ASEAN Guideline on Off-grid Rural Electrification Approaches

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ASEAN Guideline on Off-grid Rural Electrification Approaches

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ASEAN Centre for Energy

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Foreword

The access to reliable energy services is crucial for economic activitity and a sustainable development in remote rural areas in the ASEAN member states. Rural electrification was therefore high on the political agenda of the countries over the last decades and continues to be an important issue for a number of countries in the region. However, despite those efforts and a lot of ongoing initiatives, an estimated 130 million people in the ASEAN region do not yet have access to electricity what underlines the importance of continuing activities.

The present Guideline builds upon past experiences in the region, identifies good as well as bad practices and gives concrete recommendations for the development and implementation of effective, efficient and sustainable rural electrification approaches with renewable energy technologies. The Guideline was developed with an inclusive stakeholder consultation process jointly conducted by the ASEAN Centre for Energy (ACE) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in the framework of the Renewable Energy Support Programme for ASEAN (ASEAN-RESP). The paper presents know-how “from the region for the region” thereby contributing to the basic idea of regional cooperation “learning from each other”.

With the overview on regional experiences and the “DOs and DON’Ts” of rural electrification, the Guideline is a valuable input for the discussion of future rural electrification activities in the ASEAN member states.

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Abbreviations and Acronyms

ACE	ASEAN Centre for Energy
ASEAN	Association of Southeast Asian Nations
CB&T	Capacity Building and Training
ESCO	Energy Service Company
EVN	Electricity of Vietnam
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IDA	International Development Association
IEA	International Energy Agency
JICA	Japan International Cooperation Agency
M&E	Monitoring and Evaluation
MHPP	Mini Hydro Power Project
NGO	Non-Government Organization
ODA	Official Development Assistance
O&M	Operation and Maintenance
PLN	Perusahaan Listrik Negara [in Indonesia]
PPP	Public Private Partnership
PV	Photovoltaic
RE	Renewable Energy
REAP	Renewable Energy Action Plan
REE	Rural Electricity Enterprise
REF	Rural Electrification Fund
REMP	Rural Electrification Master Plan
RET	Renewable Energy Technology
SEHEN	Super Ekstra Hemat Energi (Super Extra Saving Energy)
SHS	Solar Home System

TV	Television
UNDP	United Nations Development Programme
VAT	Value Added Tax
WB	World Bank

CURRENCIES

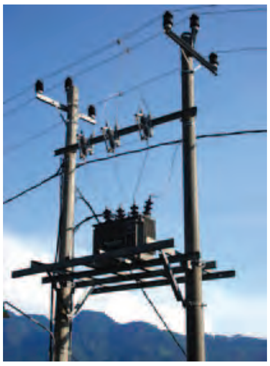
US$	United States Dollar
IDR	Indonesian Rupiah (1 US$ = 9,090 IDR used in this Guideline)
KHR	Cambodia Riel (1 US$ = 3,945 KHR used in this Guideline)
LAK	Lao Kip (1 US$ = 8,000 LAK used in this Guideline)
MMK	Myanmar Kyat (1 US$ = 820 MMK used in this Guideline)

UNIT OF MEASUREMENTS

V	Volt
VA	Volt-ampere
kVA	Kilovolt-ampere (1 kVA = 1,000 VA)
Wp	Watt-peak
W	Watt
kW	Kilowatt (1 kW = 1,000 W)
kWh	Kilowatt-hour
HP	Horse Power (1 HP = 0.735 kW)
m	Meter
m/s	Meter per second

1

Introduction



1. Introduction

1.1. Electrification in ASEAN

The Association of Southeast Asian Nations (ASEAN) has a population of approximately 600 million people, of which around 55% live in rural areas. The 10 ASEAN Member States (AMS) put high priority on providing their citizens with access to electricity and have made constant efforts to increase their respective electrification rates over the last decades.

Consequently, electrification in many AMS has developed very positively over the last years, leading to a considerable decrease of the un-electrified population in the region. The number of people without access to electricity went down from an estimated 190 million in 2005 (IEA 2006) to around 130 million in 2012 (compare Table 1). Despite those efforts and important improvements in some of the countries, to date more than 20% of ASEAN's population still does not have access to affordable, reliable and sustainable sources of electricity which hampers economic development and an improved standard of living in entire regions.

Table 1: Electricity access in ASEAN[1]

Country	Electrification rate (%)	Un-electrified population (Million, approx.)
Myanmar	26.0	44.4
Cambodia	24.0	10.6
Lao PDR	78.0	1.4
Indonesia	73.7	62.4
Total ASEAN-4	50.4	118.8
Philippines	89.7	9.5
Vietnam	97.3	2.1
Thailand	99.3	0.5
Malaysia	99.4	0.2
Brunei	99.7	0.0
Singapore	100.0	0.0
Total ASEAN-6	97.5	12.3
Total ASEAN-10	78.7	131.1

Source: ACE 2012.

1 Complete data on rural electrification in the AMS is difficult to obtain and often inconsistent. The numbers shown are therefore only approximations.

Successful examples of rural electrification based on renewable energy can be found all over ASEAN. However, less successful examples, are equally widespread since these approaches often lacked a sound long term strategy or feasible business models which are crucial to ensure sustainability. The lessons learnt from these unsuccessful rural electrification projects prove that the ASEAN region is still facing many challenges regarding rural electrification.

These challenges are, however, still not common knowledge among the ASEAN countries. Therefore, an increased exchange of experience and innovative approaches between the ASEAN member states is essential and still high on the agenda of the ASEAN community.

1.2. The Guideline

The content of this "Good Practice Guideline" was developed with the inputs from rural electrification practitioners in the ASEAN region. A stakeholder survey was carried out in 2012 in four AMS (Cambodia, Indonesia, Lao PDR, Myanmar), followed by an ASEAN-wide workshop with regional and international experts. The most relevant aspects for successful rural electrification from the experts' point of view were identified and comprise the following:

- ☑ Stable and predictable **policy framework**;
- ☑ Reliable support policies and a feasible **financing mechanism**;
- ☑ Sustainable project setup and **business models**;
- ☑ Appropriate **technology**;
- ☑ Socio-economic aspects and **community involvement**; and
- ☑ Continuous **training and capacity building**.

The Guideline on hand aims to provide decision-makers, project developers and other actors involved in the planning and implementation of rural electrification activities with practical recommendations ("DOs and DON'Ts") and gives general guidance on how to design off-grid rural electrification projects based on renewable energy technologies (RET).

It is expected that the Guideline helps to replicate successful practices and to share the lessons learnt among AMS thereby contributing to the enhanced use of RETs for off-grid rural electrification.

1.3. How to read the Guideline

The Guideline compiles the experiences of practitioners from the ASEAN region and translates them into recommendations for decision makers. The Guideline does not claim to cover all aspects of rural electrification, but wants to highlight those issues important for practitioners in the region. It is well understood that conditions differ from country to country and even from region to region in one particular country. Country-specific preconditions or technology-related aspects might require approaches and solutions which are either not covered by the Guideline, or not elaborated in detail.

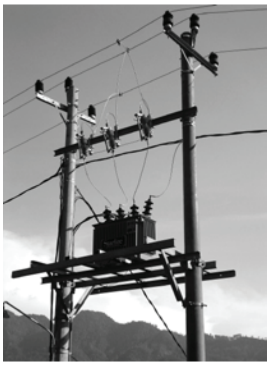
The listed recommendations should therefore be considered as starting point for the further elaboration of rural electrification activities in individual countries and environments.

The Guideline addresses off-grid rural electrification approaches based on RET which have been implemented in the ASEAN region. It focuses on the six main aspects of off-grid rural electrification as specified above.

For each aspect, key success factors and lessons learnt are identified, analyzed and presented in the form of "DOs and DON'Ts". Selected examples of successful practice are highlighted.

2

Off-grid Rural Electrification Approaches




2. Off-grid Rural Electrification Approaches

The success (or failure) of off-grid rural electrification approaches with RET[2] depends on not only a broad range of influencing factors: Geography, availability of natural resources, reliability of technical solutions, financial feasibility, but also human capacity and dedication of individuals to name only few of them. These factors vary greatly from country to country and framework conditions are comparable only to a limited extent.

However, there are certain factors which are considered to be indispensable for successful rural electrification approaches which shall be carefully considered for planning and implementation of such projects. These factors comprise: (i) a stable and predictable **policy framework**; (ii) reliable support policies and a feasible **financing mechanism**; (iii) a sustainable project setup and **business models**; (iv) the application of appropriate **technology**; (v) the due consideration of socio-economic aspects and **community involvement**; and (vi) continuous **training and capacity building**.

2.1. Policy Framework for Off-grid Rural Electrification

The policy framework for off-grid rural electrification is a set of principles, long-term goals, and commitments that form the basis of developing rules, procedures and guidelines for the domestic context. The policy framework gives overall direction to the planning, development and implementation of rural electrification projects. Thus, the right policy framework is a requirement for any success rural electrification project.

Most of the ASEAN countries have no specific policy framework for off-grid rural electrification. Provisions regarding off-grid electrification are usually included in the policies and plans for rural electrification in general, which most often focus on grid extension as the least-cost solution for many rural areas.

Considering the specific character of off-grid electrification and in order to increase electrification of remote households and villages, it is advisable to prominently include off-grid rural electrification strategies in existing policies or to establish a separate policy framework for the off-grid sector. The fact that a large share of the remaining rural households without electricity in ASEAN countries is located in poor, remote and isolated areas, underpins the importance of dedicated strategies.

Key policies for promoting off-grid electrification should, as a minimum, include a development strategy including realistic action plans, transparent electricity pricing policies, as well as policies on financial incentives and financing mobilization. A clear institutional structure for the planning and implementation of rural electrification efforts is also recommended to include all relevant levels of government (central, provincial, district, etc.).

