvantages of the different ownership and delivery models in the project context?
- What types of concession provisions exist and how well are these provisions understood?

## Additional Resources

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## Q6. WHAT POLICY AND REGULATORY PROVISIONS ARE BEING CONSIDERED TO CREATE AN ENABLING ENVIRONMENT FOR DG?

An effective policy framework, which defines targets for achieving electrification through DG and is backed by effective regulation, can serve as a blueprint for the development and successful deployment of DG options. Further, it can help put DG on the agenda as a viable option for meeting electrification targets. Policy frameworks can be effective if they clearly outline the institutional, regulatory, and financing provisions, as well as the incentive structures that will be adopted, to promote the role of DG in meeting clearly stated electrification targets. India's Rural Electrification Policy, which was enacted in 2006, explicitly defines where DG should be developed to fulfill rural-electrification objectives, rather than expanding the grid (India Ministry of Power 2006; Palit et al. 2014: 3-4).

Policy frameworks are also important in stipulating financial provisions for the development of DG options, particularly with regard to subsidies. In some cases, electricity derived from mini-grids can be more expensive than electricity from the central grid (usually because of the high subsidies granted to grid-sourced electricity and the economies of scale it enjoys). Policy frameworks will have to consider how to level the playing field when considering mini-grid-derived electricity versus grid extension. In Tanzania, the primary components of solar systems (panels, batteries, inverters and regulators) were excluded from VAT and import taxes in order to make solar PV a more attractive option. End users were thus able to acquire these systems at more affordable prices (Tanzania Ministry of Energy and Minerals: 35).

Regulations, on the other hand, provide a framework of rules and incentives to promote DG development and protect the interests of consumers. Regulation can be implemented by a department within a government ministry, by a separate national regulatory entity, or delegated to non-traditional actors, such as renewable-energy agencies, community groups, and local courts and tribunals. (See Box 5 for an example of non-traditional regulation.) Implementation of regulation by such non-traditional actors is particularly the case when these actors are closest to the sites of project implementation. In Tanzania, a Rural Energy Agency was established in 2005 to focus on RE-based on- and off-grid projects for energy access; the agency acts as a de facto regulator at local levels (Deshmukh et al. 2013).

Regulation of distributed generation can differ from that of traditional utilities because of the smaller size and engineering requirements of DG systems. Regulation of DG generally includes specific technical, quality, and process standards that specifically relate to DG applications. In the case of mini-grids, technical specifications might include interconnection standards that anticipate future potential connection to the central grid, voltage and frequency standards, and safety standards. Solar home systems might also be required to comply with certain minimum safety and performance standards. Regulation might require the system to be certified before receiving subsidies, and stipulate minimum product output, minimum voltage, and minimum hours of appliance use supplied. Safety certification (for example, IEC standards) might be required for system components.<sup>5</sup> Installation can also be subject to inspection. Guidelines for quality testing of solar home systems, solar lanterns, and pico-solar products are available under the World Bank/IFC's "Lighting Africa" program (World Bank 2014). To minimize market uptake of poor quality solar-lighting products, Lighting Africa's Minimum Quality Standards have been adopted for the solar-lanterns market in Ethiopia. Products that have met the standards are more popular in Ethiopia's solar-lantern market than products that have not (Ethio Resource Group 2013; World Bank 2014).

Quality-of-service specifications refer to service reliability and ensure that a specified amount of electricity is delivered by a generation system. The United States Department of Energy (USDOE) and the National Renewable Energy Laboratory (NREL) have designed a Quality Assurance Framework for mini-grids that provides a framework for assessing whether or not consumers receive the specified levels of service that mini-grid operators are capable of providing, given prevailing local conditions. The framework does not mandate, but provides guidance on, different levels of service based on the quality of power produced (that is, voltage and frequency variations) as well as the reliability and availability of power. Contracts of service—signed between DG project developers and communities—are based on an agreed-upon service level, which is monitored periodically (USDOE 2014).

Although regulation is intended to protect consumers (for example, from abusive monopolies or poor service quality) and ensure the financial sustainability of DG efforts, compliance can impose a burden on small distributed-generation projects (Reiche et al. 2006).<sup>6</sup> “Light-handed” regulatory approaches can help to mitigate these burdens and support DG systems. For example, small power producers (SPP’s) operating small systems may be

excluded from some standard licensing procedures. This has been done in Tanzania where operators of system sizes below 100kW are exempted from licensing requirements even though they are required to register their activities with the national regulator (Deshmukh et al. 2013; Tenenbaum et al. 2014). Standardization, for example through the use of standardized PPAs, can also help to reduce regulatory burdens.

## Q6. Action Questions

- How clear is the policy framework for DG and how it is made accessible to the public?
- How do policies and regulations encourage and support DG development?
- How clearly has the role of the regulatory agency in the regulatory process been articulated?

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## Q7. HOW ARE INVESTMENTS IN DG BEING FINANCED?

Whether DG projects are implemented by governments, private developers, or communities, their financial viability over the long term will be dependent on the availability of sufficient financial flows to cover capital expenses, as well as operation and maintenance costs over time. Financial flows for DG are usually derived from four principal (often complementary) sources: government subsidies and financial incentives, donor grants, debt and equity financing, and consumer tariffs.

Different actors involved in DG projects tend to rely on different sources of financing even though some of these may be of cross-cutting relevance to all categories of DG project developers. For instance, most community-owned mini-grids are developed with donor grants. Whereas such grants are crucial for covering the initial costs of DG options in poor rural communities, they can only be sustainable over the long term if there is a clearly defined plan for their continued flow to support the operation and maintenance of DG implementation and/or if there are plans to ensure the self-sustenance of those projects over time through, for example, tariffs that recoup costs (Alliance for Rural Electrification 2011; Martinot et al. 2002).

