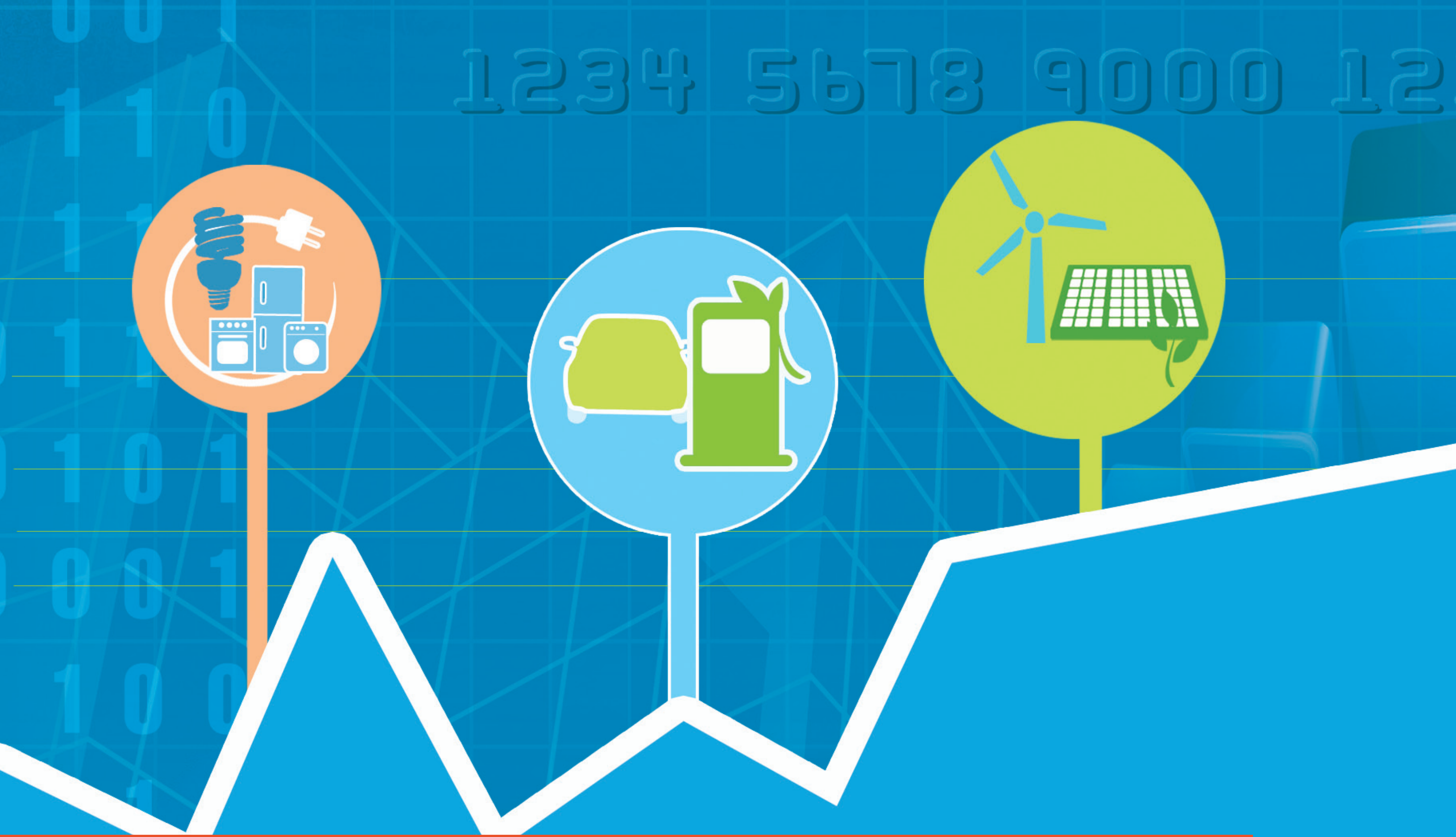

BUSINESS MODELS TO REALIZE THE POTENTIAL OF RENEWABLE ENERGY AND ENERGY EFFICIENCY IN THE GREATER MEKONG SUBREGION

ADB

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ADB

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Foreword

In 2010, the Asian Development Bank (ADB) initiated the regional technical assistance project Promoting Renewable Energy, Clean Fuels, and Energy Efficiency in the Greater Mekong Subregion (GMS), to assist the countries in the GMS—Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam (the GMS countries)—in improving their energy supply and security in an environmentally friendly and collaborative manner. The Yunnan Province and Guangxi Zhuang Autonomous Region of the People's Republic of China, which are also part of GMS, are not included in this study due to difficulties of segregation of national level data. The project was cofinanced by the Asian Clean Energy Fund and the Multi-Donor Clean Energy Fund under the Clean Energy Financing Partnership Facility of ADB.

The study prepared three reports: (i) Renewable Energy Developments and Potential in the Greater Mekong Subregion, (ii) Energy Efficiency Developments and Potential Energy Savings in the Greater Mekong Subregion, and (iii) Business Models to Realize the Potential of Renewable Energy and Energy Efficiency in the Greater Mekong Subregion.

The first report provides estimates of the theoretical and technical potential of selected renewable energy sources (solar, wind, bioenergy) in each of the countries, together with outlines of the policy and regulatory measures that have been introduced by the respective governments to develop this potential. The second report addresses the potential savings for each of the countries from improved energy efficiency and conservation measures. The third report outlines business models that the countries could use to realize their renewable energy and energy efficiency potential, including the deployment of new technologies.

The renewable energy report concludes that, apart from Thailand, the GMS countries are at an early stage in developing their renewable energy resources. To further encourage renewable energy development, the GMS countries should provide support for public and private projects investing in renewable energy. Solar energy is one which is being actively promoted in the region. While the cost of solar power is still high relative to conventional sources, it is a cost competitive alternative in areas that lack access to grid systems. Large-scale solar systems are being developed in Thailand whilst home- and community-based solar systems are increasingly becoming widespread in the GMS. Large-scale development of wind power depends on suitable wind conditions and an extensive and reliable grid system as backup; Viet Nam has the required combination and is gradually developing the potential. Biofuel production raises questions concerning the agriculture–energy nexus, but Cambodia, the Lao PDR, and other GMS countries are striving to reduce their dependence on imported oil and gas by promoting suitable biofuel crops. Biogas production from animal manure has been hampered by the difficulty of feedstock collection and the frequent failure of biodigesters. The gradual move to larger-scale farming techniques and new biodigester technologies has led to expanded biogas programs—especially for off-grid farm communities. The GMS countries have learned that maintenance and technology support is of vital importance in sustaining investments in renewable energy.

The energy efficiency report presents the steps each of the five countries has taken in this regard, noting that much greater gains in energy savings are possible while their efficiency measures are progressive. Most of the GMS countries envisage energy efficiency savings of at least 10% over the next 15–20 years except Thailand which is targeting 20%. Thailand and, to a lesser extent, Viet Nam have advanced policy, institutional, and regulatory frameworks for pursuing their energy efficiency savings targets, while Cambodia, the Lao PDR, and Myanmar are less well structured to reach their goals.

The renewable energy and energy efficiency reports chart a way for the GMS countries to become less dependent on imported fuels and more advanced in developing "green" economies. Global climate change concerns dictate greater attention to renewable energy and energy efficiency. National interests are served by both, offering a win–win outcome from investment in renewable energy and energy efficiency measures. The report on business models indicates ways in which these investments can be made through public–private partnerships, providing a basis for further dialogue among stakeholders.

In collaboration with the governments of Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam, ADB has published these reports with the objective of helping to accelerate the development of renewable energy and energy efficiency in the Greater Mekong Subregion.

James A. Nugent
Director General
Southeast Asia Department

Acknowledgments

The Asian Development Bank (ADB) carried out the regional technical assistance project in collaboration with the following government agencies: the Ministry of Mines and Energy, Cambodia; the Ministry of Energy and Mines, the Lao People's Democratic Republic; the Ministry of Energy, Myanmar; the Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand; and the Electricity Regulatory Authority of Viet Nam.

In ADB, Jong-Inn Kim, lead energy specialist, Energy Division, Southeast Asia Department (SERD), initiated the report and gave technical advice. The peer reviewer of this report was Neeraj Jain, senior advisor, Office of the Director General, SERD and Hyunjung Lee, energy economist, Energy Division, SERD. Ma. Trinidad Nieto, associate project analyst, Energy Division, SERD, provided administrative support during the implementation of the technical assistance project. David Husband served as economics editor and Maria Cristina Pascual as publishing coordinator. James Nugent, director general, SERD, and Chong Chi Nai, director, Energy Division, SERD, provided guidance in the preparation of this report.

Lahmeyer International GmbH, headquartered in Germany, was contracted by the Asian Development Bank to assess the low-carbon renewable and energy efficiency potential in five of the Greater Mekong Subregion countries (Cambodia, the Lao PDR, Myanmar, Thailand and Viet Nam). Further, Lahmeyer International lead a series of workshops in the five countries, to share experiences and to advance technical knowledge on the opportunities and challenges. The assessment of renewable and energy efficiency potential in the subregion was based on earlier reports, secondary research, and available data. The assessment included review of business models to operationalize the identified opportunities. Because of changing weather patterns and data uncertainties, Lahmeyer recommends that the research and findings - particularly those pertaining to renewable energy - be used as indicative guidelines rather than as a basis for specific investments.