Table 2 presents common key policies to promote off-grid rural electrification prevalent in the ASEAN region.

2 The Guideline focuses on off-grid rural electrification with RET. If not stated otherwise, the term “(off-grid) rural electrification” refers to activities applying RET.

Table 2: Key policies for promoting off-grid rural electrification in the ASEAN

Key policies	Main content of the policy
Strategies	▪ Long-term objectives and strategic goals; ▪ Transparent overall rules and guidance regarding development plans and financial mechanisms; ▪ Roles and responsibilities among the relevant institutions and stakeholders.
Development plans	▪ Review of energy access in the country (i.e. detailed electrification rates in different areas); ▪ Criteria for the selection of target areas/communities; ▪ Resource mapping for target areas/communities (i.e. water course, biomass, wind, sunshine); ▪ Action plans including prioritization of areas/communities to be electrified; ▪ Data collection on location, socio-economic conditions, electricity demand, etc. for the targeted villages.
Financial incentives and electricity pricing policies	▪ Specification on types and amounts of financial incentives for off-grid electrification projects (e.g. investment subsidies, VAT exemption, import duty exemption, income tax holidays, etc.); ▪ Criteria for the entities eligible for financial incentives (e.g. power producers, project owners, end-user, community, etc.); ▪ General pricing principles for off-grid electrification (i.e. tariff structure for off-grid applications).
Financing mobilization	▪ Mechanisms for mobilizing funds for off-grid rural electrification (including domestic as well as international sources).

DOs and DON'Ts on Policy Framework

DO *make a strong, long-term and unwavering commitment to rural electrification in general and off-grid rural electrification in particular.*

When embarking on an off-grid rural electrification program, it is advisable to make a strong and unwavering commitment to a long-term objective combined with a strategy on how to gradually achieving the set targets.

The principles and priorities, as well as the expected results must be clearly established and communicated to all stakeholders, in order to set the course for stakeholder participation (for example the private sector) and to manage expectations.

DO *set up realistic and achievable targets for off-grid rural electrification.*

The targets for off-grid rural electrification should be set based on a sound analysis of what can be achieved given the (natural and financial) resources.

The targets are usually set based on the following considerations:

- Grid extension is not a least-cost option;
- Local renewable energy resources are available in the target areas; and
- Funding sources that could be used for sustainable financing are available.

DO *engage all levels of government in the decision making process, and clearly allocate the responsibilities among them.*

The engagement of all levels of government early in the decision making process is an essential factor for long-term success of an off-grid rural electrification project.

The responsibilities for project planning, development and implementation need to be clearly shared among various stakeholders, from the central government to the provincial/district authorities and to the local communities. Apart from the fact that such an approach increases ownership and commitment of the different actors, it ensures that decisions are taken as close as possible to the operational level.

Box 1: Rural electrification planning in Vietnam

In Vietnam, the task of planning and promoting off-grid rural electrification is assigned to each province. The district governments and the local communities are requested to support the project developers or consultants to conduct site surveys and prepare off-grid rural electrification proposals for target communities. These proposals are submitted to the provincial government for approval. In case the projects request for a grant and/or national budget support, they are submitted by the provincial government to the central government for appraisal and approval.

This collaboration-based approach can be credited with making it possible to move forward with the off-grid rural electrification effort on all fronts, and possibly much faster than what could have been achieved by relying on the resources and capabilities of one central entity.

Source: ACE 2012.

DO *set up clear criteria for selecting the target villages for off-grid rural electrification.*

The decision between off-grid and grid-extension option has to be based on the assessment of cost-effectiveness.

Decision criteria should include:

- ☑ Average distance to the existing grid;
- ☑ Total number of potential connections (customers) in the target community;
- ☑ Expected power demand of the community (including the potential for productive use of electricity);
- ☑ Availability of local renewable energy resources; and
- ☑ Affordability/ability-to-pay of the end-users.

The assessment can also include political priorities such as social and economic development of disadvantaged regions or poverty reduction as criteria. Such priorities should, however, clearly be laid down and communicated.

Box 2: Community selection in Lao PDR

The Rural Electrification Master Plan (REMP) in Lao PDR sets a National Electrification Target of 94.7% on household basis by 2020, which will be achieved by on-grid systems, i.e. grid extension (90.9%) and by off-grid systems using mini/micro hydropower and SHS (3.8%).

In order to select a suitable village for off-grid rural electrification, the criteria are set as follows:

- Average distance from the village to the existing medium-voltage grid is more than 3 km;
- There is no existing plan for grid connection in the next 5 years;
- Road accessibility to the village is ensured throughout the year;
- Affordability of the installation fee and monthly tariff for villagers is given; and
- Management skills are prevalent in the village.

REMP considers affordability as the most important criterion. Therefore, it is requested that at the initial stage, the project developer visits the village with a sample of SHS kit, and, in detail, explains its technical features and applications as well as the payment scheme to the villagers. Then, potential customers are listed. If the percentage of candidates, that is able to pay, is less than 50% of total households, this village will not be selected for SHS-based electrification.

Source: REMP 2010.

DO *establish mechanisms for sharing the costs of off-grid rural electrification among different public actors*.

It is advisable to set up clear principles for cost sharing, in order to mobilize various resources to finance off-grid rural electrification efforts, instead of relying solely on central government financing resources.

An example is that a central authority (possibly supported by international partners) provides budget for project development and equipment procurement while the provincial government covers the construction costs and the local community contributes labour for plant construction and installation.

In addition to making financing of rural electrification systems easier, cost-sharing creates a strong sense of ownership for the parties involved. The provision of financial support by provincial, district and local authorities is therefore an important factor to rapidly increase access to electricity in off-grid rural areas.

DO *create a suitable policy framework to successfully mobilize financing from international partners*.

The involvement of international partners provides not only financial resources, but also enables the sharing of international experience, technical capabilities, and expertise on rural electrification program management.

As an example, the establishment of a central (off-grid) electrification fund can be an effective approach to provide financing for off-grid rural electrification projects in the long term. Such fund can mobilize contributions either from government budget or grants and/or soft loans from international and local financial institutions and becomes the central instrument for rural electrification efforts in a country, being largely independent from yearly negotiations of the government budget.

Box 3: Rural Electrification Fund (REF) in Cambodia

The Rural Electrification Fund (REF) is part of the Renewable Energy Action Plan (REAP) with the goal of providing financial support to achieve Cambodia's electrification targets. Renewable energies play a certain role in its program. Mini hydro plants and solar home systems are eligible to receive subsidies up to 25% of total investment costs. The International Development Association (IDA) and Global Environmental Facility (GEF) provide financial support to the REF. REF's activities include:

- Grant assistance of US$ 45 per connection (subsidy) to Rural Electricity Enterprises (REE) to increase household connections (the target of 50,000 additional connections is almost achieved) based on eligibility criteria such as location, distance from national grid, licenses, price/kWh, etc. An association of REEs has been established (2011) to collect information from REEs (possible improvements, challenges, etc.) and to spread technical knowledge and training information;
- Financial support to the 12,000 SHS rent-to-own program: around US$ 3.85 million of which US$ 1.2 million is grant and US$ 2.65 million is loan;
- The repaid loans will be used for the project "Power to the Poor", to provide poor households a US$ 100 soft-loan (no interest) to pay for the grid connection. This loan should be paid back over a two-year period with the monthly electricity bill. Households that are not connected one year after the construction of the grid, or households headed by females, are considered for this loan.

REF has started a pilot project in Kampong Speu with the first US$ 10,000 repaid from the 12,000 SHS rent-to-own programme. The target of this pilot project is 1,000 households. REEs are identifying the families and managing the loans with the customers. A similar project has been very successful in Lao PDR.

Source: ACE 2012.

DO *create an efficient national institutional structure for planning, coordinating and implementing of all off-grid rural electrification activities*.

A single institution entrusted with the overall steering, coordination and promotion of off-grid rural electrification activities allows for efficient resource allocation and consistent planning. Several other institutions need to be included as coordinating parties, but should not be allowed to implement activities on their own account.

DON'T *use a top-down approach for planning off-grid rural electrification programs.*

Centralized planning approaches, possibly conducted by several institutions in parallel, risk to disconnect with other important actors (provincial and local level) and finally do not reach the intended beneficiaries. Most of the times bottom-up approaches are the centerpiece of successful rural electrification programs. The involvement of local communities, district and provincial governments at an early stage ensures success in the long run.

DON'T *allow for overlapping and conflicting roles and responsibilities between institutions involved in off-grid rural electrification*.

Overlapping and conflicting roles in combination with a lack of proper coordination between for example the central and provincial government or between different ministries, are a common barrier to successful promotion of off-grid rural electrification. In addition to inefficient program planning, funding, and implementation, scattered responsibilities hamper systematic institutional learning.

2.2. Financing Mechanisms and Required Support Policies

There are several possibilities that can be applied to finance off-grid rural electrification projects. The option most commonly applied in the ASEAN are private financing, financing through the public power utility, government financing, and Public Private Partnerships (PPP).[3]

Private financing is used for commercially viable projects. A private company invests in an off-grid rural electrification project using its equity capital and commercial and/or soft loans. Grants and/or government budget are not required.

The main advantage of this private financing is that projects are usually set up faster and are effectively implemented due to the business interest of private companies, their financial capacity and technical as well as managerial competences.

A disadvantage of private financing is that privately financed projects require a minimum selling price for electricity (resulting in relatively high end-user tariffs) in order to pay back the investment. This financing mechanism is therefore successfully applied in cases where electricity tariffs for rural areas are high or alternatives (for example grid connection, diesel gensets) scarce (for example in Cambodia, Myanmar, islands in the Philippines and Indonesia).