For many private DG project developers, financing for DG is obtained through loans (from domestic and international banks) and through private equity from investors. Because experience with successful mini-grid business models remains limited, financiers are often deterred by concerns relating to the financial sustainability of mini-grids over the long term. This leads to diminished opportunities for equity financing and higher-interest loans from banks. Governments or donors can guarantee bank loans to DG developers in order to minimize both real and perceived risks. Government banks can also provide low-interest loans to private developers (Deshmukh et al. 2013). Governments must work to establish stable and clear policy and regulatory structures that signal support for the development of DG options, and that reduce risk, for example, by clarifying the fate of DG options when the central grid arrives (see Q4 on flexibility). Governments can also provide financial incentives such as feed-in-tariffs, tax breaks, and import-duty exemptions on home systems and system components for mini-grids, which might be beneficial to the development of DG options. The Government of Tanzania provides tax exemptions on wind

generators and solar energy systems in order to promote the development of these alternative energy sources (Tanzania Ministry of Finance 2013).

Government, private sector, and community DG projects can all benefit from subsidies, which are a popular source of funding for electricity projects, both DG and centralized. Subsidies can be targeted both at project developers and consumers. Subsidies for mini-grids are usually derived from national and sub-national governments, donors or other electricity consumers (Tenenbaum et al. 2014: 12). Subsidies are usually disbursed as capital subsidies, which go toward reducing the upfront costs of implementation of a particular DG technology. General experience with this approach, however, indicates that, like donor grants, one-time capital subsidies do not usually favor the development of sustainable projects over the long term. There is an increasing focus on performance-based subsidies that are disbursed over specified time periods and are linked to the effective delivery of services by the project developer (Deshmukh et al. 2013). For example, under India's remote village electrification program, the Ministry of New and Renewable Energy is covering up to 90 percent of the costs of implementing solar PV, biomass, and micro-hydro mini-grid systems. This is tied to a five-year maintenance agreement with the project implementer (Deshmukh et al. 2013).

Subsidies can also be targeted at consumers. Such subsidies might be targeted at reducing household connection-costs to a mini-grid or used to reduce the tariffs paid by poor households for the electricity they consume. Generally, in the electricity sector, a system of cross-subsidization has been used to provide support for lower-income consumers. In this approach, higher-income consumers pay a slightly higher tariff, which is used to offset a portion of the tariffs paid by lower-income households. (For more on cross-subsidies, see [Q10 in 10 Questions to Ask About Electricity Tariffs](#)). An important consideration when assessing and developing subsidies (both supply and demand side) is to ensure that they are well targeted and reach the intended beneficiaries. Ill-developed subsidies can be regressive and can benefit consumer segments that have little need for them. Complex and cumbersome subsidy disbursement processes that are associated with high transaction costs can also challenge the effective develop-

ment of DG projects (Deshmukh et al. 2013). In India, for example, a subsidy program designed to support the country's flagship national solar-energy initiative, the Jawaharlal Nehru National Solar Mission (JNNSM), was designed with grid-connected solar PV in mind. The complex subsidy structure made the purchase of solar home systems cumbersome and served as a disincentive to lending for small-scale solar applications. This example demonstrates that, even with the application of subsidies intended for renewable energy, their impact can be limited if subsidy design does not correspond with requirements specific to DG (SELCO 2012).

Consumer financing might also be necessary to enable poor rural consumers to pay for upfront costs of standalone home systems. Access to this kind of financing can be challenging because banks usually perceive poor consumers as high risk and, more often than not, are unwilling to extend credit to them. Government and donor support can provide loan guarantees to enable poor consumers to gain access to financing. Some microfinance institutions are helping to fill this financing gap. SELCO Solar in India has successfully worked with rural banks to provide consumer financing to enable poor rural households to purchase solar home systems. Bangladesh's Infrastructure Develop-

## Box 5 | Tariffs: Who sets them? How are they set?

### Retail Tariffs

A retail tariff is considered appropriate if it ensures the commercial viability of a project on the one hand and protects end-user interests on the other. The context of DG implementation directly affects decisions relating to who sets tariffs as well as the tariff-determination process. In markets where distributed generation is regulated, rules for tariff-setting are usually determined by a national or sub-national regulatory agency. For distributed generation options, it is important that tariff-setting procedures be streamlined to avoid imposing cumbersome administrative and financial burdens on developers. In Tanzania, the regulatory framework for small power producers permits power producers to establish tariffs that reflect the actual costs of operation (subject to approval by the national regulatory agency, EWURA). The regulations also give small producers the latitude to decide on how tariffs will be structured, that is, whether they will charge conventional kWh tariffs, flat tariffs, power tariffs or some combination of these. Retail tariffs proposed by power producers are, however, subject to approval by the national regulator. The Rural Electrification Agency has developed a project evaluation document that specifies how tariffs are to be calculated. Small power producers are also required to communicate proposed tariffs to the local communities

(through public meetings, radio and television broadcasts) and provide evidence of this community engagement to the regulatory agency (EWURA 2014).

In deregulated markets, tariff decisions are made by project implementers on a willing-buyer, willing-seller basis. The protection of community interests is particularly important under this approach, given the absence of a formal regulatory authority. Local communities and civil-society actors can serve as informal regulators in these situations. Electricity service agreements can be signed between DG operators and village representatives. Such service agreements can specify the nature of service to be received, the hours of electricity availability, and the maximum tariffs that will be charged. This approach has been successfully implemented in Cambodia, where a 15-year electricity service agreement was signed between the Smau Khney village and a private operator. The private operator also provided an annual \$200 budget to assist the village committee in carrying out its regulatory function (Tenenbaum et al. 2014: 79).

Participatory measures in tariff-setting processes help to address impacts that tariffs might have on various segments of society, whether households, small businesses, or

industries. Measures for participation include defined channels for review and appeal-of-tariff processes through public hearings or opportunities for written submissions, as well as mechanisms to address consumer grievances.