Abbreviations

ADB	–	Asian Development Bank
BOOT	–	build–own–operate–transfer
ESCO	–	energy service company
GMS	–	Greater Mekong Subregion
kW	–	kilowatt
Lao PDR	–	Lao People's Democratic Republic
MFI	–	microfinance institution
MW	–	megawatt
NGO	–	nongovernment organization
O&M	–	operation and maintenance
PPA	–	purchase power agreement
PPP	–	public–private partnership
PRC	–	People's Republic of China
SBCS	–	solar battery charging station
SMEs	–	small and medium-sized enterprises
SPC	–	special-purpose company
SPV	–	special-purpose vehicle
TA	–	technical assistance
UNDP	–	United Nations Development Programme

1 Introduction

This publication on business models for renewable energy and energy efficiency is designed to complement two companion publications of the Asian Development Bank (ADB):

- Renewable Energy Developments and Potential in the Greater Mekong Subregion; and
- Energy Efficiency Developments and Potential Energy Savings in the Greater Mekong Subregion.

These two publications focus on the potential for renewable energy and energy efficiency in Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand and Viet Nam, highlighting what has been accomplished so far and their "green energy" possibilities over the next 15–20 years. This third publication provides outlines of business models relevant to pursuing the ambitious renewable energy and energy efficiency targets adopted by the five countries—collectively referred to here as the Greater Mekong Subregion (GMS).[1]

Investments in renewable energy and energy efficiency generate benefits to society as a whole that cannot be fully reflected in investment returns, leading thereby to underinvestment by the private sector. Consequently, there is a strong case for public sector support for renewable energy and energy efficiency initiatives. Most importantly, these initiatives contribute to reducing the emission of greenhouse gases and the climate change consequences that threaten global livelihoods. More immediately, they lessen the vulnerability of energy dependence and the financial burden of oil imports. Further, advances in energy efficiency reduce energy costs and contribute to improved competitiveness. Energy savings also contribute to supplying more consumers and slowing the growth in demand for electricity, an important consideration in Southeast Asia where large areas continue to depend on firewood and other biomass sources of energy.

Business models for investments in renewable energy and energy efficiency provide policy makers and investors with alternative business methods for the deployment of new technologies, or for the application of well-established technologies and practices in new

[1] The Greater Mekong Subregion includes Yunnan Province and Guangxi Zhuang Autonomous Region of the People's Republic of China.

settings. Generally, these models are designed to address various impediments to making such investments, including the following (ECN 2012):

- information shortcomings, leading to a lack of awareness and knowledge of the importance of renewable energy and energy efficiency;
- regulatory barriers, leading to cumbersome procurement rules and permit processes; and
- financial barriers, reflecting poorly developed banking services, high up-front costs of investment, and low initial returns.

The business models outlined here focus first on ways of spreading risk and overcoming financial barriers to investing in renewable energy and energy efficiency projects, and secondly on the provision of services to facilitate such investment. The key features of the models are described, together with their advantages and disadvantages. A few examples of how these models have been applied in practice are drawn from GMS countries. The intent of the ADB technical assistance (TA) was for each of the five countries to provide three examples of renewable energy and energy efficiency business models that were either effective or not, the latter to help other countries steer clear of models that have proven difficult. Unfortunately, this aspect of the TA was largely unfulfilled. International best practices may be drawn from various reports of the World Energy Council, the International Energy Agency, and other lead organizations.

2 Basic Purpose and Broad Categories of Business Models

Business models structure how business investments are to be designed, implemented, and managed, and incorporate critical financing, service, and monitoring features. The most appropriate business model for a given project will depend on local conditions, the financial and regulatory environment, and the institutional framework and support mechanisms in place. The scale and purpose of the project or service must be well defined, together with the end consumers. Business models are not set structures; each must be adapted to the local circumstances and risk profiles of the selected project.

Business models can be broadly categorized as follows:

- ownership models, which focus on financing and risk mitigation concerns; and
- service models, which focus on providing specified services and highlight different methods of operation and maintenance.

In practice, most real-world business models are hybrids, combining elements of various types and approaches. For example, a utility or a private company may develop and own a minigrid system, operated and managed in turn by a community-based organization, while a private maintenance company provides the technical backup and support services (Rolland 2011).

The following considerations bear on the choice of the appropriate business model: (i) product or service considerations, (ii) the scale of the project, (iii) the consumer, and (iv) the regulatory environment.

Product or Service Considerations

As a rule, projects are assessed mainly in terms of their financial feasibility. However, renewable energy and energy efficiency projects may also have important, nonquantifiable or nonmonetizable public good benefits. Rural electrification projects, for example, may contribute to the following benefits:

- labor savings (from not having to collect wood);
- reduced deforestation (from less reliance on fuel wood and charcoal);
- health benefits (from reduced indoor air pollution and improved water and sanitation services);

- education benefits (from improved lighting in schools and residences, and better study conditions); and
- reduced poverty (from agricultural and industrial productivity improvements).

Such benefits would be difficult to reflect in electricity tariffs for consumers. The appropriate business model may therefore need to provide for some form of public subsidy or recognition that tariffs would at most cover only the cost of supply.

The Scale of the Project

The type of business model chosen depends largely on the scale of the project and its investment costs. The business model required for a residential or community-scale rural electrification solar project is very different from that for a 200 megawatt (MW) project designed to supply the national grid.

The Consumer

Is the consumer a household, a small village cooperative, a large industrial user, or the national grid company? The appropriate administration requirements and individual payment risk will vary markedly depending on the nature of the consumer.

The Regulatory Environment

"Business models are designed to extract maximum value from a business activity conducted within a particular regulatory framework. It is the regulatory environment, therefore, that is largely instrumental in shaping the various business models that have been developed" (APEC Energy Working Group 2009). This is particularly true for business models that are wholly dependent on regulatory or institutional mechanisms, such as feed in tariffs, tax credit systems, or clean-energy quotas.

3 Ownership Business Models

Ownership business models address the technical complexity, economies of scale, capital costs, and funding challenges of renewable energy and energy efficiency projects. For medium- to large-scale or grid-connected projects, the most appropriate ownership business model is frequently a public–private partnership (PPP), implemented as a form of build–own–operate–transfer (BOOT) or multiparty ownership. Smaller-scale projects frequently involve lease or hire purchase and dealer credit sale models. Each of these models is described in the following subsections.

Public–Private Partnership

PPP schemes usually provide a service or exclusivity in the right to "own" specified public infrastructure, such as a highway section, over a given period of time, and the right to impose a toll for its use. A PPP involves a contract between a public sector authority and a private party, in which the private party provides a public service (e.g., electricity supply) and assumes a substantial amount of the financial, technical, and operating requirements. The main purpose of a PPP is to allocate the tasks and risks to those parties best able to manage them, notably to the private sector partners.

Depending on how the PPP contract is structured, the cost of using the service can be borne exclusively by the users of the service (no taxpayer or public participation) or the government, or by both in some blend of these opposite approaches. Government contributions to a PPP may also be in kind, for example, the transfer of assets or land. Alternatively, the government may support the project by providing revenue subsidies, through favorable taxes or other means.

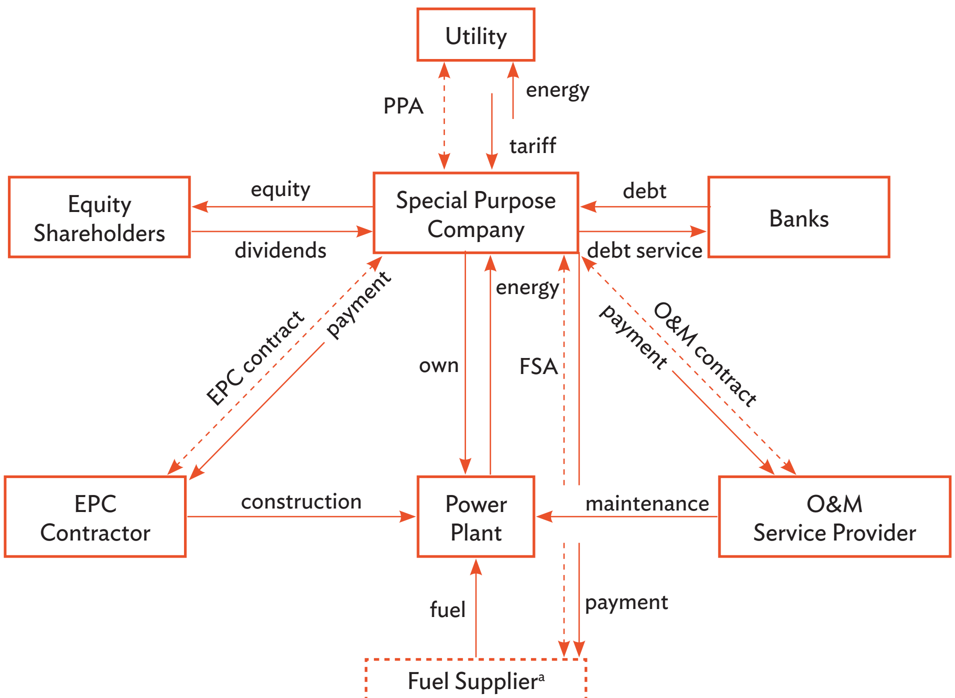
Common PPP models are:

- build–own–operate–transfer (BOOT) model;
- build–own–operate (BOO) model; and
- build–own–transfer (BOT) model.

PPP schemes typically involve the creation of a special-purpose company (SPC) or special-purpose vehicle (SPV) to develop, build, maintain, and operate the (project) asset for a contracted period of time. The SPC or SPV enters into a contract with the government and with subcontractors to build the facility and then operates and maintains it. Because of their complexity and high overhead costs, BO(O)T forms of PPP are usually favored for large infrastructure projects.