Public power utility financing is commonly applied for rural electrification through grid-extension. In recent years, public power utilities are increasingly obligated by legislation to invest in off-grid rural electrification in order to reach all un-electrified households.

The public power utilities (e.g. PLN in Indonesia, EVN in Vietnam) are investing in off-grid rural electrification projects using their equity capital and (soft) loans from local and/or international financing institutions, thereby cross-subsidizing rural electrification activities and - in some cases - creating business cases for private developers.

3 The term “PPP” is widely used in different contexts. Within this Guideline PPP refers to a project where the public and the private sector cooperate and both parties provide investments.

This financing mechanism/cross-subsidy results in affordable electricity tariffs for rural villagers. The project revenues are usually used for paying operation and maintenance costs of the project, but are not sufficient for reinvesting in expansion of the project or new projects.

Government financing is usually used for commercially not viable projects. It relies on government budget, international/local grant (Official Development Assistance, ODA), and/or local/international long-term soft loans for financing the projects.

Projects are tendered and commonly realized by private developers or NGOs. The developers are responsible for developing and constructing the off-grid power system and, after its commissioning, usually hand over the ownership and responsibility for operation and maintenance to a local community-based entity such as village electrification committee, community cooperatives, etc.

Government financing can offer low, affordable electricity tariffs to rural villagers. However, the investment is hardly paid back. In some cases, subsidy is even required to pay for operation and maintenance costs. The project setup and implementation often takes long due to the complexity of project arrangements and coordination between the numerous public and private actors involved.

In addition, government financing depends on the availability of budget which is regular subject to re-negotiation and political interests and therefore predictable only to a limited extend.

A *Public Private Partnership (PPP)* combines the advantages of the private and the government financing mechanisms. It can offer lower tariffs of electricity, reduce the time of project setup and implementation and ensure sustainability through the inclusion of a business case.

Investment in off-grid power facilities can be jointly or separately made. However, the operation and maintenance of the whole power system is usually done by the private partner. In most PPP off-grid rural electrification projects, financial incentives such as direct and indirect subsidies are applied.

Table 3: Financing mechanisms and required support policies

Financing mechanisms	Financing sources	Key support policies required
Private financing	▪ Equity ▪ Commercial and/or soft loans	▪ Market-based electricity pricing policy in target areas; ▪ Clear legal framework on private financing in off-grid rural electrification; ▪ Indirect subsidies (e.g. technical assistance, free land use, VAT and import duty exemption, income tax holidays, etc.); ▪ Soft loan policy for RET-based rural electrification projects.
Public power utility financing	▪ Equity ▪ Commercial and/or soft loans	▪ Inclusion of off-grid electrification into the utility's work program (e.g. through regulation); ▪ Policy on cross-subsidized tariffs; ▪ Indirect subsidies (e.g. technical assistance, free land use, VAT and import duty exemption, income tax holidays, etc.); ▪ Soft loan policy for RET-based rural electrification projects.
Government financing	▪ Government budget ▪ International/local grant (ODA) ▪ Local/international long-term soft loans	▪ Policy on off-grid rural electrification; ▪ Institutional setup to implement off-grid rural electrification programs; ▪ Financial incentives including direct and indirect subsidies.
Public Private Partnership (PPP) financing	▪ Private financing ▪ Government budget ▪ Grants and loans	▪ Grants (e.g. project preparation, seed investment, etc.); ▪ Soft loans policy for RE-based rural electrification projects; ▪ Financial incentives including direct and indirect subsidies.

DOs and DON'Ts on Financing Mechanisms

DO *establish a legal framework to encourage the private sector to get involved in off-grid rural electrification.*

A stable and reliable legislation is crucial for the private sector to become active in the off-grid rural electrification sector. Only if security of investment and of expected returns is ensured, project developers and private financing institutions will decide to become active.

A reliable legal framework is of particular importance to attract long-term commercial and/or soft loans for project development by private developers as well as (public) power utilities.

Since financing off-grid rural electrification projects is uncommon practice to most of the financing entities, credit enhancements are a key instrument to reduce the perceived risk of lending instiutions and to encourage them to involve in financing off-grid rural electrification projects. Credit enhancements are for example interest-free loans provided to commercial finance institutions which are passed on for rural electrification projects with low interest rates.

DO *get the local banking sector involved.*

Local banks and especially microfinance institutions can offer preferential micro-credits for rural villagers to pay for electricity service (for example downpayment of SHS) and to initiate or expand their productive activities. This helps to increase the number of customers and the plant use factor of off-grid power system, thereby improving the financial viability of the project.

DO *carefully design the financial incentives for off-grid rural electrification.*

If properly designed, financial incentives are an effective way to overcome market imperfections and give private investors the incentive to enter the off-grid rural electrification market.

The key is to design financial incentives that are effective (triggering actual market activity), targeted (leading to the electrification of poor households), and cost-effective (achieving electrification at the lowest costs).

Subsidies are regularly provided by the government or international partners in order to ensure financial viability for the project developers/investors and affordability for the costumers at the same time.

Box 4: Subsidy types for off-grid rural electrification

Direct subsidies, which are commonly applied for off-grid rural electrification in the ASEAN, are:

- *Investment-based:* Capital subsidies targeting the initial investment. These are regularly granted to project investors or developers.

  In an example from the Philippines, the capital subsidy for SHS of 20-100 Wp is 20-60% of investment cost (WB 2008).

- *Connection-based:* One-time subsidy granted according to the number of connections, either regularly provided to the project investors, developers or directly to the customers to support downpayments.

  In a SHS project in Cambodia with 12,000 planned installations, US$ 100 are granted for each supplied household. This subsidy makes the rental fee payment to the developer affordable for the customers at US$ 4.86 per month for a 50-Wp SHS and US$ 3.35 per month for a 30-Wp SHS over a 4-year period without interest.

- *Output-based:* Subsidies supporting the project revenue. Most of the output-based subsidies are transition measures to help bridge the gap between the revenues and the costs. The output-based subsidies can for example be provided in form of topping-up kWh premiums to the project investors/developers.

  In a hybrid rural electrification project in Indonesia consisting of a 60 kW PV plant, a 10 kW wind turbine, and a 100 kW diesel generator, output-based subsidies were applied. The system serves 100 households. The total project costs were about IDR 2.0 Billion (US$ 220,000) financed by the government, the public power utility is managing and operating the system. The limit of electricity supply for each household is 450 VA. The households pay a monthly electricity fee to the utility following the national electricity tariff set by the government. The national average electricity tariff for the households is about IDR 500-600/kWh (US$ 0.05-0.06/kWh) while the production costs of electricity by the hybrid system is estimated at IDR 2,000/kWh. The difference is subsidized by the government.

- *Operation-based:* subsidies supporting the operation costs of the power system but not the initial investment.

Indirect subsidies include the support provided by the government (or international partners) to the projects through technical assistance (e.g. conducting the surveys and preparing the feasibility studies/ business plans, etc.), training and capacity building in project management, operation and maintenance, etc.

Other indirect incentives such as VAT exemption, import duty exemption and income tax holidays can have a big influence on the financial viability of an off-grid rural electrification project.

DO *properly set up the electricity tariffs for off-grid rural electrification.*

Sound electricity tariffs (or fees) are, similar to financial incentives, key to balance attractiveness for investors, affordability for end-users and sustainability over project lifetime.

For rural electrification projects with subsidized initial investment, it is recommended to set tariffs high enough to at least cover operating, maintenance and replacement costs over the estimated project lifetime.

For rural electrification projects without direct subsidies, financially viable tariffs (or market-based tariffs) need be chosen to cover all project costs and to allow for sufficient return on investment for private investors.

Box: 5 Fixed monthly electricity fees in ASEAN countries

Fixed monthly fees are pre-determined based on expected power consumption of the consumers. The fees are usually set for different levels so that the consumers with higher demand buy a higher level and pay more. The advantage of such a tariff system is that electricity meters are not necessary, and that consumers know in advance how much they are going to pay. The disadvantage is that there is no incentive for electricity saving and that the system is at risk of being overloaded due to the limited electricity available for the end-users. In addition, abuse might be difficult to avoid. Several methods applied by private developers and community-based entities to overcome abuse as well as system overload are described below:

Using of time limiters:

- This method is used in a 15-kVA biogas-based off-grid rural electrification project in Myanmar. The project was funded by a Village Electrification Committee using the soft loans (63.6% of total project cost, no interest) and the government contribution (30.3% of total project cost) in forms of free-of-charge consulting services and provision of hardware (biogas engine and electric generator). The electricity is sold to the households in packages: the use of 2 fluorescent lamps of 2 feet (0.6 m) lighting 5 hrs/day costs MMK 500/month (US$ 0.61/month) and the use of 1 TV/video player set costs MMK 1,500/month (US$ 1.83/month).

Using of load limiters:

- Load limiters have been used in a 2-kW pico hydropower project in Lao PDR. The project was funded by a 100% from the government. The participating households provide in-kind contributions such as labor, local construction materials, etc. Households were divided into two different tariff levels reflecting their electricity demand: a low tariff level provides a limit of 30 W for lighting only, and a higher tariff provides a limit of 100 W for the households which require also power for TVs and stereos. The fee was set at LAK 6,000/month (US$ 0.75/month) for low tariff users and LAK 23,000/month (US$ 2.88/month) for high tariff users.
- A similar approach was applied in a 37 kW hydropower off-grid rural electrification project in Indonesia setting a fixed monthly electricity fee. The investment costs were covered by a 100% grant from an international donor, operation and maintenance is managed by a community-based cooperative. The households can choose a capacity level 0.5 Ampere (110 VA) or 1.0 Ampere (220 VA) for their connection. For the former, monthly charge is IDR 20,000 (US$ 2.2/month), and for the latter is IDR 40,000 (US$ 4.4/month).

Source: ACE 2012.