### Feed-in Tariffs

In the case of grid-connected DG systems, a clear process for the determination and implementation of feed-in tariffs is important. Mini-grid owners, for example, are guaranteed earnings on their projects even if the grid arrives; they are therefore able to plan with more certainty. Tariff methodologies are usually designed by national or sub-national regulatory agencies. There are two primary approaches to feed-in tariff determination: a technology-specific approach, which involves standardized calculations of tariffs based on the generation costs of specific renewable-energy technologies, and a technology-neutral avoided-cost approach, which sets tariff levels based on the utilities' avoided costs of generating the electricity produced by the DG operator (Tenenbaum et al. 2014). In order to promote transparency and accountability, it is important that tariff determination methodologies be transparent and publicly accessible. Processes for stakeholder engagement in the tariff-determination process should also be clearly outlined.

ment Company Limited (IDCOL), a non-bank financing institution, uses an interest-rate subsidy approach that provides capital subsidies—phased out over time—and interest-rate subsidies for consumers (via partner organizations) to improve the affordability of systems for the end user (IRENA 2013). New business models such as the “energy as a service” approach, where consumers pay for services provided rather than for equipment, are also

gaining ground and helping to circumvent some of the challenges associated with obtaining capital for the upfront costs of solar home systems.

Along with consumer financing, it is equally important to ensure that DG projects are somehow linked to income-generating activities and other development sectors in order to support sustained demand for energy services and greater ability to pay on the part of consumers (GVEP 2014).

## Q7. Action Questions

- How well known and explored are the available financing options for DG?
- How effective are subsidy structures and disbursal processes for DG?
- How effective is consumer financing for DG?
- How are DG projects linked to development sectors and productive activities?

## Additional Resources

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## Q8. HOW ARE LONG-TERM TECHNICAL, INSTITUTIONAL, AND OTHER CAPACITY REQUIREMENTS FOR DG BEING CONSIDERED?

Institutional capacity, technical knowledge, business skills and capacity in DG development, finance, operation, and maintenance are necessary for the successful implementation and expansion of distributed electricity access.

Institutional and human resource capacity requirements for distributed systems are often different from the typical capacity requirements of a centralized grid system. Training will therefore be required for project developers, regulators, utilities, financiers, and, in some cases, consumers. Governments and/or relevant agencies (such as rural electrification agencies) that are involved in oversight or regulation of DG might require additional education or training to manage mini-grids and home systems, for example.

Relevant agencies can prepare themselves to handle new challenges and complexities by identifying the knowledge and capacity requirements for long-term distributed electricity planning. This would involve identifying the kinds of regulatory oversight, technical knowledge, financing, stakeholder participation, commissioning, and monitoring that are required. For example:

- Agencies tasked with assessing cost-effectiveness of DG solutions versus central grid extension should have the capacity to analyze and validate cost and resource assessments. Regulators should understand how the tariff-setting process for mini-grids differs from that of the central utility. This is the case in India, where tariff structures are different for publicly and privately implemented mini-grid systems.
- Planners developing protocols for the future arrival of the central grid to off-grid areas should have the technical knowledge of requirements for the connection of distributed generation sources to the central grid (Palit et al. 2014).

Community/local capacity-building programs can be particularly beneficial for the success of decentralized projects. The presence of local technicians and project operators on site, who handle the operation and maintenance of systems throughout their lifetime, can help to promote long-term sustainability. In India, capacity building at the community level is emphasized through the national Decentralized Distributed Generation pro-

gram, which specifies that it is the responsibility of the project developer to provide training at the local level to facilitate project implementation. The Chattisgarh Renewable Energy Development Agency designed the “Installers Certification Program” to build the capacity of its internal workforce in readiness for the installation and commissioning of projects (Palit et al. 2014).

Since 2005, Grameen Shakti in Bangladesh, a rural-based renewable-energy company, has been setting up Grameen Technology Centers (GTCs) across the country to scale up its solar home system program. GTCs are meant to train local communities, and specifically women and children, to become solar technicians to produce and repair solar accessories. The aim is to empower people locally to produce solar accessories, provide maintenance services, and become entrepreneurs (Grameen Shakti 2015). By 2012, 45 village centers had been set up, all of which are managed by women engineers who live, work, and train in rural communities. GTCs provide villagers the option of getting their solar equipment repaired locally, rather than having to contact a central Shakti branch (Wimmer 2013).

Local capacity building is particularly critical for community-owned DG systems (Zerriffi 2011). The success of community-owned mini-hydro grids in Nepal, for example, has been attributed to the existence of effective capacity-building programs, among other factors. In Nepal, two donor-funded programs, the Energy Sector Assistance Program (ESAP) and the Rural Energy Development Program (REDP), have provided technical assistance to communities for the development of mini-hydro grids.<sup>7</sup> The REDP has focused specifically on community mobilization and has channeled its capacity-building efforts to communities through programs targeted at technical training and skills development, market development, environmental management, and enhancing the capacity of vulnerable groups to participate in mini-grid projects. Private-sector actors such as the Nepal Mini-Hydro Development Association (NMHDA) have also been instrumental in mini-hydro capacity-building efforts in the country. Working together with the Alternative Energy Promotion Center (AEPCC), a government institution established to promote the use of renewable-energy resources in Nepal, the NMHDA has worked under various donor-funded

programs to offer capacity-development programs for mini-hydro installers, operators, and maintenance and monitoring personnel (Bhattacharyya et al. 2014).

Consideration should be given to the financial resources needed to implement capacity-building programs. Train-

ing and skills-development programs can be costly, and have typically been covered by local or national governments, and international organizations. Private-sector actors are increasingly playing a role in capacity building because they recognize its relevance to the long-term sustainability of their projects.

## Q8. Action Questions

- How have the specific capacity-needs for planning, developing, operating, and maintaining the DG project under consideration been identified?
- Who is responsible for capacity building and how effective have they been in fulfilling their role?
- What community/local capacity-building programs exist?
- How accessible are financial resources for capacity-development programs?

## Additional Resources

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## Q9. HOW ARE CONSUMERS BEING ENGAGED IN DG EFFORTS?

Consumer engagement (either collectively as a community, or as individuals) is important not only for building support for projects, but also to promote the financial sustainability of DG efforts. Consumers can be engaged in both the planning and implementation of DG efforts.