The special-purpose or project company is the central administrative and operating entity handling all contracts for funding with equity and debt investors. It also manages the construction and operation and maintenance (O&M) contracts, as well as the billing of end users. This type of business model is suitable for both conventional and renewable energy projects. An example of a possible PPP–BOOT business model for a power plant project is shown in Figure 3.1. Table 3.1 summarizes key aspects of the business model.

Figure 3.1: **PPP–BOOT Model for a Power Plant Project: Relationship Diagram**



BOOT = build–own–operate–transfer model; EPC = engineering, procurement, and construction; FSA = fuel supply agreement; O&M = operation and maintenance; PPA = power purchase agreement; PPP = public–private partnership.

[a] For thermal plants only.

Table 3.1: **PPP–BOOT Model for a Power Plant Project: Key Aspects**

Item	Features of the Model
Key Aspects	A special-purpose company (SPC) or special-purpose vehicle (SPV) is created to develop, build, maintain, and operate the plant, and assume a substantial portion of its financial, technical, and operating requirements, thus minimizing risk to the public entity.
	A power purchase agreement is established between the SPC or SPV and a public or private utility.
Implementation	Suitable for larger, normally grid-connected, power plants
Benefits	Enables the allocation of specific risks to those parties best able to manage them
Disadvantages	Can be extremely complex, involve high transaction costs, and be costly to the public if risks are misallocated

BOOT = build–own–operate–transfer model, PPP = public–private partnership.

Multiparty Ownership

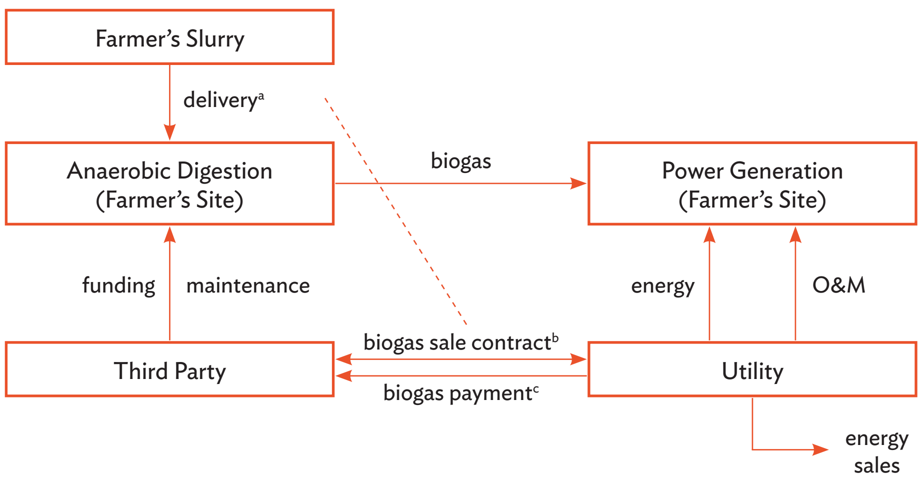
A multiparty ownership model is particularly suited to energy projects with high technical complexity or multiple separate elements, such as biogas production and power generation. Multiparty ownership models are frequently combined with user co-op models so that the projects are part public and part private. This ownership model can be a good option for multipurpose renewable energy projects, such as community-based biogas digester projects. Key aspects of the multiparty ownership model, as applied to an energy project, are presented in Table 3.2.

Table 3.2: **Multiparty Ownership Model for an Energy Project: Key Aspects**

Item	Features of the Model
Key Aspects	Renewable energy or energy efficiency projects may be technically complex and have high capital costs, requiring special models (to achieve economy of scale).
	In the case of biogas digester generation systems, the power-generating equipment is funded and installed by the utility, and the digester is owned and maintained by a third party (energy service company, user cooperative, or other entity).
	In the biogas digester generation example, funding is provided by a third-party installer or an outside source, freeing the farmer from any major liability. The equipment is installed at the farmer's site.
	Revenues from the sale of the biogas to the utility are used to repay debt and interest.
Implementation	Biogas systems, micro- or minigrid systems
Benefits	Low risk for farmer; can incorporate donor funding for rural electrification
Disadvantages	High technical risk (particularly if third-party maintenance company does not properly support the farmer)

The multiparty ownership aspects for a combined biomass digester and biogas power generation system are illustrated in Figures 3.2 and 3.3. Figure 3.2 illustrates the relationships among the farmer, the third-party energy supply company, and the power utility. Figure 3.3 elaborates on the networking required to realize economies of scale and to make the overall system commercially viable. The power generation plant is placed centrally to facilitate collection of the biogas. The biodigesters may be owned by the individual farmers, a cooperative of farmers, or a separate company. The energy generation equipment is normally owned and maintained by the offtake utility.

Figure 3.2: **Multiparty Ownership Model for a Combined Biomass Digester and Biogas Power Generation System: Relationship Diagram**



– farmers have no equipment liability
– site-related risk with third party or utility

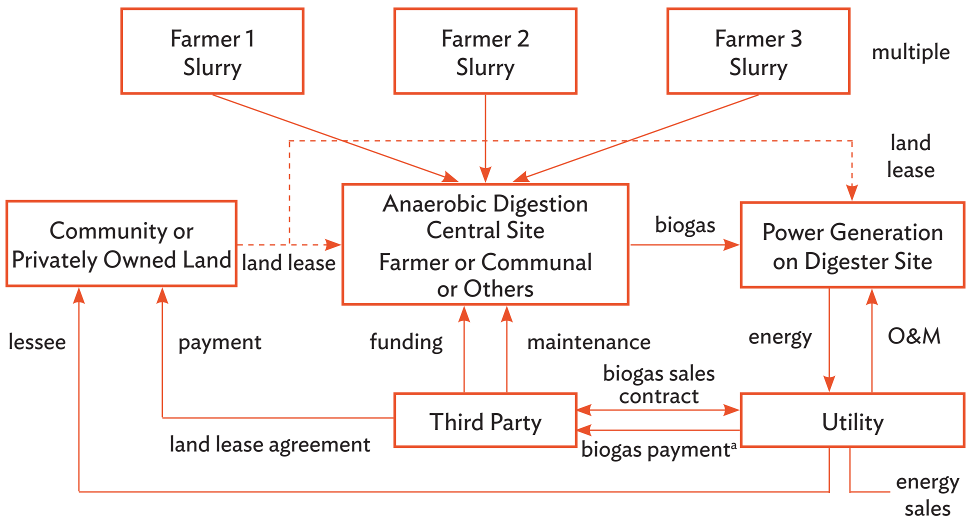
O&M = operation and maintenance.

[a] Farmers obliged to deliver slurry and provide land.
[b] Most likely requiring tripartite agreement.
[c] To cover debt and interest of digester.

Lease or Hire Purchase Model

This model is another variant of the ownership business model. Typically, it enables users to purchase equipment in installments. A leasing company (lessor) or equipment supplier provides the equipment to the end user for a contracted period of time in exchange for regular payments. The lessor is responsible for sourcing, financing, and installing the equipment, and for maintaining it during the contract period. Depending on the provisions of the contract, at the end of the contract period ownership of the equipment can either remain with the lessor or pass to the lessee (sometimes for an additional amount). Leased equipment cannot become an inherent part of a building, industrial facility, or power

Figure 3.3: **Community Digester System: Relationship Diagram**



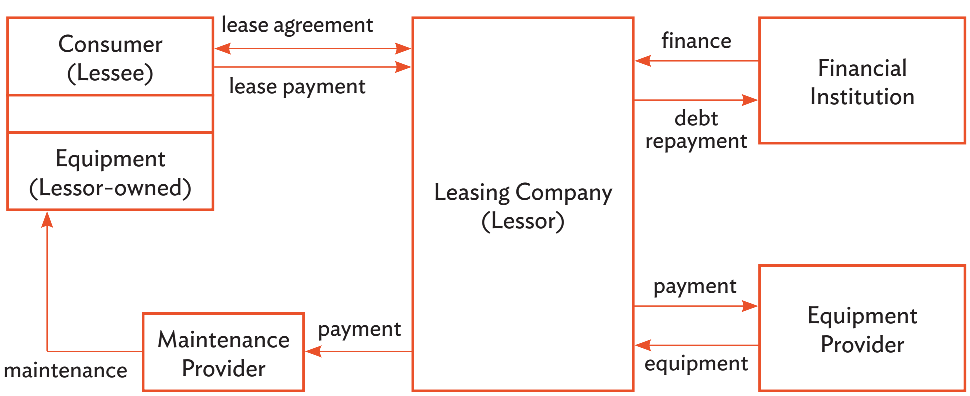
- farmers have no equipment liability
- site-related risk with third party or utility
- project may benefit from lease payment/property exemption if on commercial land

O&M = operation and maintenance.

[a] To cover debt and interest of digester.

generation plant. Rather, it must be "fungible"—interchangeable, removable, or usable elsewhere. This provision makes the model inapplicable to some renewable energy and energy efficiency projects. Figure 3.4 illustrates a lease or hire purchase business model based on an independent leasing company.

Figure 3.4: **Lease or Hire Purchase Model Based on Independent Leasing: Relationship Diagram**



Dealer Credit Business Model

The dealer credit business model is still another variant of the ownership business model, where the equipment or system supplier provides the initial credit for the system. "As a 'one-stop-shop', the micro-finance institution (MFI) and the energy/technology company promote simple and standardized (accredited) energy products (e.g., solar [photovoltaic] systems), together with loans. The micro-financing function includes the collection of down payments, monthly instalments and system/capital recovery in case of default. The technology function includes marketing, installation, customer training and after sales service" (Rolland 2011). Ownership of the systems is transferred to consumers at the end of the loan repayment period (Rolland 2011).