DON'T *provide excessive or unnecessary direct subsidies*

Subsidies are a burden to government budgets and best to be minimized. It is recommendable to choose investment-based and connection-based subsidies since they are relatively predictable and bound to physical implementation.

Output-based and operation-based subsidies for electricity generation do not properly reflect the actual cost of electricity, and might lead to inefficient electricity use.

DON'T *provide subsidies where market-based approaches are feasible.*

Government supports (i.e. subsidies) are instrumental to supply poor and remote communities with electricity. However, it is advisable that subsidies (direct or cross-subsidies) are applied where no business case for the private sector can be made. In case (rural) markets for electricity services already exist (for example solar lanterns), subsidies are best to be avoided in order to not distort efficient markets.

DON'T *allow complex and unclear application procedures for subsidies*.

In order to attract the private sector and its know-how in project development to the off-grid market, transparent procedures are key. Unclear criteria and/or complex application procedures unnecessarily prolong the development process and increase the costs, discouraging the private sector from investing in off-grid rural electrification projects.

2.3. Project Setup and Business Models

One of the big hurdles for off-grid rural electrification is the fact that private investments are not economically viable or that the return on investment is comparably low. Thus, a sound project setup including a feasible business model indispensably ensures effectiveness and sustainability of rural electrification projects

The lack of organizational structures, high levels of initial capital investments, and lack of ability or willingness to pay by rural customers are some of the major issues that make it challenging to develop a business model for off-grid rural electrification.

A large variety of business models for off-grid rural electrification exist in the ASEAN region, depending largely on local conditions and political objectives. In the AMS, successfully applied business models can be categorized as: (i) market-based business models (fee-for-service model, dealer model, lease model), (ii) government induced community-based business models (grant-based models, partially grant-based models), and (iii) public private partnership models (compare Table 4). In reality, however, a hybrid types of these models are often applied, combining the advantages of different approaches.

Table 4: Project types and business models

Business model	Key features
Market-based models:	
Fee-for-service model	A project investor/developer invests in and owns the off-grid power generating system and supplies electricity to rural customers. The investor/developer ensures operation, maintenance and replacement of the power system. The customers pay for the electricity they use either based on metering (kW/h) or a fixed (monthly) charge (compare also Box 6). The electricity tariffs are usually set at a financially viable level (cost covering) and are relatively high compared to other approaches. ▪ *Ownership of the power system:* ESCOs (e.g. private company, public utility, community cooperative, etc.); ▪ *Financial sources:* Equity/investment, loans, financial incentives (subsidies), fees; ▪ *Tariff system:* Market-based tariffs; ▪ *Operation and maintenance:* ESCOs.
Dealer model	Customers/end-users purchase the power system either with own cash and/or loans. The customer is normally a household or a facility owner (e.g. rice miller). Beyond warranty service, the customer assumes responsibility for all operational and replacement costs. There is no payment for consumed electricity, only consumables and spare parts required for the operation and maintenance of the power system have to be purchased. ▪ *Ownership of the power system:* Custormer/end-user; ▪ *Financial sources:* Cash payment and/or loans (e.g. microfinance institutions, dealer credits); ▪ *Tariff system:* No payment for electricity consumed, but the costs of consumables and spare parts have to be paid by the customer him/herself; ▪ *Operation and maintenance: C*ustomer.
Lease model	In contrast to the dealer model, the equipment is owned by the lessor (e.g. ESCO) and transferred to the customer only at the end of the leasing period. The lessor remains responsible for maintenance and repair, while the customer pays a (monthly) rental fee during the leasing period. ▪ *Ownership of the power system:* ESCO/lessor (during the leasing period) and customer/end-user (after leasing period);

Business model	Key features
	▪ *Financial sources:* Equity/investment (by ESCO/lessor), fees; ▪ *Tariff system:* Market-based rental fee; ▪ *Operation and maintenance:* Lessor (during the leasing period) and customer (after expiring of the leasing period).
Government induced community-based business models:	
Fully grant-based model	An off-grid power system is 100% grant-financed, usually by government or international partners, while the projects implemented under the partially grant-based business model will be financed by a mix of grant and long-term soft loans and/or local contributions (e.g. from the government budget or the community). A successful application of this model in combination with lease model is presented in Box 7. The power system is usually owned, operated and maintained by a community-based entity such as village committee, community cooperative, etc. ▪ *Ownership of the power system:* Community-based entities; ▪ *Financial structure:* 100% grant from government (or international partners); ▪ *Tariff system:* Strongly-subsidized low tariffs; ▪ *Operation and maintenance:* Local community.
Partially grant-based model	▪ *Ownership of the power system:* by Community-based entities; ▪ *Financial structure:* Mix of grant and long-term soft loans, government budget and/or community contributions; ▪ *Tariff system:* Break even tariffs with financial incentives; ▪ *Operation and maintenance:* Local community.
Public Private Partnership (PPP) models:	
Operation-Maintenance PPP model	The Operation-Maintenance model is a partnership, in which a public partner invests in an off-grid power generating system and contracts a private partner to operate and maintain the system. The public partner retains ownership and overall management of the power system. ▪ *Ownership of the power system:* by Public partner; ▪ *Financial structure:* Public funds; ▪ *Tariff system:* Quasi market-based subsidized tariffs; ▪ *Operation and maintenance:* Private partner.
Operation-Maintenance-Management PPP model	Under the Operation-Maintenance-Management model, a public partner enters a contract with a private partner to operate, maintain and manage the off-grid power system. The public partner remains the owner of the system, but the private partner may invest own capital in the system. This model was successfully applied in an off-grid rural electrification project in Cambodia (see Box 3). ▪ *Ownership of the power system:* by Public partner; ▪ *Financial structure:* Public funds and private financing; ▪ *Tariff system:* Quasi market-based subsidized tariffs; ▪ *Operation and maintenance:* Private partner.

DOs and DON'Ts on Project Setup and Business Models

DO *allow for flexibility in developing a business models that fit the specific conditions.*

Off-grid rural electrification business models depend greatly on a number of factors: applied technology, electricity use, social and behavioural issues that determine, among others, the suitable model. The business model therefore needs to be assessed and selected for each individual project.

It is important to choose a business model that has some degree of flexibility and fits the community implementing the project. In some cases, the business model of a project may have to be changed over time in order to cater to the actual developments and changes in the project structure during project implementation.

DO *select fee-for-service business model projects where the customers' ability and willingness to pay is high*.

Fee-for-service business models help attract the private sector to invest in off-grid rural electrification. This model, however, requires market-based electricity tariffs for the private investors to recover their investments (compare above). Especially with mini-grids facilitating the development of productive activities, local customers may have a relatively high ability and willingness to pay for electricity tariffs.

If necessary, a subsidy on capital costs or a grant component may need to be provided to assure the investor a reasonable profit. Additional support involving technical assistance, site surveys, feasibility studies, and capacity building may be provided to the investor during the project development phase.

Box 6: Fee-for-service model in Myanmar

In the Shwe Hlay Chaung village a project was implemented in 2008 to replace diesel-based battery charging system by a rice husk gasification power system using a dual-fuel engine. The system includes a rice husk gasifier, a 30 HP dual gas/diesel engine, a 20 kVA electric generator, the power distribution network to supply electricity to 50 households and a battery charging station. The system also supplies electricity to a pagoda and a monastery free of charge.

The project is owned by a private developer who operates and maintains the system. Total investment costs of the project was around MMK 5.0 million (US$ 6,100) financed by a commercial loan with an interest rate of 7% per annum. The equipment was supplied and installed by a local company.

The electricity is sold to households in two packages: for two fluorescent lamps of 2 feet (0.6 m) lighting radius, customers pay MMK 3,500/month (US$ 4.3/month) and for one TV/video player set, customers pay MMK 10,000/month (US$ 12.2/month). With 50 households using electricity for lighting and 20 TV/video sets, the income is MMK 375,000/month (US$ 457/month). The project is charging batteries during daytime. With 40 units of 6V batteries and 15 units of 12V batteries, the project can earn MMK 500/day. The project also rents the LED lanterns for MMK 100/day.

The total income is MMK 393,000/month. The expenses are estimated at about MMK 150,000/month making a net profit of MMK 243,000/month. Taking into account the costs of equipment maintenance, the investment is paid back in 2 years.

Source: ACE 2012.

DO *consider dealer and lease models for stand-only electricity systems*.

Stand-alone systems or pico systems are most suitable for villages where the customer base is small and/or ability-to-pay is low (i.e. scattered customers and little or no productive use of electricity, poor households). Stand-alone systems are usually relatively affordable since they do not require very high investment costs. In addition, operation and maintenance is not necessary or rather simple so that over-the-counter sales are feasible.

Box 7: Partially grant-based rent-to-own model in Lao PDR

The rent-to-own Solar Home System (SHS) project is implemented in 16 provinces in three phases: phase 1 (1999-2004), phase 2 (2004-2009) and phase 3 (2009-2014). By the end of phase 2, a total of 15,000 SHSs had been installed. Each rent-to-own SHS consists of solar kit (i.e. solar panels, outdoor wiring, mounting pole and charge controller) and house kit (i.e. indoor wiring, saving lamps, car battery and battery box).

The project costs are financed by 20% grant, 50% soft loan and 30% down (upfront) payment by the households. The project is managed by the Village Off-grid Promotion and Support (VOPS) office established by the Ministry of Industry and Handicraft (MIH) (now, Ministry of Energy and Mines). The installation, operation and maintenance of SHSs are performed by trained Village Electric Managers (VEM). Newly-formed or existing Local Electricity Service Companies (ESCO) are responsible to support the VEMs during installation and O&M. A Village Electricity Advisory Committee (VEAC) is formed in each target village and plays an advisory role for the village electrification strategy and implementation. VOPS owns the SHS during the renting period of 5 or 10 years, and the household will own the SHS at the end of renting term.