In the planning phase, consumer engagement ensures that local energy needs, socio-economic characteristics, and capacity needs are well understood. Before decisions are made on technology choice, business models, and operation and maintenance structures for distributed generation options, consumers should be engaged to better understand the nature of their energy needs and their ability and willingness to pay for distributed energy services. The CHOICES project (Community and Household Options in Choosing Energy Services) in South Africa works closely with communities to enable them to make sustainable energy choices that reduce poverty and stimulate local development. Through capacity-building workshops, the project helps build capacity on questions around energy-access issues and opportunities, and identify energy-access investment options for the community.

Consumer engagement can help to inform decisions on whether to use mini-grids or solar home systems in the electrification effort. In addition, project developers can make informed decisions about tariff levels and payment and collection methods that are well suited to the nature of income flows and livelihood patterns of the target consumers. Decentralized Energy Systems of India (DESI Power), a non-profit power company in India that serves five villages in the states of Bihar and Madhya Pradesh, employs a differential tariff approach. Customers pay different tariffs based on whether they are commercial or residential, their locations, and their electricity usage. In the village of Gaiyari, for example, commercial customers are charged 12Rs/kWh, whereas residential customers pay 8Rs/kWh. Residential customers in other locations pay for the energy services received by paying a flat fee for lighting, refrigeration etc. (Schnitzer et al. 2014). This differential approach has been successful because of its sensitivity to the contextual realities of the target consumers.

Consumers can also be involved in the actual implementation of DG efforts. Consumers may participate in the marketing of solar home systems as well as the operation and maintenance of mini-grids. In order to enable consumers to engage effectively and perform these functions, it is important that their capacity needs be well understood. These might include technical, business/financial, and management capacities. Capacity gaps should not be identified by experts working in isolation, but should involve a participatory process in which local consumers actively engage in the identification of capacity gaps and participate in capacity-building programs designed to address the identified gaps (Bhattacharyya et al. 2014).

Gender considerations are important if consumer engagement efforts are to be inclusive. In many rural communities, decision-making processes tend to be skewed in a way that gives women very little representation in discussions on issues that affect them directly. A conscious effort to ensure the representation of women in such decision-making processes is therefore important. In addition, the energy-service needs of men and women may differ markedly. DG project developers can effectively address the energy needs of local communities if they have a clear understanding of these gendered differences in energy-service needs so as to respond to them appropriately. In some cases, women might have lower purchasing power than men. Equally, they might have very little access to credit and therefore be unable to participate in income-generation activities. This could affect their ability to pay for energy services in spite of their need for such services. A focus on gender in consumer engagement can enable effective responses to these challenges.

In spite of the benefits of consumer engagement, it might be perceived as a costly and time-consuming process by many DG project developers. However, it is important that these costs be weighed against the benefits of project success and sustainability over the long term.

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## Q9. Action Questions

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- How are consumers involved in the planning processes?
- How well articulated are the consumers' roles and responsibilities in the DG effort?
- What capacity-building programs exist for consumers?
- What processes exist to ensure that the concerns of women and marginalized groups are captured in consumer-engagement efforts?

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## Q10. HOW ARE ENVIRONMENTAL AND SOCIAL CONSIDERATIONS BEING FACTORED INTO DG PLANNING?

Well-planned DG programs can result in positive environmental and social benefits such as improved air quality, access to electricity and/or increased economic productivity for households, small businesses or entire communities. Poorly designed DG electrification plans, however, can have negative impacts on environmental and social well-being, including water, air, and noise pollution; disruption of local ecologies; adverse health effects; and safety issues, as well as increased social conflict and gender and economic divides (Alliance for Rural Electrification 2011).

Considering the impacts associated with DG early in the planning process can help to mitigate negative impacts, and build support for electrification initiatives among various stakeholders, including policymakers and local communities. For example, large-scale biomass use can increase competition for land that supports biodiversity and the livelihoods of local communities. A country can mandate an impact assessment of land use and biodiversity as a prerequisite for obtaining a license to operate a DG system that utilizes biomass on a significant scale (see Q10 in 10 Questions to Ask About Scaling Renewable Energy).

In addition to environmental impacts, DG can also have adverse social impacts. For example, local economic inequality and social conflict can increase if the benefits of electrification are enjoyed by only the wealthier households in a community (Alliance for Rural Electrification 2011: 7, 22; Zerriffi 2011: 170, 175). To minimize the likelihood of both environmental and social adverse effects, Sri Lanka's regulatory system includes a rigorous preapproval process for mini-grid systems that accounts for non-sector considerations. Obtaining approval under the Sri Lankan system requires much more than simply submitting an application to the national Sustainable Energy Authority (SEA) office. A detailed prefeasibility study must be conducted, which includes obtaining electricity sector approvals, environmental clearances, and projecting electricity production (Tenenbaum et al. 2014).

Electrification with DG can also have positive social impacts. DG implementation can create downstream jobs related to project management, system installation, operation, and maintenance (Alliance for Rural Electrification

2011: 21). For example, an assessment of the employment potential of a DG project can help in forecasting human resources requirements in cases where job creation is an objective of the electrification effort. Such information can include the projected number of jobs, types of jobs, and human know-how necessary for plan implementation (Wood et al. 2014: 20).

It is important that the impact assessment process be participatory so that the views of those affected by the project both positively and negatively are recognized. Impact assessments should be particularly sensitive to the views of marginalized members of communities. A participatory process that ensures that the views of women are captured can enable a clearer understanding of their links to resources such as land, water, and biomass. Such understanding will sometimes be important for the development of DG options. Women might depend directly on these resources for agriculture and household energy. Considerations of the gender implications of resource use in DG development is critical to ensure that the development of DG options does not result in negative impacts and/or hamper access to resources for women or other marginalized members of society. Understanding and communicating potential positive and negative impacts of DG project can help assuage stakeholder anxiety and garner support for decentralized electricity plans. If assessments are made publicly available and the public is given opportunities for consultation in the electrification plan, local communities can have a greater participatory role in the planning process. This presents the opportunity to address local stakeholder concerns and increase acceptance of distributed-generation systems among local communities. Effective mechanisms should also be set up to offer redress for consumer grievances (Deshmukh et al. 2013).