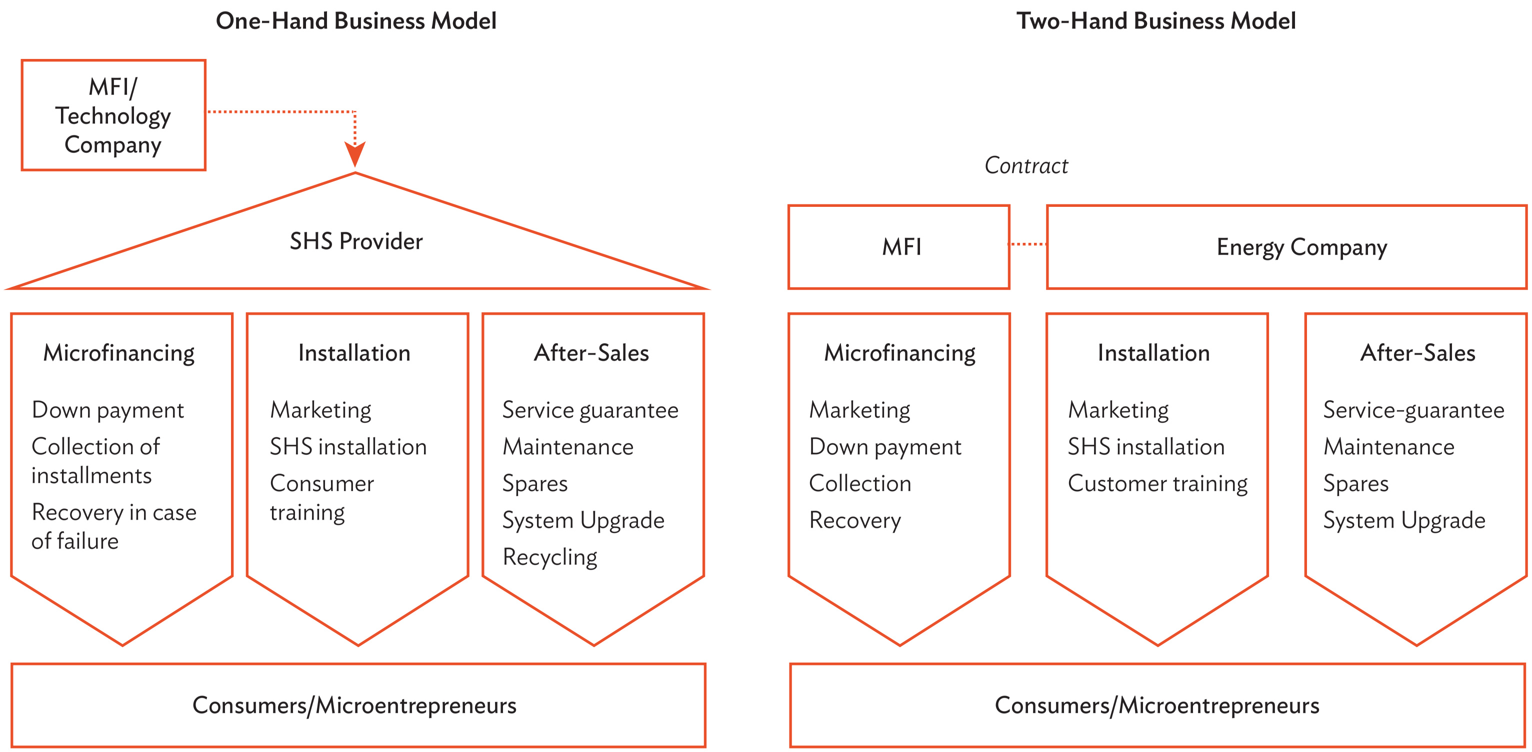
There are two main forms of the dealer credit model: in the "one-hand" model, a single company provides both the technology and the financing, and in the "two-hand" model, the technology company and the microfinance institution (MFI) are separate entities but work closely together in a long-term partnership. The two-hand form makes it easier to diversify and customize energy products, but at the additional risk that the MFI may need to take over the project if the technology company fails to deliver proper services or product guarantees that are essential for loan repayment (Rolland 2011).

Figure 3.5 illustrates the distinction between the one-hand and two-hand forms of the dealer credit model. Table 3.3 summarizes the main features of the model.

Table 3.3: **Dealer Credit Model: Key Aspects**

Item	Features of the Model
Key Aspects	Combines promotion of simple and standardized energy products with microloans
	Dealers advise on, promote, sell, install, and maintain installations; train consumers; and administer corresponding microloans to consumers to finance the equipment, including collecting the down payment and monthly installments from consumers and recovering systems and capital in case of default.
	Ownership of the system is transferred to the consumer at the end of the loan repayment period.
Implementation	Successful implementation for solar home systems and rural electrification in Bangladesh, Sri Lanka, Tanzania, and Uganda
Benefits	Enables donor-subsidized microcredit; consumer gains ownership of system
Disadvantages	If the technology company fails to deliver proper services or product guarantees that are essential for loan repayment, the dealer must either take over the value chain or risk losing the investments.

Figure 3.5: **Dealer Credit Model: Relationship Diagram**



MFI = microfinance institution, SHS = solar home system.
Source: Rolland (2011); ARE (2011).

4 Service Business Models

The service-based business model is focused on providing a product or service to the end user. The service is provided by an energy service company (ESCO), which can be a private or public utility, a cooperative, a nongovernment organization (NGO), or a private company. ESCOs may be categorized into two broad groups:

- an energy supply contracting company, supplying the consumer with electricity, heat, steam, or other forms of energy under a long-term contract; or
- an energy performance contracting company, creating energy savings for the consumer against a predefined baseline.

The fee for service in some variant is the most common energy business mode. The user pays a fee based on usage or energy savings. Under the standard utility service contract, users pay a tariff for electricity drawn from the national grid. However, in the case of rural electrification, where the infrastructure and generation assets must first be established, a user cooperative business model may be employed.

User Cooperative

A user cooperative business model involves the establishment of a nonprofit community organization owned and managed by its members. Projects are funded by member contributions, with or without outside private or public support (APEC Energy Working Group 2009). The cooperative manages all administrative and operational functions, including the installation, maintenance, and safe operation of renewable energy or energy efficiency projects, as well as financial management and payments between users, contractors and operators, and the cooperative. The tasks are usually performed by managers selected from among the members. As the managers may be volunteers, a lack of commitment and appropriate management skills may hamper efficient management (APEC Energy Working Group 2009).

The user cooperative business model provides a mechanism for governments or NGOs to support renewable energy and energy efficiency projects at the local level. For example, an NGO or government could assist in financing such projects through up-front investment grants or interest-free loans to the user cooperative, allowing the system to be installed and reducing user charges. User cooperatives are well suited to the expansion of infrastructure services in developing economies and to rural electrification. They have also been successfully implemented in industrialized countries.

According to a working paper prepared by OASYS South Asia (Off-grid Access Systems for South Asia), a user cooperative operates on the basis of the following principles (Krithika and Palit 2011):

- **Voluntary and open membership.** Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership.
- **Democratic member control.** Cooperatives are democratic organizations controlled by their members, who participate actively in setting policies and making decisions.
- **Members' economic participation.** Members contribute equitably to, and democratically control, the capital of their cooperative.
- **Autonomy and independence.** Cooperatives are autonomous, self-help organizations controlled by their members.
- **Education, training, and information.** Cooperatives provide education and training to their members, elected representatives, managers, and employees so they can contribute effectively to the development of their cooperatives.
- **Cooperation among cooperatives.** Cooperatives serve their members most effectively and strengthen the cooperative movement by working together.
- **Concern for the community.** While focusing on member needs, cooperatives work for the sustainable development of their communities.

The main features of the user cooperative business model are shown in Figure 4.1 and Table 4.1.

User cooperatives are often set up for rural electrification projects such as battery charging stations, (hybrid) minigrid systems, and community solar systems. Although the model is popular, user cooperatives may be confronted with special risks. International experience indicates that one key to successful application is a high degree of early participation by the community. Good planning and a clear plan of action are required. Formal processes

Figure 4.1: **User Cooperative Business Model**

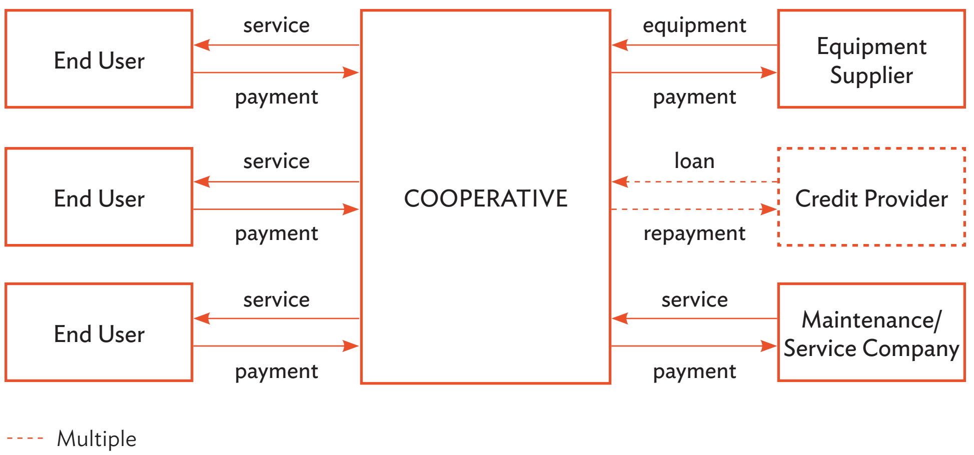


Table 4.1: **User Cooperative: Main Features**

Item	Features of the Model
Key Aspects	A nonprofit community organization owned and technically and financially managed by members. It is generally run by volunteers selected from among its members. Projects are funded by member contributions, with or without outside private or public finance.
	The cooperative ensures and oversees the installation, maintenance, safe operation, financial management, and payments between users, contractors and operators, and the cooperative.
Implementation	Biogas, community solar, wind power, rural electrification, and isolated hybrid powered minigrids
	Solar photovoltaic
	Diesel hybrid powered minigrid electrification in West African countries
Benefits	Start-up capital can include government or donor funding.
Disadvantages	As tasks are performed by managers selected from among the members, management skills and capacity can be limited.
	The participation of managers is voluntary, so a lack of commitment can sometimes be a problem.