The households pay reasonable monthly rental fees, which ranges from US$ 2.0 - 5.0 for 5-year, or US$ 1.0 - 2.5 for 10-year repayment period, depending on the size of the SHS (20 to 50 Wp). The household is also responsible for the cost of replacing house kit's components, which is estimated at US$ 6.0 - 14.0 per year depending on whether the system is used carefully or not.

The collected monthly rental fee is used by VOPS for paying the costs of services provided by VEM, VEAC and ESCO and for repaying the soft loan.

Source: ACE 2012.

DO *apply government induced business models in poor areas with lack or low ability or willingness to pay*.

The grant can help set low electricity tariffs/fees, which are affordable by poor villagers. These models usually require strong financial incentives from the government to ensure the operation and maintenance of the system. Investment decisions can be made based on political and socio-economic considerations rather than pure economic concerns (payback, etc.).

DO *select or create a community-based entity to own the power system implemented under government induced business models.*

The community-based entities may be village committees, community cooperatives or alike. A strong advantage of the community-based entities is that the owners are also the customers and have a strong incentive to operate and maintain the system sustainably.

A weak point of the community-based entities is that they often lack the technical skills to operate and maintain the power systems and the business skills to implement a sustainable business plan. It therefore requires substantial capacity building and training (compare below).

DO *allow for long-term agreements between public and private partners (PPP)*.

The private sector needs planning security for the investment decision. Off-grid projects bear a relatively high risk from the investors' point of view and payback, including a reasonable return needs to be ensured. In addition, a long-term agreement (i.e. investment security) allows the private partner to set lower tariffs.

DO *ensure a suitable fee-collection scheme.*

As methods of payment can influence the willingness to pay, it is advisable to make it easy for the rural villagers to pay for the electricity use, both by making it practically feasible and by allowing the customers to pay when they have cash. A fee-collection scheme can be based on monthly payments, but also on larger down-payments for example in the harvesting season.

DON'T *delay the selection of the owner of the off-grid power system.*

It is advisable that ownership is clarified at an early stage of project development.

If for example the local community/community-entity shall bear ownership, it has to be involved from the start in order to ensure commitment and contribution and to give sufficient time for developing the necessary technical and management capacties for sustainable operation.

DON'T *allow for political interference in selecting business model for off-grid rural electrification project.*

The selection of a business model must be based on the objective assessment of the specific situation of the particular off-grid rural electrification project. Once the overall framework and criteria are set (see above), construction and implementation is best carried out by experienced companies and organizations (private sector, NGOs). An important role for the public sector lies in monitoring implementation and performance of the project.

2.4. Appropriate Technology Solutions

Technology choice is one of the most critical factors that affect the success and sustainability of an off-grid rural electrification project.

There are several types of technologies that can be used for off-grid rural electrification:

- Diesel generators;
- Hydro power (mini, micro or pico system);
- Biomass gasification power system;
- Biogas-based power system;
- Wind power (home-scale system);
- Solar PV (mini, home-scale or pico systems);
- Hybrid power system.

The key features of the technologies and their off-grid applications are summarized in Table 5.

Two steps should be carried out in order to select an appropriate technology for an off-grid rural electrification project:

☑ A technical analysis to preliminarily identify the appropriate technologies; and

☑ Economic and financial analysis of different possible technologies.

The technical analysis includes the collection and assessment of the main input data such as local renewable energy resources, population, dispersion of customers, energy consumption, income level, willingness to pay, requirement on reliability of electricity supply, productive use of energy, etc. The technical analysis should also take into account the efficiency, reliability and expected lifetime.

The economic and financial analysis includes the capital costs, O&M costs, and other related costs (e.g. O&M training cost, environmental protection cost) of each technology, the tariff system proposed and the subsidies offered.

These assessments are usually conducted technology neutral and are not pre-determined by choosing a particular technology.

Table 5: Type of technologies and their off-grid application

Type of technology	Key features and off-grid applications of the technology
Diesel generator	▪ Input energy source: Diesel fuel; ▪ Typical capacity range: Any capacity (from 5 kW up to some megawatts); ▪ Application: Mini-grids, towns, villages; ▪ Pre-condition: No renewable energy resources available in the area.
Mini hydropower system	▪ Input energy source: Hydro potential; ▪ Typical capacity range: 100-1,000 kW; ▪ Application: Mini-grids, villages; ▪ Pre-condition: Sufficiently strong water course in vicinity.
Micro hydropower system	▪ Input energy source: Hydro potential; ▪ Typical capacity range: 5-100 kW; ▪ Application: Mini-grids, individual small farms (productive use), villages; ▪ Pre-condition: Sufficiently strong water course in vicinity.
Pico hydropower system	▪ Input energy source: Hydro potential; ▪ Typical capacity range: Less than 5 kW; ▪ Application: Individual household or a cluster of households (for lighting, in-house appliances, water pumping, etc.); ▪ Pre-condition: Sufficiently strong water course in vicinity.

Type of technology	Key features and off-grid applications of the technology
Biomass gasification power system	▪ Input energy source: Biomass resources (e.g. rice husk, sawdust, wood waste); ▪ Typical capacity range: 50-1,000 kW; ▪ Application: Mini-grids, villages, productive use; ▪ Pre-condition: Reliable feedstock supply.
Biogas-based power system	▪ Input energy source: Livestock wastes (e.g. manure); ▪ Typical capacity range: 20-1,000 kW; ▪ Application: Mini-grids; ▪ Pre-condition: Reliable feedstock supply.
Wind home system	▪ Input energy source: Wind energy; ▪ Typical capacity range: Less than 1 kW; ▪ Application: Individual household (for lighting and in-house appliances); ▪ Pre-condition: Sufficient wind speed (typically minimum 4 m/s for wind home systems).
Solar home system	▪ Input energy source: Solar radiation; ▪ Typical capacity range: 10-130 Wp; ▪ Application: individual household (for lighting and TV set, battery charging); ▪ Pre-condition: Sufficient sunshine hours.
Pico solar PV system	▪ Input energy source: Solar radiation; ▪ Typical capacity range: Less than 10 Wp; ▪ Application: Indidviual household (lighting); ▪ Pre-condition: Sufficient sunshine hours.
Solar PV mini-grid	▪ Input energy source: Solar radiation; ▪ Typical capacity range: More than 5 kWp; ▪ Application: Mini-grids, villages, productive use; ▪ Pre-condition: Sufficient sunshine hours, (battery).
Hybrid power system	▪ Input energy sources: Diesel oil and/or renewable energy such as wind/diesel, hydro/diesel, PV/diesel, PV/hydro/diesel or PV/wind/diesel hybrid systems (possibly including a battery bank); ▪ Typical capacity range: Any capacity (from 5 kW up to some megawatts); ▪ Application: Mini-grids, villages, towns, productive use; ▪ Pre-condition: See above, depending on type.

DOs and DON'Ts on Appropriate Technology Solutions

DO *conduct a comprehensive assessment of local renewable energy resources.*

The assessment of local renewable energy resources as a basis for project feasibility studies has to be conducted with systematically.

The data, especially on solar and wind energy resources is ideally collected over a longer period (1-2 years). In the case of hydropower, the water flow measurements must be carried out during the dry season.

It is advisable that renewable energy resources in off-grid villages are surveyed and mapped out by experts during the off-grid rural electrification planning stage.

DO *conduct a technology neutral assessment.*

Taking into account the available renewable energy resources in the target areas, the technical assessment needs to be done as technology-neutral as possible. The technical options need to be assessed and selected based on performance, economic, and social factors. The pre-setting of technologies to be applied most often lead to inefficient and therefore costly solutions for example through oversized systems.

DO *conduct a detailed survey on electricity demand of various sectors in the community.*

As the electricity demands and their variation strongly influence the selection of the possible technologies and the installed capacity, this data has to be carefully collected and assessed.

The assessment of electricity demand of an off-grid community needs to be conducted with a participatory approach, involving the villagers in assessing their electricity needs.

The assessment has to cover all potential electricity consumers such as households, public institutions (e.g. schools), commerces (e.g. shops), and productive activities (e.g. agricultural production and processing, manufacturing, etc.).

DO *forecast and, during the technical analysis, consider the potential electricity demand once the off-grid power system is built.*

Once the power system is installed, private, as well as commercial electricity demand are likely to increase by connecting new appliances or increasing commercial or productive activity. This increase in electricity demand needs to be forecasted and considered during the technical analysis of the project.

DO *combine with already existing power systems in the target areas.*

In case a local distribution grid (mini-grids) and for example a diesel genset are in place from previous electrification efforts, it is advisable to upgrade those systems with RET to allow for more affordable electricity supply in the long run. Such hybrid systems trigger important fuel savings, bringing down generation costs considerably.

DO *select hybrid diesel-RE systems when interruption in electricity supply cannot be tolerated.*

RETs usually face strict limitations imposed by site specificity and seasonality of resources (especially solar PV). Therefore, in order to ensure safety and reliability of electricity supply, RET systems can be combined with diesel gensets to ensure a continuous supply of electricity. An alternative to the diesel backup is sufficiently large battery banks to store electricity, but batteries are relatively expensive and have to be replaced regularly (approx. every 2 years) over the project lifetime.

DO *consider small systems for target areas with only few and dispersed potential customers.*

Where the customer base is weak (i.e. the electricity customers are few and dispersed and their electricity use is limited), individual RET systems such as pico-hydropower system, small SHS and pico PV system, are preferably applied.

High upfront investment costs are not necessary and operation and maintenance efforts are limited for these systems.

Box 8: Technology selection for a micro grid in Lao PDR

In Angsang village, Huaphanh province in Lao PDR, several stand-alone pico hydropower generators were used to supply electricity to individual households before the implementation of the project.