Conducting impact assessments takes time and resources, however, and can be cumbersome for dealers trying to sell smaller capacity systems (for example, solar home systems). Governments can decide to require impact assessments only in the case of specific system sizes with potential for creating significant environmental impacts, in order to reduce the burden associated with project development. Ultimately, the protection of environmental and social interests should be the key determinant of any such decision.

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## Q10. Action Questions

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- How are environmental and social impacts associated with DG projects considered and accounted for in project planning?
- How effective is the process for impact assessments, including environmental and social impact reviews?
- How are impacts communicated? For example, through official documents, websites, media and/or public hearings?

## Additional Resources

## Pages

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Sustainable Development of Renewable Energy Mini-Grids for Energy Access: A Framework for Policy Design .....	4-5, 14, 18-19
From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa.....	88-97
10 Questions to Ask About Scaling On-Grid Renewable Energy .....	22

## SUMMARY TABLE

The summary table features a tabulated list of the supplementary action questions identified under the ten major questions. This table can serve as a quick reference guide or can be used to steer stakeholder discussions. The table identifies key actors relevant to each question, who represent the proposed target audiences with whom Civil Society Organizations (CSOs) might choose to engage. The actors identified are parties commonly involved in these processes and issues but they can vary depending on the context.

QUESTION	ACTION QUESTIONS	KEY ACTORS
<b>Q1</b> How is DG being integrated into national power sector planning?	<ul style="list-style-type: none"> <li>■ How effectively does your national electricity planning framework integrate both on-grid and off-grid options?</li> <li>■ How publicly accessible are national planning frameworks?</li> <li>■ How well integrated are long-term national priorities with short- or medium-term electrification planning goals?</li> <li>■ How clear are the roles and responsibilities of actors in DG implementation (national utilities, independent power producers, and communities)?</li> <li>■ How inclusive, transparent, and effective is the process for stakeholder participation in the planning process?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries<sup>8</sup></li> <li>■ National planning agencies</li> <li>■ Local planning agencies<sup>9</sup></li> <li>■ Regulators</li> <li>■ Power producers</li> </ul>
<b>Q2</b> How are the objectives of DG efforts being established?	<ul style="list-style-type: none"> <li>■ How clearly articulated are the direct and indirect objectives of the distributed generation effort?</li> <li>■ How clear are the links between distributed generation efforts and other development goals?</li> <li>■ How are choices made between competing priorities?</li> <li>■ How inclusive, transparent, and effective is the process for stakeholder participation in the identification of objectives?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Development agencies</li> </ul>
<b>Q3</b> How are DG targets being established and monitored over time?	<ul style="list-style-type: none"> <li>■ How are DG targets established?</li> <li>■ How well do targets reflect supply conditions as well as present and future energy demand profiles?</li> <li>■ What baselines and indicators are used to track progress toward stated targets?</li> <li>■ How effective is the process for monitoring and evaluating stated targets?</li> <li>■ How inclusive, transparent, and effective is the process for stakeholder participation in the monitoring and evaluation process?</li> </ul>	<ul style="list-style-type: none"> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> </ul>
<b>Q4</b> How flexible and responsive is DG planning to changing conditions in your country?	<ul style="list-style-type: none"> <li>■ What mechanisms are in place to monitor and respond to changes in energy demand over time?</li> <li>■ How clear and effective are policies for transitioning from DG if the central grid arrives?</li> <li>■ How effective are processes for the periodic review of tariffs?</li> <li>■ What safeguards against unanticipated policy and regulatory changes exist?</li> </ul>	<ul style="list-style-type: none"> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Regulators</li> </ul>
<b>Q5</b> What ownership approaches can be used successfully for DG implementation in your country?	<ul style="list-style-type: none"> <li>■ What kinds of DG ownership models have been used successfully in the project context?</li> <li>■ What are the advantages and disadvantages of the different ownership and delivery models in the project context?</li> <li>■ What types of concession provisions exist and how well are these provisions understood?</li> </ul>	<ul style="list-style-type: none"> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Utilities</li> <li>■ Private sector</li> <li>■ Community groups</li> </ul>



	QUESTION	ACTION QUESTIONS	KEY ACTORS
<b>Q6</b>	What policy and regulatory provisions are being considered to create an enabling environment for DG?	<ul style="list-style-type: none"> <li>■ How clear is the policy framework for DG and how it is made accessible to the public?</li> <li>■ How do policies and regulations encourage and support DG development?</li> <li>■ How clearly has the role of the regulatory agency in the regulatory process been articulated?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Regulators</li> </ul>
<b>Q7</b>	How are investments in DG being financed?	<ul style="list-style-type: none"> <li>■ How well known and explored are the available financing options for DG?</li> <li>■ How effective are subsidy structures and disbursement processes for DG?</li> <li>■ How effective is consumer financing for DG?</li> <li>■ How are DG projects linked to development sectors and productive activities?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ Regulators</li> <li>■ Banks</li> <li>■ Donors and lending institutions</li> <li>■ Private investors</li> </ul>
<b>Q8</b>	How are long-term technical, institutional, and other capacity requirements for DG being considered?	<ul style="list-style-type: none"> <li>■ How have the specific capacity-needs for planning, developing, operating, and maintaining the DG project under consideration been identified?</li> <li>■ Who is responsible for capacity building and how effective have they been in fulfilling their role?</li> <li>■ What community/local capacity-building programs exist?</li> <li>■ How accessible are financial resources for capacity-development programs?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Community groups</li> <li>■ Banks</li> <li>■ Donors and lending institutions</li> </ul>
<b>Q9</b>	How are consumers being engaged in DG efforts?	<ul style="list-style-type: none"> <li>■ How are consumers involved in the planning processes?</li> <li>■ How well articulated are the consumers' roles and responsibilities in the DG effort?</li> <li>■ What capacity-building programs exist for consumers?</li> <li>■ What processes exist to ensure that the concerns of women and marginalized groups are captured in consumer-engagement efforts?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Community groups</li> <li>■ Banks</li> </ul>
<b>Q10</b>	How are environmental and social considerations being factored into DG planning?	<ul style="list-style-type: none"> <li>■ How are environmental and social impacts associated with DG projects considered and accounted for in project planning?</li> <li>■ How effective is the process for impact assessments, including environmental and social impact reviews?</li> <li>■ How are impacts communicated? For example, through official documents, websites, media and/or public hearings?</li> </ul>	<ul style="list-style-type: none"> <li>■ Relevant ministries</li> <li>■ National planning agencies</li> <li>■ Local planning agencies</li> <li>■ Environmental agencies</li> </ul>