and a supervisory structure should be developed, and legal rules and binding contracts should be signed to secure payments with clear penalties in case of contract breaches (ARE and USAID 2011). A complete business plan should address the following:

- **Community engagement and leadership.** Community members, particularly users of the renewable energy or energy efficiency measures, should be involved early in the planning process. Past experience has shown that when there is no personal sense of ownership, projects are not sustainable: "after only five years, most of the state-financed photovoltaic facilities are damaged–people don't take care of things that they get for free" (ARE and USAID 2011). If first efforts fail, communities can become disillusioned with renewable energy or energy efficiency projects. Care must be taken to establish community leadership with the appropriate checks and balances. User cooperatives are particularly susceptible to "friend participation," where one or two influential members persuade the group to enter into partnerships with "friends," which may not be the best technical or financial option. Corruption is a constant concern.
- **Long-term sustainability.** In an effort to reduce as much as possible the cost of renewable energy or energy efficiency systems, low-cost hardware is often installed. While this helps to keep tariffs affordable, the combination of low-quality hardware, insufficient technical training, lack of spare and replacement parts, and late payments has contributed to significantly reducing the life span of systems and in some cases has led to their collapse. The business plan should be geared toward long-term sustainability.
- **Clearly defined ownership and maintenance responsibility.** Rural electrification projects involving user cooperatives often have mixed ownership structures, with public and private entities financing and owning different parts of the system. As reported by the Alliance to Rural Electrification, this type of structure can lead to

issues in maintaining the system: "unless ownership rights, responsibilities, and risks are clearly established–the project is unlikely to maintain sustainable operation over an extended period of time–confused ownership arrangements can swiftly lead to short-cuts on operating practices and long-term maintenance" (ARE and USAID 2011). Lack of proper maintenance due to unclear lines of responsibility among the owners and users of the assets results in projects that fall into disrepair after a short time.

- **Appropriate tariffs and collection arrangements.** Tariffs should be set high enough to cover ongoing maintenance and operating costs, taking into consideration the variations that occur in O&M costs with changes in system load. Tariffs must also be affordable to the members. The user cooperative is often provided with start-up capital for the purchase of equipment or the equipment is donated by an NGO or government agency. As the initial capital cost is largely covered by grant funding, the resulting tariff is normally low enough to be affordable to every member of the community. In the case of rural electrification and other pro-poor energy projects, payments may be collected irregularly (i.e., after the harvest). This must be provided for during the planning phase to avoid insufficient funding for proper maintenance, resulting in disruptions to power supply. Regular supply of spare parts is also critical.

Table 4.2 outlines the risks and mitigation measures applicable to the user cooperative business model.

Table 4.2: **User Cooperative Business Model: Risks and Mitigation Measures**

Risk	Mitigation Measures
The project is improperly or insufficiently maintained because of the unclear ownership structure, and therefore becomes unsustainable.	Responsibilities for ongoing maintenance and monitoring must be clearly defined.
Local community has insufficient technical and operational skills, resulting in technical or operational failures.	Capacity-building training should be provided to: – technicians – operators – consumers The project should undergo regular monitoring (technical and operational) over its lifetime. Regular training for operational and technical staff, and awareness building for consumers, should also be conducted during the life of the project.
Committees formed to manage the system are often vulnerable to the free rider problem.	The system should include individual meters for measuring (and limiting) the consumption of each user.
Social conflict, as well as internal corruption, could occur.	A private or public entity should take on technical, administration, or monitoring responsibilities, to create a system of checks and balances.
The social composition of the committee in charge of management is important, as are the rules of leadership.	This arrangement has been successfully applied in Sri Lanka. The systems are owned and operated by user cooperatives, but the government retains some control over technical specifications and safety in its role as provider of subsidies.

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Table 4.2 *continued*

Risk	Mitigation Measures
Tariffs are not paid.	Prepayment systems can be implemented.
Particularly in community-based organizations, some members may feel entitled to special favors; others may simply be unable to pay.	Responsibilities should be defined. The operator is responsible for bill collection and should be directly responsible for collection shortfalls. Consumers should be made aware that nonpayment of bills will mean disconnection, and this rule must be enforced. Consumers should also be made aware of the longer term consequences of nonpayment, including the possible impact on plant operations.
The independence of the user cooperative, together with its assumed responsibilities, may be challenged, such that the cooperative's ties to the community are compromised.	Bylaws should be passed to minimize political interference. The government should not decide unilaterally who should be managing directors of the cooperative (Krithika and Palit 2011).
In some cases, low-quality equipment is installed in an effort to reduce the costs and to lower the tariff. But the result could be unreliable service, poor availability, higher maintenance costs, and a shorter life span for the system.	In the choice of equipment, total lifetime cost, not just initial capital cost, should be considered.

Energy Performance Contracting

This business model is widely used in projects that are designed to improve energy efficiency. The ESCO receives performance-based remuneration, determined as a fixed portion of energy savings against a predefined baseline consumption of energy by the consumer. There are two primary types of energy performance contracts (IFC 2011):

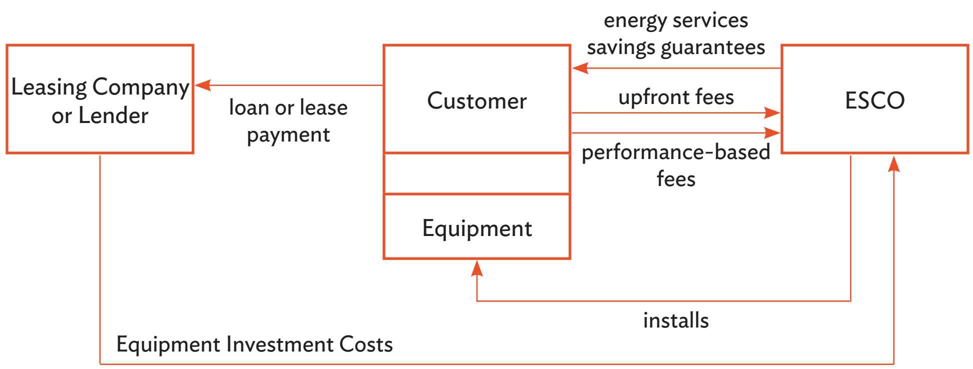
- guaranteed savings (consumer financed); and
- pay as you save (ESCO financed).

In the guaranteed-savings variant, the ESCO analyzes the consumer's needs and recommends the appropriate energy efficiency equipment and other measures. Once the consumer and the ESCO agree on the measures, the consumer provides financing for the measures (either through self-financing or through a bank loan), while the ESCO implements the measures and shares in a portion of the guaranteed energy savings (Figure 4.2).

In the pay-as-you-save model, the initial capital cost is financed by the ESCO, which recovers the costs through monthly surcharges (Figure 4.3). Both variations allow ESCOs to develop innovative programs that guarantee a level of energy savings for the consumer.

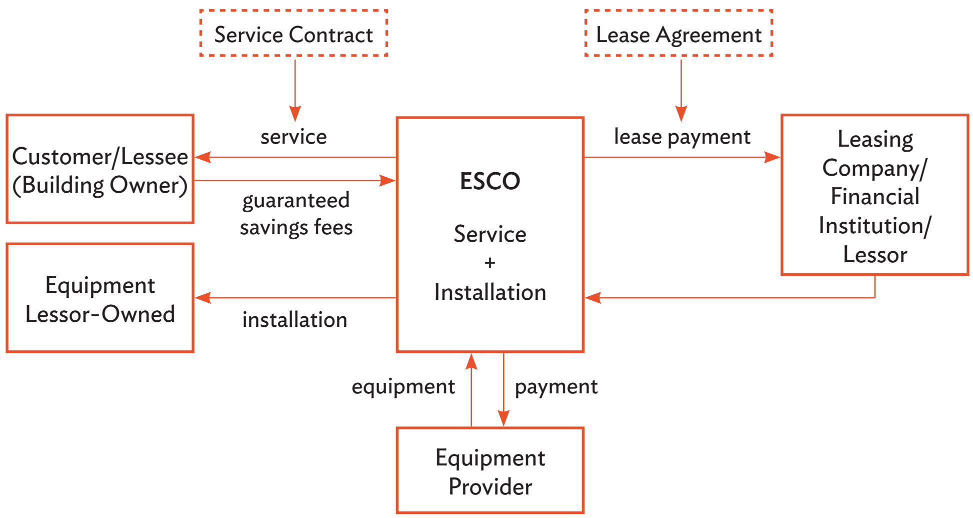
A major barrier to energy performance contracting is that many ESCOs are small, single-technology manufacturers or service providers, which have limited access to financing and limited industrial or technical experience (beyond their single technology).

Figure 4.2: **Energy Performance Contract: Guaranteed-Savings Relationship Diagram**



ESCO = energy service company.