However, as these equipments were purchased and installed by the households without any professional support, the systems were unreliable. In addition, the poor operation and maintenance conducted by untrained individual households damaged many systems. Furthermore, water conflicts between the households caused a big problem for efficient use of pico hydropower systems.

In 2009, the Lao Institute for Renewable Energy (LIRE) launched a project called “shared-pico hydro power” to demonstrate how a rural community can efficiently use pico hydro technology for electricity supply in Angsang village. 24 participating households, 3 teacher accommodations and one communal office were interconnected into a micro-grid supplied by a central power plant consisting of 2 x 1 kW pico hydro units.

The creation of a micro-grid and the use of a central power plant have solved: (i) technical problems related to stand-alone pico hydropower systems, (ii) in addition, the project helped reduce the electricity expenses of the households, and (iii) eased the water conflicts. The fee was set at LAK 6,000/month (US$ 0.75/month) for small users (30 W max.) or LAK 23,000/month (US$ 2.88/month) for bigger users (100 W max). There are 10 households using high package and the remaining 18 using low package. The monthly fee collected from the households was sufficient to cover the operation and maintenance costs of the power system.

Source: ACE 2012.

DO *take into consideration the spare parts supply when selecting the technology for off-grid power system.*

Unreliable or costly supply of spare parts for off-grid rural electrification projects is one of the main causes of project failure.

The availability and costs of spare parts need to be included in the economic and financial analysis to select the most appropriate technology for off-grid electrification.

DO *take into account the involvement of local manufacturers in equipment supply.*

The involvement of local manufacturers in equipment supply helps reduce the project investment costs and increases the reliable access to spare parts and service. It is advisable to rely on local components as much as possible provided they are cost-competitive.

It is, however, necessary that quality, reliability and lifetime of the locally-made equipment are carefully assessed (see Box 9 below).

Box 9: Replacement of diesel generators in Cambodia

Implemented by a Rural Electricity Enterprise (REE) in Bat Deng village, Kampong Speu province, a rice husk gasification power system has replaced a diesel genset and is in operation since December 2008. The system consists of a rice husk gasifier, a 50 kW 100%-gas engine generator, a 150 kW dual gas/diesel engine generator (modified) and an existing mini-grid to supply electricity to 1,300 households in the village.

Before the REE was supplying electricity to the households by using diesel gensets at high tariffs of US$ 0.9/kWh. With the new technology the electricity generated is sold at US$ 0.58/kWh (36% lower than electricity price from diesel generators). The electricity production cost was estimated at US$ 0.29/kWh. REE reported that the biomass gasification project would make a profit of up to US $64,000/year and investment costs can be paid back within less than 1.5 years.

Source: ACE 2012.

DON'T *overestimate the electricity demand of the potential electricity customers.*

While an increase in electricity demand is probable when a new system is installed, oversized power systems increase investment costs on a marginal capacity that may lie idle and decreases the plant capacity factor, which negatively affects the economic performance of the project. Especially mini hydropower plants are often oversized and run only at 20-60% of their capacity.

DON'T *use diesel generators for newly established off-grid rural electrification.*

Diesel generators have been a traditional solution to off-grid rural electrification. Although diesel generators have much lower investment costs per kilowatt than RET systems, their applications are generally reduced due to the high fuel costs, including transportation costs, in remote areas. Thus, along with environmental considerations, the use of diesel generators for off-grid rural electrification should be avoided as much as possible.

DON'T *use cheap and low quality equipment for rural electrification projects.*

It is common to see off-grid projects using relatively inexpensive, but low-quality equipment to reduce initial investment and generation costs.

While the initial investment for low-cost equipment is in fact lower, generation costs are most probably higher in the long run. Low quality leads to unreliable supply of electricity, low plant load factor due to regular shutdowns for system maintenance, and an increase in operation and maintenance costs over the project lifetime. In many cases these issues made rural electrification projects fail.

2.5. Socio-economic Aspects And Community Involvement

Socio-economic and environmental aspects as well as potential impacts on the community need to be taken into consideration in off-grid project planning and implementation.

The benefits of electricity for an increased standard of living, productive activities and social institutions (hospitals, schools, community centres, etc.) are main socio-economic impacts from off-grid rural electrification. Environmental benefits include positive impacts on soil, water and air pollution.

In addition, local community involvement is an essential aspect in rural electrification projects. If a project is not well explained, accepted or appreciated by the community beneficiaries, sustainability can be hampered. Community involvement is therefore important at all stages of the project cycle, from planning and project development to project implementation and long-term operation.

It is crucial to understand the community's needs and potential before starting with the actual planning of a project. For example the chosen project design (e.g. business model) will only work, if it is accepted by villagers. The communities and their representatives play furthermore a crucial role in supporting the construction works (especially for hydropower projects) as well as in operating and maintaining the power system in case this task is not carried out by a private entity (compare "business models" above).

Table 6 presents the main project activities and the potential community involvement.

Table 6: Main project activities with community involvement

Stage of the project	Main project activities with community involvement
Project planning:	
Need assessment	☑ Assessing energy needs; ☑ Estimating electricity demand; ☑ Defining the problems and possible solutions regarding electricity supply.
Project pre-feasibility study	☑ Measurement and assessment of renewable energy resources (e.g. feedstock supply); ☑ Mapping of potential socio-economic and environmental impacts; ☑ Cultural acceptance of technology and/or project setup; ☑ Community involvement/contributions; ☑ Potential management setup; ☑ Site selection.
Project design	☑ Choice of technology (technical skills for operation and maintenance within the community); ☑ Selection of beneficiaries and ownership (developing selection criteria); ☑ Development of institutional structure and business model; ☑ Decision on the organizational/management setup.
Project implementation:	
Setup of community organization	☑ Setting up community organization for supervision and monitoring (committee) and/or investment (cooperative); ☑ Training and capacity building (operators, managers).
Project construction	☑ In-kind contributions (labour, local materials); ☑ Monitoring the construction works.
Project commissioning and handover	☑ Taking over the project facilities (if ownership is handed over to the community); ☑ Monitoring the commissioning and handover process.

Stage of the project	Main project activities with community involvement
Project O&M and management:	
Project O&M and management	☑ Planning and organizing the operation and maintenance of the facilities (e.g. hiring staff); ☑ Management setup including financial management (fee collection, profit sharing, etc.); ☑ Technical and business training (for community entity in charge).
Project Monitoring and Evaluation (M&E)	☑ Monitoring of technical performance of power system; ☑ Monitoring and evaluating of socio-economic and environmental impacts of the project.

A close monitoring and evaluation of the socio-economic and environmental impacts of off-grid rural electrification is of particular interest in order to asses and understand the long-term impacts and benefits of the measure. Since rural electrification programs most often have a political and development objective, the monitoring of economic progress, social and welfare impacts as well as environmental consequences of a particular off-grid electrification program is important.

The main indicators used for monitoring and evaluating the socio-economic and environmental impacts of off-grid electrification in the ASEAN region are summarized in Table 7 below.

Table 7: Socio-economic impacts of rural electrification

Type	Impacts
Economic	▪ *Job creation:* Increased number of jobs directly or indirectly created by the off-grid rural electrification project (staff to operate, maintain and manage the power facilities, increased economic activity by home businesses and productive users); ▪ *Household income:* Increase in household income after the provision of electricity; ▪ *Household expenditures:* Decreasing expenditures on energy including fuels and/or electricity mainly for lighting and cooking; ▪ *Business use of electricity:* Improved productivity and increased use of electricity in existing home businesses; increased number of newly established home businesses; ▪ *Productive use of electricity:* Improved productivity and increased use of electricity by existing productive users (mills, manufacturers, etc.); Increased number of newly established productive users; ▪ *Economic development of the community:* Improved economic development indicators such as overall income growth, income per capita, poverty alleviation, etc. compared to the situation before electrification.
Social and welfare	▪ *Electrical appliance ownership:* Increased use of electrical appliances (i.e. electric lamps, radios, televisions, electric fans, rice cookers, refrigerators, or water pumps) in a household after being electrified; ▪ *Health benefits:* Improvements to the community health facilities (cooling, lighting); better health due to cleaner air as households reduce the use of polluting fuels for lighting and cooking (indoor-lighting); improved knowledge through increased access to information on radio/TV; ▪ *Education benefits:* Improved quality of schools through the provision of electricity-dependent equipment (computers, TV, lighting); increased study time for children at home (lighting); improved access to information (radio/TV); ▪ *Social benefits:* Increased time spent on community activities.
Environmental	▪ *Global environmental benefits:* Decrease of greenhouse gases (GHG) emissions (only to a limited extend due to relatively small system size).

DOs and DON'Ts on Socio-economic Aspects and Community Involvement

DO *involve the local community as much as possible in all stages of the project cycle.*

The participation of the local community in the project development helps to design a setup close to the local needs and demands.

Ensuring community involvement mobilizes and maintains local support and commitment, while creating employment, building local capacity, and thereby laying the foundation for the sustainable management and operation of the project.

Early in the project planning stage, the target community needs to be reached for example via awareness campaigns, regular meetings with community leaders and community-based meetings.

DO *use participatory approaches when working with the local community.*

It is advisable to use participatory approaches that are inclusive and equitable when working with the local community, especially during project planning stage.

Meetings are to be held with beneficiaries, villagers, community officials, representatives from public institutions, businesses, etc. The participation of all relevant stakeholders and groups has to be ensured.

Results and feedbacks need to be kept in written form and shared as they are important documents of reference for further project planning and implementation.

Box 10: Benefits of community involvement

An experience from the rural electrification programs supported by the World Bank shows clearly that rural electrification programs benefit greatly from the involvement of local communities. The participation of local communities from the start of a project offers the advantages of improving the design (Lao PDR, Peru, Vietnam), avoiding disputes and gaining local support (Bangladesh), and mobilizing cash or in-kind contributions (Nepal, Thailand).