## REFERENCES

- Bardouille, P. and S.A. Clancy. 2013. "Toward universal energy access: Designing a new household electrification strategy for South Africa." Washington, D.C.: International Finance Corporation. Online: [http://smartlessons.ifc.org/uploads/smartlessons/20130911T113850\\_2013%20-%20Pepukaye%20Bardouille%20-%20SA%20Electrification%20%28UPDATED%29.pdf](http://smartlessons.ifc.org/uploads/smartlessons/20130911T113850_2013%20-%20Pepukaye%20Bardouille%20-%20SA%20Electrification%20%28UPDATED%29.pdf)
- Bhatia, M., and N. Angelou. 2014. "The Multi-Dimensionality of Energy Access." *Live Wire*. World Bank Group. Online: [http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/02/27/090224b082b6d2b4/2\\_0/Rendered/PDF/Capturing0the00ity0of0energy0access.pdf](http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/02/27/090224b082b6d2b4/2_0/Rendered/PDF/Capturing0the00ity0of0energy0access.pdf)
- Bhattacharyya, S. 2006. "Energy access problem of the poor in India: Is rural electrification a remedy?" *Energy Policy* 34: 3387-3397.
- Bhattacharyya, S. (Ed.) 2013. "Rural electrification through decentralised off-grid systems in developing countries." London: Springer-Verlag.
- CAMCO, UNDP (United Nations Development Program) and Climate Parliament. (N.d.). "Mini-grid toolkit field study report for Kenya, Mozambique and Zambia." Online: <http://www.climateparl.net/cpcontent/pdfs/Mini-Grid%20Pack%20-%20Fieldwork%20Report.pdf>
- Denholm, P. and M. Hand. 2011. "Grid flexibility and storage required to achieve very high penetration of variable renewable electricity." *Energy Policy* 39 (3): 1817-1830.
- Deshmukh, R., J.P. Carvallo, and A. Gambhir. 2013. "Sustainable development of renewable energy mini-grids for energy access: A framework for policy design." University of California: Lawrence Berkeley National Laboratory and Prayas Energy Group.
- Ethio Resource Group. 2013. "Lighting Africa Program: Ethiopia market intelligence." Addis Ababa, Ethiopia.
- Ezzati, M. and D. Kammen. 2001. "Quantifying the effects of exposure to indoor air pollution from biomass combustion on acute respiratory infections in developing countries." *Environmental Health Perspectives* 109(5): 481-488.
- FERC (Federal Energy Regulatory Commission). 2007. "The potential benefits of distributed generation and rate-related issues that may impede their expansion." Washington, D.C.: U.S. Department of Energy, Federal Energy Regulatory Commission.
- Glemarec, Y. 2012. "Financing off-grid sustainable energy access for the poor." *Energy Policy* 47:87-93.
- Grameen Shakti. 2015. "Diversification and scaling up GS Activities through entrepreneur development." Online: [http://www.gshakti.org/index.php?option=com\\_content&view=article&id=79&Itemid=68](http://www.gshakti.org/index.php?option=com_content&view=article&id=79&Itemid=68).
- Gujba, H., S. Thorne, Y. Mulugetta, K. Rai, and Y. Sokona. 2012. "Financing low-carbon energy access in Africa." *Energy Policy* 47: 71-78.
- IDCOL (Infrastructure Development Company Limited). 2014. "Solar Home System Program." Online: <http://idcol.org/home/solar>.
- IEA (International Energy Agency). 2002. "Distributed generation in liberalised energy markets." Paris: OECD Publishing. Online: [http://www.oecd-ilibrary.org/energy/distributed-generation-in-liberalised-electricity-markets\\_9789264175976-en](http://www.oecd-ilibrary.org/energy/distributed-generation-in-liberalised-electricity-markets_9789264175976-en).
- IEA. 2011. *World Energy Outlook 2011 Energy for all: Financing access for the poor.* Paris: OECD/IEA. Online: [http://www.iea.org/papers/2011/weo2011\\_energy\\_for\\_all.pdf](http://www.iea.org/papers/2011/weo2011_energy_for_all.pdf).
- IEA. 2013. *World Energy Outlook 2013*. Paris: IEA.
- IEA and World Bank. 2015. "Progress towards sustainable energy 2015: Global tracking framework report." Washington, D.C.: World Bank. Online: <http://trackingenergy4all.worldbank.org/~media/GIAWB/GTF/Documents/GTF-2105-Full-Report.pdf>.
- IEC (International Electrotechnical Commission). 2014. "Renewable energy standards development: Solar power." Online: [http://www.iec.ch/renewables/solar\\_power.htm](http://www.iec.ch/renewables/solar_power.htm).
- India Ministry of Power (2006) "Rural electrification policy." Online: [http://powermin.nic.in/upload/RE\\_Policy.pdf](http://powermin.nic.in/upload/RE_Policy.pdf).
- IRENA (International Renewable Energy Agency). 2012. "Mozambique renewables readiness assessment 2012." Abu Dhabi: IRENA Secretariat.
- IRENA. 2012. "IOREC 2012: International off-grid renewable energy conference: Key findings and recommendations." Abu Dhabi: IRENA Secretariat. Online: [http://www.irena.org/DocumentDownloads/Publications/IOREC\\_Key%20Findings%20and%20Recommendations.pdf](http://www.irena.org/DocumentDownloads/Publications/IOREC_Key%20Findings%20and%20Recommendations.pdf).
- IRENA. 2013. "IRENA workshop series on efficient renewable energy integration in the pacific islands region." Online: <https://www.irena.org/DocumentDownloads/events/2013/March/Palau/Agenda.pdf>.
- IRENA. 2014. "Accelerating off-grid renewable energy IOREC 2014: Key findings and recommendations." Abu Dhabi: IRENA Secretariat. Online: [http://www.irena.org/DocumentDownloads/Publications/IRENA\\_2nd\\_IOREC\\_2015.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_2nd_IOREC_2015.pdf).
- MNRE (India Ministry of New and Renewable Energy). 2014. "Decentralized systems programme." Online: <http://mnre.gov.in/schemes/decentralized-systems/>.
- NREL (National Renewable Energy Laboratory). 2012. "Life cycle greenhouse gas emissions from solar photovoltaics." Golden, CO: NREL. Online: <http://www.nrel.gov/docs/fy13osti/56487.pdf>.