Figure 4.3: **Energy Performance Contract: Pay-as-You-Save Relationship Diagram**



ESCO = energy service company.

Their ability to serve large consumers or to adapt new technologies for established consumers is hampered.

Lessons learned concerning the energy performance contracting business model are derived from countries such as the People's Republic of China (PRC) and Thailand. World Bank–supported energy efficiency projects in the PRC over the past 15 years have widely employed this business model, with over 600 ESCOs offering energy performance contract services. Many, however, were unable to finance the up-front capital costs of their proposed projects, in part because the PRC contract forms typically stipulated fees rather than guaranteed savings or shared savings (IFC 2011). Thailand began demand-side energy efficiency (DSM) programs in 1993 "to promote the development, manufacture, and adoption of energy-efficient equipment and processes in the country, as well as to build sufficient institutional capability within the energy sector to deliver cost-effective energy services throughout the economy" (WRI 2013). This was supported by the Thailand Energy Conservation Promotion Fund (ENCON), which helped secure financing mechanisms for energy efficiency projects (UNDP 2012). It is estimated that the DSM program has reduced peak demand by more than 3,000 MW annually, and since 2000 has generated 15,700 gigawatt-hours in energy savings.

Table 4.3 summarizes the risks and mitigation measures associated with the energy performance contracting business model.

Table 4.3: **Energy Performance Contracting Business Model: Risks and Mitigation Measures**

Risk	Mitigation Measures
ESCOs do not add value, from the point of view of some consumers, who believe they can manage energy efficiency themselves and are unwilling to pay guaranteed- or shared-savings fees to ESCOs (IFC 2011).	ESCOs must develop expertise in more than one technology to demonstrate competence and clear value added to large consumers.
Actual savings are often lower than forecast because of the inadequate performance of O&M personnel (IFC 2011). This further hinders future investment as companies are more reluctant to invest.	Remuneration must be performance-based to motivate ESCOs to provide the promised level of service.

ESCO = energy service company, O&M = operation and maintenance.

5 Business Model Examples

A few examples of how these diverse forms of business models have been applied in practice are given in the following subsections. As indicated in the Introduction, the intent of the ADB TA was for each of the five GMS countries to provide three examples of business models that they had employed to promote and implement renewable energy and energy efficiency investments. Unfortunately, examples, positive or negative, were not forthcoming from the five countries; hence, this aspect of the TA was largely unfulfilled. As a result, the GMS-based examples are limited and supplementary examples are from other regions and countries. International best practices may be drawn from various reports of the World Energy Council, the International Energy Agency, and other lead organizations.

The examples selected focus on the following forms of renewable energy or energy efficiency investment:[2]

- solar battery charging station (not grid connected),
- hybrid minigrid (decentralized systems, not grid connected),
- community biogas (decentralized systems, not grid connected),
- mid- to large-scale wind or solar (public utility, grid scale), and
- building energy efficiency (energy efficiency).

For each project type, local implementation examples (where available) and lessons learned are discussed. These are intended as illustrative examples only. The actual business model selected for a given project should be determined only after careful analysis of the local project circumstances.

How the business models described in sections 3 and 4 can be applied to renewable energy and energy efficiency projects depends highly on the roles of the five primary project stakeholders:

- the financier, who will finance the initial investment costs;
- the owner, who will own the system after it is installed;
- the operator, who will operate the system and collect the tariffs;
- the maintenance entity, who will maintain the systems; and
- the consumer, the target consumer of the project services.

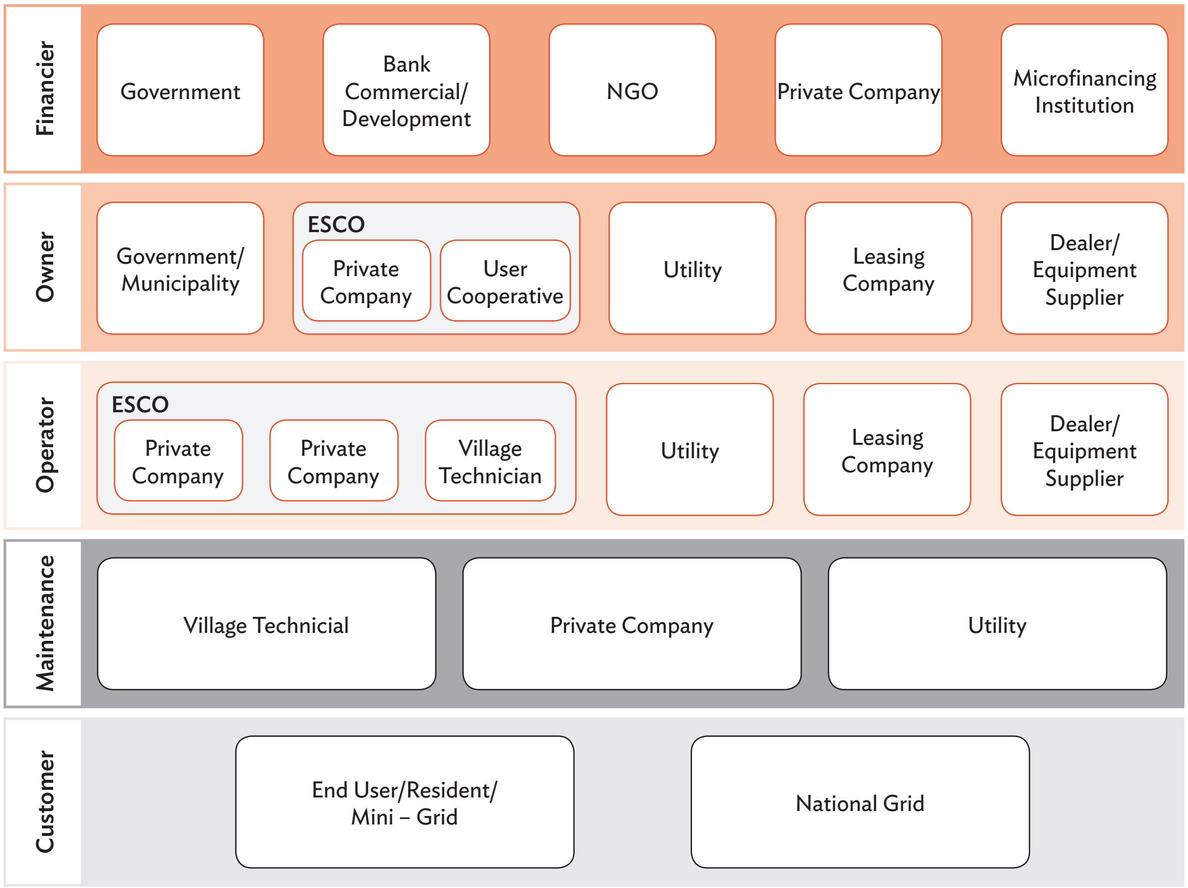
[2] The project examples were selected on the basis of feedback from the national focal points during the SEF-7 Workshop in Vientiane, Lao PDR, in October 2013.

Figure 5.1 shows some common options for each stakeholder category. A business model may consist of several stakeholders and each stakeholder in turn may incorporate several groups.

Because of the variety of stakeholders and services provided, business models suitable for decentralized applications differ from those suitable for large-scale grid-connected or energy efficiency projects. Accordingly, the project examples showing the application of the business models have been categorized into decentralized (non-grid-connected), grid-connected, and energy efficiency project types.

Large-scale projects are generally grid connected; therefore, the overall structure of their business model is regulated by national electricity laws and strongly influenced by semi-standardized financing schemes. In most cases, they sell to the grid at a given rate. In some cases, the investor or stakeholder may have a private power purchase agreement (PPA),

Figure 5.1: **Project Stakeholder Options**



ESCO = energy service company, NGO = nongovernment organization.

under which the generated capacity is sold to a third party. As the choice of an overall business model is often predetermined, only the administration-specific aspects may vary. In most cases, the ownership model would be a form of BOOT.

The business environment for decentralized or rural electrification projects is different. For decentralized systems, the operating environment is often not as defined. Moreover, decentralized systems target different consumer groups, so local situations must be taken into account.

Decentralized Systems

Rural electrification projects are designed to provide electricity services in areas where poverty may be widespread and the ability to pay for electricity is generally low, and securing interested and qualified private investors is therefore a challenge. Most rural electrification projects require at least some degree of public funding support so that tariffs can be set within the users' ability to pay.

Community-supported solar systems, whether household-based or available through community battery charging stations, have been widely implemented in rural areas to serve the needs of households and the community, including health centers and schools. These systems can be built in a modular fashion, increasing generation capacity incrementally as they add new consumers and load.

A commonly applied business model is the user cooperative, which acts as an ESCO, providing services under a fee-for-service system. The user cooperative owns and maintains the system, and users pay a fee for electricity consumed, including the power used to charge batteries.