Community involvement also increases local ownership, thereby helping to ensure the operational sustainability of the project. An interesting feature in some countries is the role of women's associations in the management of multipurpose platform projects that usually include diesel generation, mills, battery chargers, and pumps; a set of installations is chosen by the community with the aim of increasing productivity using electricity.

Source: WB 2010.

DO *keep the community organization small and functional during project implementation.*

Following the broad participatory approach in early project steps, the community entity (e.g. rural electrification committee or community cooperative) involved in project implementation should be kept small and functional. It includes a group of respected individuals with a good standing and reputation in the village.

In order to avoid being "captured" by the governing elites, the selection process for members to a community organization should be democratic and should be supervised.

DO *make sure that women are represented and involved in the project planning.*

Rural women are among the principal beneficiaries of an off-grid rural electrification project. Access to electricity may have a large impact on their health, income and status.

Women often know families' needs best, also regarding electricity use. In some rural villages, women head the households and are responsible for household energy expenditures. In this case, the voice of women about their ability and willingness to pay for electricity is important for project planning.

DO *give support to the communities to develop a suitable management setup for the off-grid project.*

The sense of ownership motivates the local community to get effectively involved in design, implementation, operation and maintenance of the project. Even though the planning process needs to have a certain flexibility regarding the management model, it has to be clarified in due time.

The inclusion of the community in establishing a suitable management model includes an open deliberation of electricity tariffs (in community-based projects). The importance of reasonably high tariffs needs to be understood as well as the whole tariff system.

Box 11: Creation of village energy committee in Lao PDR

The shared-pico hydropower project was implemented in 2009 by the Lao Institute for Renewable Energy (LIRE) in Angsang Village, Huaphan province.

The key success factor learnt from the project was the creation of the village energy committee. Through it, the local people got involved in project planning and implementation, and were trained to manage the system themselves. The Committee nominated two local representatives to receive further training to operate and maintain the system. The Committee also sets the tariff (in the case of Angsang Village, there are two types of tariffs – a low one and a high one, allowing villagers to chose their power needs and pay accordingly).

The tariff shall be decided in such a way that it generates enough income for the system maintenance and the stipends to the village energy committee and the two people trained to operate the system. The underlying concept is that power should be as cheap as possible, but the operational costs need to be covered. The village energy committee is given clear guidance and support with respect to the range of viable tariffs, so it is a feasible and reasonable local decision for them. Also, the community understands the benefits provided by the approach, as power generation is more reliable and available for most of the year.

Source: LIRE 2009.

DO *establish a common guideline for monitoring and evaluating off-grid rural electrification projects.*

It is advisable that the institution in charge (see above) establishes a common national guideline for monitoring and evaluating the impacts of off-grid rural electrification projects.

The guideline should define M&E indicators, methodology, baseline approaches, data formats and reporting format. A common M&E system helps facilitate not only monitoring in the field but also subsequent analysis and use of monitored data.

Against this background it is advisable to conduct a comprehensive socio-economic baseline study of the target community before implementing an off-grid rural electrification project in order to monitor developments and improvements.

DON'T *allow misunderstanding and mistrust among the villagers.*

The criteria for selecting the project beneficiaries should be clearly set up and explained to the community. The calculations of the electricity tariffs should be publicly disclosed and discussed with the customers as well as the potential sharing of project profits.

DON'T *neglect the social safeguards and environmental impacts of an off-grid rural electrification project.*

Off-grid power systems may use products and material (lead-acid batteries, compact fluorescent lamps, etc.) which must be recycled or disposed safely. Mechanisms for proper collection need to be in place or have to be established.

In the case of hydropower projects, catchment area protection and management is of particular importance.

2.6. Capacity Building and Training

Capacity Building and Training (CB&T) is fundamental for all involved stakeholders to ensure that they can fulfill their roles and responsibilities in an off-grid rural electrification project.

Typically, the following stakeholders are eligible for targeted CB&T measures:

- Policy makers and government officials (central and local level);
- Project developers;
- Financial institutions and private investors;
- Equipment manufacturers and construction companies;
- Power plant operators and managers;
- Local communities/end-users.

General information on aspects such as policy, technology, financing, project impacts and benefits, etc. are to be provided to most of the stakeholders in order to raise awareness and general knowledge on off-grid rural electrification.

However, for each target group of stakeholders specific capacity building and training are necessary (compare overview in Table 8 below).

Various formats of CB&T measures such as seminars, workshops, study tours, site visits, classroom and on-site training can be applied. The selection of an appropriate type of CB&T depends on the target stakeholders as well as the topics presented.

Table 8: Types and main topics of the training and capacity building activities

Project stakeholders	Main topics of CB&T	Types of CB&T
Policy makers and government officials	▪ General aspects of off-grid rural electrification projects (including policy, financial aspects, technology, impacts/ benefits); ▪ Policy frameworks for sustainable off-grid rural electrification; ▪ Tendering/contracting.	▪ Seminars ▪ Workshops ▪ Study tours/site visits
Project developers and consultants	▪ Prevalent policy frameworks and legal aspects; ▪ Project planning (needs assessment, (pre-) feasibility, project design and business models, etc.); ▪ Project implementation (project organization, construction/ installation, supervision/monitoring, testing/commissioning and handover, community involvement).	▪ Seminars ▪ Workshops ▪ Classroom trainings ▪ On-site trainings ▪ Site visits
Financial institutions and private investors	▪ General aspects of off-grid rural electrification projects (including policy, financial aspects, technology, impacts/ benefits); ▪ Prevalent policy frameworks and legal aspects; ▪ Project financing; ▪ Business models; ▪ Risk assessment of RET.	▪ Seminars ▪ Workshops ▪ Study tours ▪ Site visits
Equipment manufacturers and construction companies	▪ General aspects of off-grid rural electrification projects (including policy, financial aspects, technology, impacts/ benefits); ▪ Prevalent technical standards; ▪ Project implementation (construction/installation, tendering/ contracting, supervision/monitoring, testing/commissioning and handover).	▪ Seminars ▪ Workshops ▪ Classroom trainings ▪ On-site trainings ▪ Site visits

Project stakeholders	Main topics of CB&T	Types of CB&T
Power plant operators and managers	▪ General aspects of off-grid rural electrification projects (financial aspects, technology, impacts/benefits); ▪ Plant operation; ▪ Plant maintenance; ▪ Business management (Accounting, fee collection, etc.)	▪ Seminars ▪ Workshops ▪ Classroom trainings ▪ On-site trainings
Local communities/ end-users	▪ General aspects of off-grid rural electrification projects (financial aspects, technology, impacts/benefits); ▪ Project design and business models; ▪ Efficient use of electricity; ▪ Productive uses of electricity.	▪ Community discussions ▪ On-site trainings

DOs and DON'Ts on Capacity Building and Training

DO *conduct an adequate capacity building needs assessment at the beginning of the off-grid electrification activity*.

Capacity building needs assessment should be considered as a mandatory step in the planning of off-grid rural electrification projects. It assesses the existing capacity of each group of stakeholders and identifies their capacity building needs.

The findings of such an assessment are important for drawing up and designing a comprehensive capacity building plan that best responds to the needs and requirements of each group of stakeholders involved in off-grid rural electrification projects.

DO *earmark sufficient resources for continuous CB&T measures during the whole project cycle.*

Capacity building is not a one-time effort, but needs a certain continuity especially for operators and managers. The provision of sufficient funds for these activities and/or the inclusion of training measures into tender documents is important to guarantee for knowledgeable stakeholders.

DO *carry out a comprehensive training on power plant operation, maintenance and business management as a standard.*

Insufficient capacities on operation and maintenance as well as business management are among the main reasons for project failure. It is advisable to consider the O&M and business management training as a mandatory requirement for every off-grid rural electrification project.

In case the training is provided by suppliers and/ or contractors (as part of the tender), it has to be ensured that they have the relevant capability and experience to conduct the required training.

Box 12: Capacity building and training in Vietnam

The Vietnam-Sweden Rural Energy (VSRE) Program aimed at increasing the access of Vietnam's rural population to reliable, affordable, appropriate and sustainable rural energy services. The program focused in off-grid rural electrification.

One of the key factors contributing to the success of the program was capacity building and training. During a period of 3 years, about 38 CB&T events with more than 1,150 participants had been organized. They included 13 workshops, 12 seminars, 2 study tours and 11 trainings. The stakeholders involved in capacity building and training varied from policy makers/government officials to the power plant operators. The CB&T topics included policy, technical and financial issues, project planning and implementation, O&M and business management.

Priority was given to training on power plant O&M, and business management. A three-step approach was used for training personnel selected from 4 pilot projects. In a first step, VSRE trained the personnel in basic principles of power plant operation and maintenance and business management. Then, an in-depth classroom training was conducted by a local vocational school for 4 months. Finally, the personnel was trained by the equipment suppliers and contractors during construction and equipment installation.

Source: VSRE 2010.

DO *utilize, whenever possible, local training institutions*.

Unlike international trainers who usually require interpreter, local trainers can deliver the training contents directly in the local language, hence limiting risks of misunderstanding.

Provided sufficient quality of the local training insititutions, they are key to institutionalize know-how in the country and to build up sustainable teaching and learning capacities in the country.

DO *use the capacity building and training materials that have been specifically adapted to the project context and translated into local language*.

The capacity building and training materials, especially those used for training of power plant operators should be practical and adapted to the project context as much as possible.

All the training materials, including equipment catalogues and O&M manuals should be translated into the local language to enable an easy and correct understanding.

DO *pay particular attention to capacity building measures for the local community*.