---

NREL. 2013. "Wind LCA harmonization." Golden, CO: NREL. Online: <http://www.nrel.gov/docs/fy13osti/57131.pdf>.

Obiko Person, N. 2014. "Cheap electricity for poor squeezing out solar in India." *Line Mint*, November 20, 2014. Online: <http://www.livemint.com/Industry/BZDb90P26Z46hukdj1QXfl/Cheap-electricity-for-poor-squeezing-out-solar-in-India.html>.

Ohiare, S. 2015 "Expanding electricity access to all in Nigeria: a spatial planning and cost analysis." *Energy, Sustainability and Society*: 5:8.

Palit, D. and G.K. Sarangi. 2014. "Renewable-energy-based rural electrification: The mini-grid experience from India." New Delhi: TERI (The Energy and Resources Institute) and GNESD (Global Network on Energy for Sustainable Development).

Practical Action. 2013. "Poor people's energy outlook 2013: Energy for community services." Rugby, United Kingdom: Practical Action Publishing.

Practical Action. 2014. "Poor people's energy outlook 2014: Key messages on energy for poverty alleviation." Rugby, United Kingdom: Practical Action Publishing.

REA (Tanzania Rural Energy Agency). 2014. "Rural energy agency home." Online: <http://www.rea.go.tz/>.

REA. 2013. "National electrification program prospectus." Online: <http://www.ied-sa.fr/index.php/en/documents-and-links/publications/send/3-reports/33-national-electrification-program-prospectus.html>

Reiche, K., B. Tenenbaum, and C. Torres. 2006. "Electrification and regulation: Principles and a model law." Energy and Mining Sector Board Discussion Paper No. 18, July. Washington, D.C.: The World Bank.

Schnitzer, D., D.S. Lounsbury, J.P. Carvallo, R. Deshmukh, J. Apt, and M. Kammen. 2014. "Microgrids for rural electrification: A critical review of best practices based on seven case studies." Washington, D.C.: UN Foundation.

SELCO (Solar Electric Light Company). 2012. "The national solar mission: A practitioner's perspective." Online: [http://www.selco-india.com/pdfs/nsm\\_practitioner%27s\\_perspective.pdf](http://www.selco-india.com/pdfs/nsm_practitioner%27s_perspective.pdf).

Sevea, Association Loi. 2013. "Husk Power Systems—Power to empower." France: Sevea. Online: [http://www.sevea-asso.org/wa\\_files/Case\\_20study\\_20HPS\\_20Vcomprime\\_CC\\_81.pdf](http://www.sevea-asso.org/wa_files/Case_20study_20HPS_20Vcomprime_CC_81.pdf).

SE4ALL (Sustainable Energy For All). 2013. "Global tracking framework." Online: <http://www.se4all.org/tracking-progress/>.

St. John, G. 2013. "The military micro-grid as smart grid asset." *Green Tech Media*: May 17, 2013. Online: <http://www.greentechmedia.com/articles/read/the-military-microgrid-as-smart-grid-asset>.

Sustainable Engineering Lab. 2015. "Rural electrification." New York: The Earth Institute, Columbia University. Online: <http://sel.columbia.edu/rural-electrification/>.

Tenenbaum, B., C. Greacen, T. Siyambalapatiya, and J. Knuckles. 2014. "From the bottom up: How small power producers and mini-grids can deliver electrification and renewable energy in Africa." Washington, D.C.: The World Bank.

The Africa Electrification Initiative. 2012. "Institutional Approaches to Electrification: The Experience of Rural Energy Agencies/Rural Energy Funds in Sub-Saharan Africa." Washington, D.C.: The International Bank for Reconstruction and Development/The World Bank Group.

UNEP (United Nations Environment Programme). 1992. "Rio Declaration on Environment and Development." Online: [http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163](http://www.unep.org/Documents/Multilingual/Default.asp?documentid=78&articleid=1163)

USDOE (United States Department of Energy). 2014. "Promoting energy access through a quality assurance framework for mini-grids." Online: <http://www.cleanenergyministerial.org/Portals/2/pdfs/GlobalLEAP-MiniGrids-QA-framework.pdf>.

U.S.EPA (United States Environmental Protection Agency). 2014. "Solar power purchase agreements." Online: <http://www.epa.gov/greenpower/buygp/solarpower.htm#three>

Washington State DOE. 2011. "Focus on Diesel Exhaust Health Risks." Olympia, WA: Department of Ecology. Online: <https://fortress.wa.gov/ecy/publications/publications/1102005.pdf>

Wimmer, N. 2013. "Grameen Shakti: A vanguard model for rural clean energy." *International Rivers*. Online: <http://www.internationalrivers.org/resources/grameen-shakti-a-vanguard-model-for-rural-clean-energy-7888>.

Winiacki, J., and K. Kumar. 2014. "Access to energy via digital finance: Overview of models and prospects for innovation." Washington, DC: CGAP (The Consultative Group to Assist the Poor).