Solar Battery Charging Stations

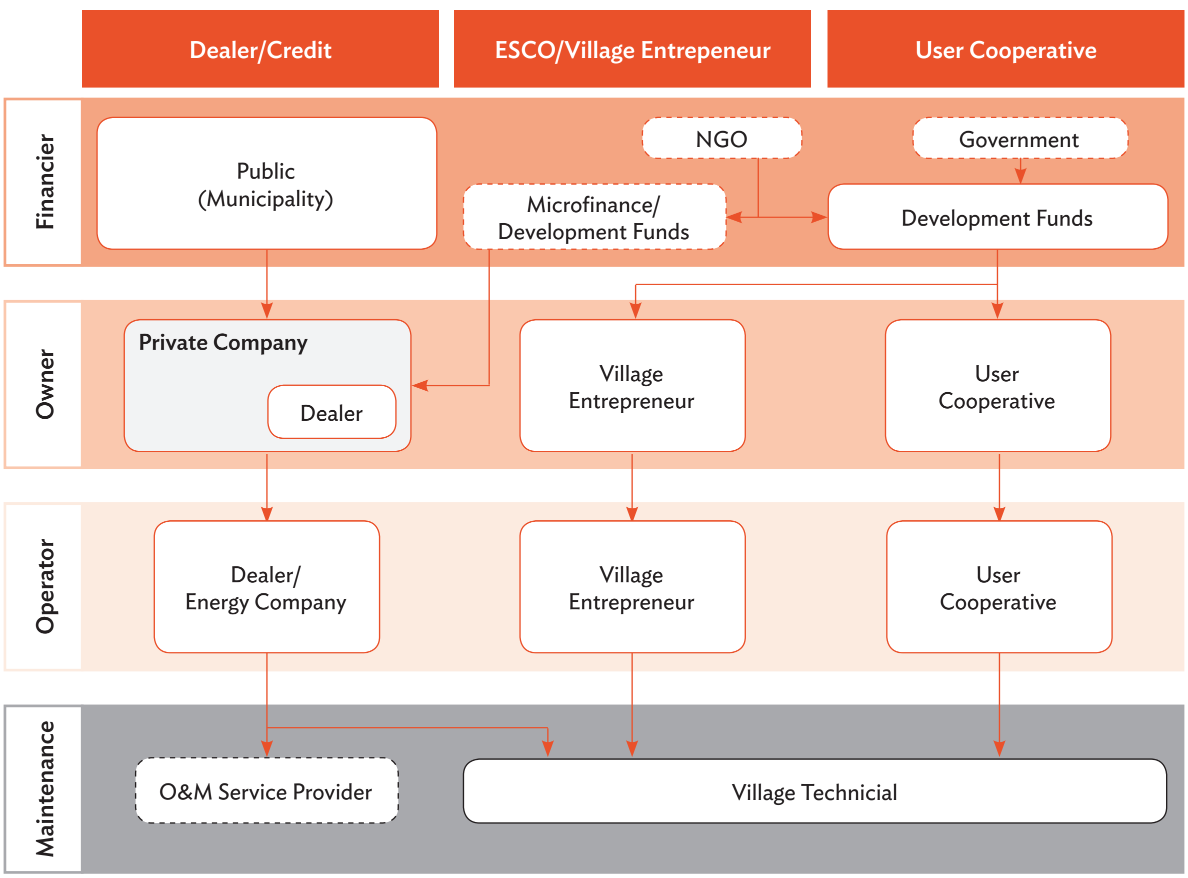
Solar battery charging stations (SBCSs) are usually established in rural areas where no electrical grid system is available. The primary benefit of such stations is sufficient electricity through the charged batteries to provide domestic lighting, power radios, and other small-scale domestic appliances and needs. The target consumers are rural residential users, generally with a low ability and willingness to pay.

The main obstacle to establishing SBCSs is the initial capital investment cost and the generally low return. SBCSs tend to target the poorest of users, most of whom could not afford a full-cost coverage tariff, including investment costs. Experience has shown that, even if the initial investment cost is covered by an outside agency (e.g., an NGO, a development agency, or the government), users have a difficult time paying tariffs sufficient to cover general maintenance. SBSCs are therefore normally implemented in cooperation with government development programs, which cover most of the capital and implementation costs, and the assets often remain in public hands (they are owned by a municipality, a user cooperative, or other public entity).

The general business model for SBCSs is the fee-for-service model, where the user pays for each battery charge. The batteries can be privately owned or owned by the cooperative and rented to the users. Depending on the circumstances and scale of the project, there are several possible business model variations for SBCS projects, primarily: user cooperative, ESCO or village entrepreneur, or dealer credit sale (Figure 5.2).

A sustainable business model for SBCSs does not necessarily mean a financially profitable project. For SBCSs, the primary goal is providing lighting and electricity for other limited domestic uses for households and communities without electricity; investor returns are secondary. A sustainable business model in this case requires sufficient revenue to maintain the system in proper working order. Private sector charging stations have also been set up in areas where users were comparatively better off and were able and willing to pay enough to meet a full-cost recovery tariff, but such cases are relatively exceptional.

Figure 5.2: **Solar Battery Charging Stations: Stakeholder Structure**



ESCO = energy services company, NGO = nongovernment organization, O&M = operation and maintenance.

Solar Battery Charging Station Business Models: Lessons Learned

SBCSs have a long history and therefore offer lessons learned from past experience. A large number of SBSCs have been installed throughout Southeast Asia, with the support of the World Bank (Global Environment Facility), the United Nations Development Programme (UNDP), GIZ, and others. The primary issues involved in SBCS projects are described in Table 5.1, together with suggested mitigation measures. SBCS planning should consider the fact that the number of hours of sun (particularly in the rainy season) can vary significantly from day to day. Diesel generation or another form of backup may be required for consistent operation. For a proper assessment of the appropriate capacity of the system, and a proper estimation of project revenues, the types of batteries used by consumers should also be taken into account. A high-quality rechargeable battery can last about 2 weeks, while old, poor-quality batteries require recharging after 2–5 days.

Table 5.1: **Solar Battery Charging Stations: Potential Issues and Mitigation Measures**

Potential Issue	Mitigation Measures
Impression of Poor Quality	
Batteries charged by diesel-powered charging stations tend to be hot because of overcharging. Properly charged batteries do not heat up, but consumers may think that the battery is incompletely charged. "An entrepreneur in Kien Svay [in Cambodia] who participated in establishing a solar battery charging station (SBCS) had disappointed customers because their solar-charged batteries were cool to the touch. Although their batteries were actually fuller and cared for much better compared to a conventional diesel-powered station, they were dissatisfied. Common belief is that fully charged batteries should be hot. The pilot project was terminated." (ASEIC and GGGI 2012).	Consumers should be trained in proper battery maintenance and charging.
Short Life-Span	
Often, old car batteries are used, resulting in "deep discharging," which significantly shortens the battery life span.	Ideally, proper deep-cycle rechargeable batteries should be used. When that is not possible because of financial or supply constraints, consumers should be trained in proper battery maintenance and charging. Deep-cycle rechargeable batteries could be included in the project and rented or sold on credit to users or provided under a lease arrangement.

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Table 5.1 *continued*

Potential Issue	Mitigation Measures
Sustainability	
Some projects have reported excessive project size, with a capacity utilization that is too low to cover the station's maintenance costs. Different projects have reported different utilization requirements to remain sustainable: • 60%–70% of capacity • 70%–90% of capacity	A detailed feasibility study should be carried out for each potential location to avoid overcapacity and to determine ability or willingness to pay.
Institutional Issues	
Construction is delayed by the failure of the community to pay the installer.	Community buy-in can be gained through involvement in project development from the start. Also, community members should be trained in proper operational and financial management.
In-kind contribution may lead to unfair distribution of work.	Bylaws should be established within the cooperative to regulate the distribution of work. The community should be required to make the up-front contribution in cash.
Operational Issues	
Ineffective, inefficient maintenance, or poor financial management leads to insufficiency of replacement parts and system degradation.	Monthly monitoring should be done during the first 12 months, and technicians and operators should be given support and management tools. On-site technical monitoring will prevent equipment misuse and offer opportunities for capacity building.

Cambodia provides examples of successful and unsuccessful project approaches. SBCSs using a number of different business models and supported by various development agencies have been implemented in the country. While many have been more or less successful, revenues collected were often not enough to cover basic O&M cost—even when the equipment was donated. There were also reports of photovoltaic panels not consistently delivering the expected level of electricity, so that consumers had to revert to diesel generation.

Hybrid Minigrid Systems

A hybrid minigrid system is one in which electricity infrastructure is installed village-wide. It involves electricity generation, using a combination of picohydro (hydroelectric power generation of under 5 kilowatts [kW]), solar photovoltaic, wind, biogas, diesel, and battery banks, and a distribution infrastructure with poles, wiring, and connections to the houses, as well as individual meters or controllers. Public infrastructure such as street lighting may also be included. Depending on the type of system and the local situation, the system can supply electricity anywhere from a few hours a day to around the clock.

The project provides the primary benefit of electricity on a small to medium scale, enough to power lights, small household appliances, and equipment for income-generating activities, enabling markets to stay open in the evening hours. The target consumers are rural users and small businesses with low to medium ability or willingness to pay. Without development support to finance the infrastructure (poles, meters, wiring) and a portion of the fixed assets, hybrid minigrid projects are generally too capital intensive to allow for full cost recovery tariffs that consumers can pay. Generally, users can afford a maintenance-covering tariff and a small connection fee, but not a tariff that covers the full cost of infrastructure and generation capacity. Therefore, a business model for hybrid minigrid projects that provides enough revenue to cover O&M (spare parts, savings fund for parts replacement such as batteries, fuel where necessary, and operation and administration costs) is generally considered sustainable. A financial return to private investors is likely possible only where the consumers have per capita incomes well above the poverty line.

Hybrid minigrids are a potential solution in rural areas with natural resources suitable for electricity generation (e.g., biogas or minihydro sites). When the national grid is extended to the village, the minigrid can be connected and the generation capacity sold to the national agency. A particular advantage of minigrid systems is the potential for income-generating activities enabled by access to reliable electricity. However, to realize these gains the institutional infrastructure (access to credit) must also be in place.