Awareness raising of the local community is important for several reasons. First, it ensures transparency and make the community aware of the project activities, the potential positive impacts and benefits as well as the expected role and obligations of the local community and the end-users. Second, it creates demand for electricity among the potential local customers by showing forms of applications, in particular for productive use.

In general, a well-informed community is less reluctant to accept the project and, in the long run, more willing to support the project and to purchase the electricity generated as well as taking care of the hardware.

Box 13: Capacity building and training of local communities

The Mini Hydro Power Project for Capacity Development (MHPP[2]) In Indonesia promotes the dissemination and exchange of know-how on mini hydropower, as well as the sharing of best practices in the building of sustainable facilities. A Best Practice Guideline developed within the framework of this project drew on the following best practices in capacity building and training of local community on Mini Hydro Power (MHP) applications:

- The intensity of community capacity building largely depends on the implementation approach of the MHP schemes. Significantly, more technical and managerial capacity building is required for schemes that are built by communities instead of by contractors;
- Whenever possible, utilize locally based capacity building organizations, institutions, and Civil Society Organizations (CSOs);
- Identify and utilize in capacity building activities the "community champions" - successful and highly motivated villagers that have experience from other community-based MHP schemes in the region;
- Clearly explain and reach an agreement about expectations, role and responsibilities of the participants before any capacity building is provided;
- Provide on-site training and use training materials that have been specifically adapted to the local situation;
- Train and involve community members in participatory monitoring of the MHP construction process;
- At a later stage, provide information to communities on productive end-use of energy, including a number of relevant income generating activities that can be powered by the MHP plant;
- Train community members in participatory mapping of micro-catchment boundary, tree seedling production, sustainable land management, and agro-forestry practices to safeguard the MHP catchment area.

Source: MHPP[2] 2011.

DO *evaluate trainings.*

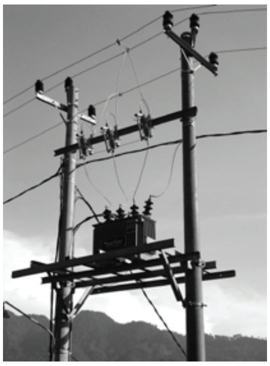
Feedback from the participants about the CB&T activity can help to enhance the effectiveness of future activities.

DON'T *rely on single training course, especially at the start of the project*.

As capacity building is a long-term iterative process, a number of small-scale training interventions repeated over time are more adequate than selective training courses.

3

Summary and Conclusion




3. Summary and Conclusion

This Guideline is prepared based on experiences and lessons learnt from past and ongoing off-grid rural electrification projects in various ASEAN countries. It aims to provide the decision-makers and project developers in the region with practical recommendations for the planning and implementation of off-grid rural electrification using renewable energy technologies.

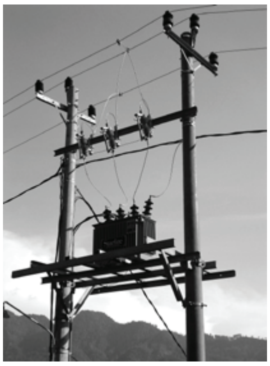
The Guideline focuses on six main aspects of off-grid rural electrification: (1) Policy framework; (2) Financing mechanisms and support policies; (3) Project setup and business models; (4) Appropriate technology; (5) Socio-economic aspects and community involvement; and (6) Capacity building and training.

For each aspect, a number of successful approaches and lessons learnt were analyzed and recommendations are presented in the form of “DOs and DON’Ts”:

- ☑ Policy makers shall develop the key policies for promoting off-grid rural electrification which shall include a development strategy and concrete action plans, a suitable electricity pricing policy, financial incentives and a framework on funding mobilization;
- ☑ A clear legal framework for private investment in off-grid rural electrification needs to be established in order to mobilize the private sector to become actively involved in this market;
- ☑ A central institution/agency shall be created to coordinate the planning and implementation of all off-grid rural electrification activities in a country;
- ☑ The public sector should use its resources to finance off-grid projects in poor rural areas where business models can hardly be established and projects are less or not profitable. Wherever possible and economically viable, priority should be given to the private sector to get engaged for investment and project development;
- ☑ The business model selected for an off-grid rural electrification project shall have some degree of flexibility and fit the specific conditions of the community implementing the project. The business model may have to be modified along the way in order to cater to the actual developments and changes in the project structure during project implementation;
- ☑ Whatever is the selected business model, care should be taken to ensure that end-users have access to quality electricity services at affordable prices;
- ☑ The project design must not be technology driven. Technology choices are to be based on practical considerations. A cost-benefit analysis of different technology options (including grid extension) should be carried out to determine the least-cost solution;
- ☑ Productive and institutional applications of electricity not only help to improve standards of living (e.g. job creation, better health care) but also increase the economic attractiveness of the off-grid power project. The project developers therefore must consider initiating or enhancing productive activities as they significantly increase the sustainability of the project;
- ☑ Maximizing the awareness and involvement of the benefitting community in the early stages of the project cycle, especially during the project assessment phase, is vital to the success of off-grid project implementation. Key activities include public awareness campaign, regular meetings with community leaders and focus-group meetings;
- ☑ Capacity building and training to develop local capacities in design, implementation, management and O&M is essential for the success of off-grid rural electrification projects. Therefore, adequate resources should be devoted to developing local capacities.

4

Appendices




4. Appendices

Appendix 1: Glossary

Affordability: the extent to which the electricity is affordable to the consumer, as measured by its cost relative to the amount that the purchaser is able to pay.

Biogas-based power system: is a system that converts biodegradable matter (e.g. livestock manure) into electrical energy. A typical biogas-based power system consists of a biogas digester, a gas engine-generator plant and auxiliaries. The biodegradable matter is biologically converted into biogas in a digester. The biogas, which typically contains 50-70% methane (CH_4) and 30-50% carbon dioxide (CO_2), is then used in a gas engine-generator plant to generate electricity.

Biomass gasification power system: is a system that converts solid biomass (e.g. rice husk, sawdust, wood wastes, etc.) into electrical energy. A typical biomass gasification system consists of biomass gasifier, gas cleaning system, gas engine-generator plant and auxiliaries. Firstly, biomass is converted through a thermo-chemical process into a combustible gas in a gasifier. Then, the gas is cleaned to produce clean gaseous fuel called producer gas or syngas. Finally, syngas is fed into a gas engine-generator plant to generate electricity.

Break-even electricity tariff: the price of electricity provided to the electricity producer at which the project cost (or expense) and revenue are equal. There is no net loss or gain.

Commercial loan: a debt from a bank granted to a business. In this type of loan, the bank usually offers the borrower an interest using market rates.

Diesel generator: the combination of a diesel engine and an electric generator (often an alternator) to generate electrical energy.

Energy Service Company (ESCO): a commercial business providing a broad range of comprehensive energy solutions, including design, funding and implementation of electricity generation as well as supply of electricity for rural customers.

Equity capital: money that is invested into a project in exchange for an ownership interest in that project. The equity capital, in contrast to debt capital, is not repaid to the investor according to a specific schedule and is not secured (or guaranteed) by the project assets.

Financial incentive: monetary benefit offered to power producers and/or consumers to encourage behavior or actions which otherwise would not take place.

Financing mechanism: method or source through which funding is made available.

Grants: the non-repayable funds disbursed by one party (grant makers), often a government authority or a donor, to a recipient (e.g. a community-based cooperative or a household). Most grants are made to fund a specific project and require some level of compliance and reporting.

Grid extension: an expansion of transmission or distribution network from the national power grid to new rural areas and communities.

Hybrid power system: is an arrangement of power generation sources designed to guarantee a continuous supply of electricity for an isolated power grid. Hybrid systems normally contain a number of different RET systems (i.e. hydro, wind, solar PV, etc.) and/or diesel generators. Hybrid power systems range from small systems designed for one or several households to large ones for remote island grids or large communities.

Hydropower system: is a system that converts the potential energy of falling water into electrical energy. Hydropower plants are classified by size into large, small, mini, micro or pico system. However, there is no international consensus for setting the size threshold between different classes of hydropower plants. In this Guideline, the size thresholds for hydropower systems typically used for off-grid rural electrification are 100-1,000 kW for mini, 5-100 kW for micro, and up to 5 kW for pico hydropower plant.

Isolated mini/micro-grids: an electricity distribution system that is energized by local power generation that is not connected to a national power grid.

Off-grid rural electrification: the process of bringing electricity to rural and remote areas that are not connected to a national power grid.

Off-grid rural electrification plan: a list of steps with timing and resources, used to achieve the objectives of off-grid rural electrification.

Off-grid rural electrification strategy: a plan of action designed to achieve a specific goal for off-grid rural electrification.

Project stakeholders: the individuals and organizations that are actively involved in an off-grid rural electrification project, or whose interests may be affected as a result of project implementation.

Project sustainability: the ability of a project to maintain its operations, services and benefits during its projected lifetime.

Public-Private Partnership (PPP): a government or private project which is funded and operated through a partnership between government and one or more private sector companies.

Stand-alone power system: an off-grid electricity system for a location that is not connected to an electricity distribution system. A typical stand-alone power system includes one or more methods of electricity generation, energy storage and regulation.

Subsidy: financial assistance given to an off-grid rural electrification project in order to make it affordable to the rural consumers and at the same time ensures financial viability of the project.

Willingness to pay: the amount a consumer would be willing to pay for electricity supplied.

Wind power system: is a system used to convert energy from wind into electricity. Wind power is very consistent from year to year but has significant variation over shorter time intervals. The intermittency of wind creates problems when used to supply an off-grid electrical network. Therefore, the off-grid system users should either adapt to intermittent power supply or use batteries, other RETs or diesel generators to supplement wind turbines. Wind power systems range from home-scale systems (less than 1 kW) for individual households to larger systems supplying micro or mini-grids.

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