Wood, D., S. Martin, B. Jairaj, S. Dixit, and L. Tawney. 2014. "10 Questions to ask about scaling on-grid renewable energy." Working Paper. Washington, D.C.: World Resources Institute. Online: <http://www.wri.org/publication/10-questions-scaling-on-grid-renewable-energy>.

Wood, S., M. Martin, and A. Sinha. (Forthcoming.) "Sustainable energy access forums: Strengthening enabling environments through multi-stakeholder partnerships." Washington, D.C.: WWF and WRI.

World Bank. 2008. "Designing sustainable off-grid rural electrification projects: principles and practices." Washington, D.C.: The World Bank, The Energy and Mining Sector Board. Online: <http://siteresources.worldbank.org/EXTENERGY2/Resources/OffgridGuidelines.pdf>.

World Bank. 2013. "Mali Rural Electrification Hybrid System Project". World Bank Energy Group. Online: [http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/11/22/000356161\\_20131122125659/Rendered/PDF/PAD6880PAD0P13010Box379866B000UO090.pdf](http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/11/22/000356161_20131122125659/Rendered/PDF/PAD6880PAD0P13010Box379866B000UO090.pdf)

World Bank. 2014. "IFC/World Bank set global standard for clean off-grid lighting." Online: <http://lightingafrica.org/ifcworld-bank-set-global-standard-for-clean-off-grid-lighting/>.

World Bank. 2014. "Readiness for investment in sustainable energy (RISE)." Online: <http://rise.worldbank.org/>.

World Bank. 2015. "Open knowledge repository." Online: <https://openknowledge.worldbank.org/>

WRI (World Resources Institute). 2013. "Implementation strategies for renewable energy services in low-income, rural areas." Keys to achieving universal energy access series, Issue Brief 1. Washington, D.C.: World Resources Institute.

Zerriffi, H. 2011. "Rural electrification: strategies for distributed generation." New York: Springer Science+Business Media.

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## ENDNOTES

1. A full and more robust list of sources can be found at the end of the document in the Bibliography.
2. Off-grid delivery can complement the central grid supply, and enhance supply security and sustainability.
3. Figure given to exemplify the magnitude of energy needed to supply basic use. 1 kWh/household/day was used as the minimum lifeline electricity access goal under India's 2005 National Electricity Policy, intended to be achieved by 2012. Source: Bhattacharyya 2006.
4. The Global Tracking Framework provides a platform for tracking the progress made by countries toward the attainment of the three SE4ALL goals: energy access, renewables, and energy efficiency.
5. Palit, D. and G.K. Sarangi 2014; Sevea, Association Loi 2013; and World Bank 2008.
6. IEC Technical Committee 82 prepares International Standards for systems of photovoltaic conversion of solar energy into electrical energy, and for all elements in the entire photovoltaic energy system. Source: IEC 2014.
7. Well-defined tariff-determination processes can also help to protect consumers and producers from service quality or financial burdens (see Boxes 4 and 5 for more on tariffs, and 10 Questions to Ask About Tariff Setting).
8. Support for these programs have come from DANIDA, DFID, and UNDP.
9. Relevant ministries in this table, and depending on the context of implementation, can include: Ministry of Energy, Agriculture, Development, Industry, Finance, etc.
10. Local Planning agencies in this table, and depending on the context of implementation, can include: state planning commissions, rural electrification agencies, etc.

## ACKNOWLEDGMENTS

The authors would like to thank a number of people who contributed to this working paper. External reviewers for this paper included Ami Indriyanto, Philip Odhiambo, Monali Ranade, and Kartikeya Singh. Internal reviewers included Gaurav Dahal, Alex Doukas, Deepak Krishnan, and Jesse Worker.

We gratefully acknowledge the expert inputs and guidance of Davida Wood from the inception of the paper through completion. Many thanks to Shantanu Dixit and Ashwin Gambhir for providing expert input and advice. We would like to thank Hyacinth Billings for her assistance in the publication process, Emily Matthews for copy editing, and Carni Klirs and Julie Moretti for the publication design.

This paper was made possible through the generous support of WWF. We would also like to thank Stanford University's MAP Sustainable Energy Fellowship program. While our reviewers were very generous with their time and advice, the authors alone are responsible for the content of this working paper.

## ABOUT THE AUTHORS

**Lily Odarno** is an Associate with the Energy Program and the World Resources Institute's signature initiative, Charge.

Contact: [LOdarno@wri.org](mailto:LOdarno@wri.org)

**Sarah Martin** is a Research Analyst with the Electricity Governance Initiative (EGI).

Contact: [smartin@wri.org](mailto:smartin@wri.org)

**Catalina Angel** is an Analyst at Mercer. She is a former Fellow of Stanford University's MAP Sustainable Energy Fellowship program.

Contact: [catalina.malkun@gmail.com](mailto:catalina.malkun@gmail.com)

## ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

### Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

### Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

### Our Approach

#### COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

#### CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

#### SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

## ABOUT WWF

The world's leading conservation organization, WWF works in 100 countries and is supported by 1.1 million members in the United States and close to 5 million globally. WWF's unique way of working combines global reach with a foundation in science, involves action at every level from local to global, and ensures the delivery of innovative solutions that meet the needs of both people and nature. WWF's mission is to conserve nature and reduce the most pressing threats to the diversity of life on Earth. Our vision is to build a future in which people live in harmony with nature.

For more information, please visit [www.worldwildlife.org](http://www.worldwildlife.org)

## ABOUT PRAYAS, ENERGY GROUP

Prayas is a nongovernmental, nonprofit organization based in Pune, India. Members of Prayas are professionals working to protect and promote the public interest in general, and interests of the disadvantaged sections of the society, in particular, Prayas, Energy Group (PEG) has been active since 1990 in the electricity sector. We believe that effective control and influence on governance by people and civil society organizations is the key to efficient governance that would protect and promote the public interest. Public interest issues include consumer issues as well broad social issues. In consumer issues, PEG gives more attention to the issues affecting the poor and the disadvantaged. Social issues include environmental sustainability and equity.

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