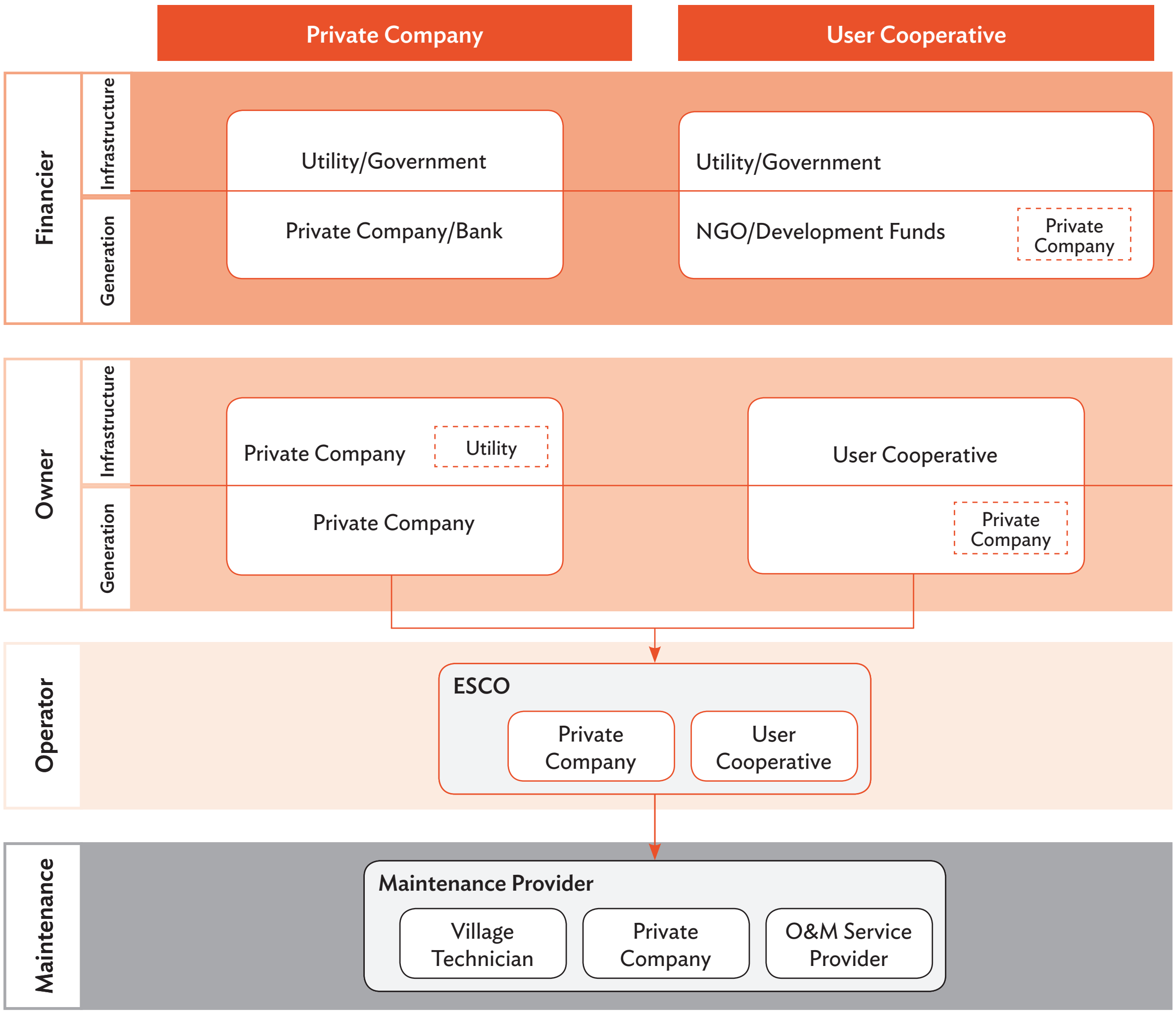
Hybrid minigrid systems can vary in size from those that serve a handful of residents to those that provide power to a medium-sized village with a few small businesses, communal buildings (school or health center), and sometimes even street lighting. Because of their modular setup, minigrids can accommodate a number of business models. The most appropriate model will depend on the state of the infrastructure at hand, the local energy resource, and the geographic setup of the village.

Minigrid systems generally conform to the fee-for-service model, with fees charged on the basis of the electricity used by each consumer. A number of possible ownership and operating structures can be applied, depending on the project-specific circumstances. As shown in Figure 5.3, possible owner and operator structures are as follows:

- private operator (a structure possible only in areas of medium to high willingness to pay, as private operator will participate only if project is profitable);
- utility-based operator (generally a structure with the advantage of technical ability, financial resources to implement projects, and economies of scale);
- user cooperative; or
- a hybrid of the foregoing structures.

Hybrid minigrid system maintenance and administration can be complex, particularly if done by the local community, which may be inexperienced. Significant training, in both technical and business issues, is required. The user fees for hybrid minigrid systems generally consist of in-kind contribution in the form of labor for installing the systems, individual connection fees, and monthly usage fees. The connection fees are generally used to recover part of the up-front capital cost such as meters, poles, or other equipment, as well as to ensure user commitment. Monthly usage fees can be implemented as a fixed flat fee, a fee based on usage, or a combination of the two.

Figure 5.3: **Hybrid Minigrid Systems: Stakeholder Structure**



ESCO = energy service company, O&M = operation and maintenance.

Hybrid Minigrid Business Models: Lessons Learned

A number of hybrid minigrids have been implemented with a variety of business models. A key success factor is user training, which should include technical aspects of the system as well as its operation. According to the Alliance for Rural Electrification (ARE):

> At the local level, detailed technical training for end-users (i.e., customers) must cover both electricity uses (energy efficiency, load management) and technical limitations of the minigrid. The personnel responsible for O&M should also be trained right from project implementation, with follow-up training over the long term. For the sake of project sustainability, the involvement of all the local

> stakeholders of the project is fundamental. Local authorities should be involved from the inception regardless of the business model chosen for the project. They can help assess electricity needs, conduct good project monitoring, help organize the community, enforce the rules, help develop local productive enterprises or added-value activities, etc. (ARE and USAID 2011)

Minigrid systems in Morocco illustrate this emphasis on training:

> Training is delivered in two stages. First, during project preparation and implementation, three levels of training are delivered: to the end users on the possibilities and limitations of the system and on the uses of electricity; to the institutional structure in charge of the system; and to the local technicians who will ensure the O&M work. Second, after about 6 months, TramaTecnoAmbiental (TTA) visits the project, answers ... the problems that have appeared and completes the trainings [sic]. Hence, the different local parties receive a first "theoretical" training and a second level of training in light of the actual operation of the system (ARE and USAID 2011).

Training should be incorporated in the project design and included in the project initiation funding to ensure that it takes place properly.

The Lao PDR provides examples of hybrid minigrid business models. Sunlabob, a private energy company based in the Lao PDR, has been active in extending rural electrification, through minigrids and other systems. The business model used is a hybrid of the PPP, user cooperative, and fee-for-service structures. The grid infrastructure was financed with public (municipal) funds. The community participated in the investment with in-kind contributions, notably in the form of construction labor. Sunlabob funded the power generation equipment (movable assets) and retains ownership of the equipment. The grid infrastructure is owned by the community but maintained by Sunlabob, which employs villagers to operate the system and collect the fees. Sunlabob has a vested interest in ensuring that all users have access to its electricity services.

Other community-supported local hydro minigrids in the 5–100 kW range in the Lao PDR have similar features. They are owned by the user community, which sometimes includes a local provincial department or district office of the Ministry of Energy and Mines. The systems were installed by international development partners or Electricité du Laos and are managed by the user cooperative, called the village electricity committee, usually comprising village authority members and 1–3 village electricians, depending on the size of the system. The committee is responsible for tariff collection and for system maintenance. Because of the donated initial funding, the tariff is generally affordable and set at an average monthly rate per appliance (e.g., KN2,000, or around $0.03 per light bulb per month).

In some cases, the village lacks the resources and technical skills to manage the system. There have also been instances of mismanagement: inappropriate tariff systems together with irregular payments resulting in lack of maintenance and poor quality of power supply. Because of substandard installations and the unavailability of spare parts, the systems have a short life span (2–5 years).

Table 5.2 describes some potential implementation issues with minigrid systems, as well as possible mitigation measures.

Table 5.2: **Hybrid Minigrid Systems: Issues and Mitigation Measures**

Potential Issue	Mitigation Measures
The system is incorrectly sized. "The demand on site was lower than originally expected, which required the company to lower its revenue projections. This was due to the lack of additional income generating activities that the company had planned on. After a period of two years, the company had counted on an average consumption of 1.5kWh/day/household, taking into account all village applications, but mainly because of the absence of the banking sector and of investment, these activities have been slower to develop" (ARE and USAID 2011).	A feasibility study, including an assessment of the institutional framework required to support demand growth, must be carried out to size each system properly.
Users do not pay.	To address the issue of nonpayment, community leaders should emphasize that the payments go to maintaining the system and when some users do not pay that burden must then be taken on by others. A firm policy of disconnecting users who do not pay should be in place and this policy must be enforced.
Users tamper with meters.	This problem, which must be dealt with within the community, can be particularly difficult to address when the system is owned by private entities rather than by the community. The equipment chosen should make tampering difficult. Community leaders should make it clear that tampering with the system will result in fines.
The village lacks the resources and the technical skills to manage the system.	Training (management, operation, technical) should be provided not only during project start-up but also during the first 1–2 years of operations.
The system is poorly maintained and is not performing well.	Maintenance personnel should have had proper training and should continue to receive regular training after the start of operations. The salaries of maintenance personnel should be at least partially performance-based.

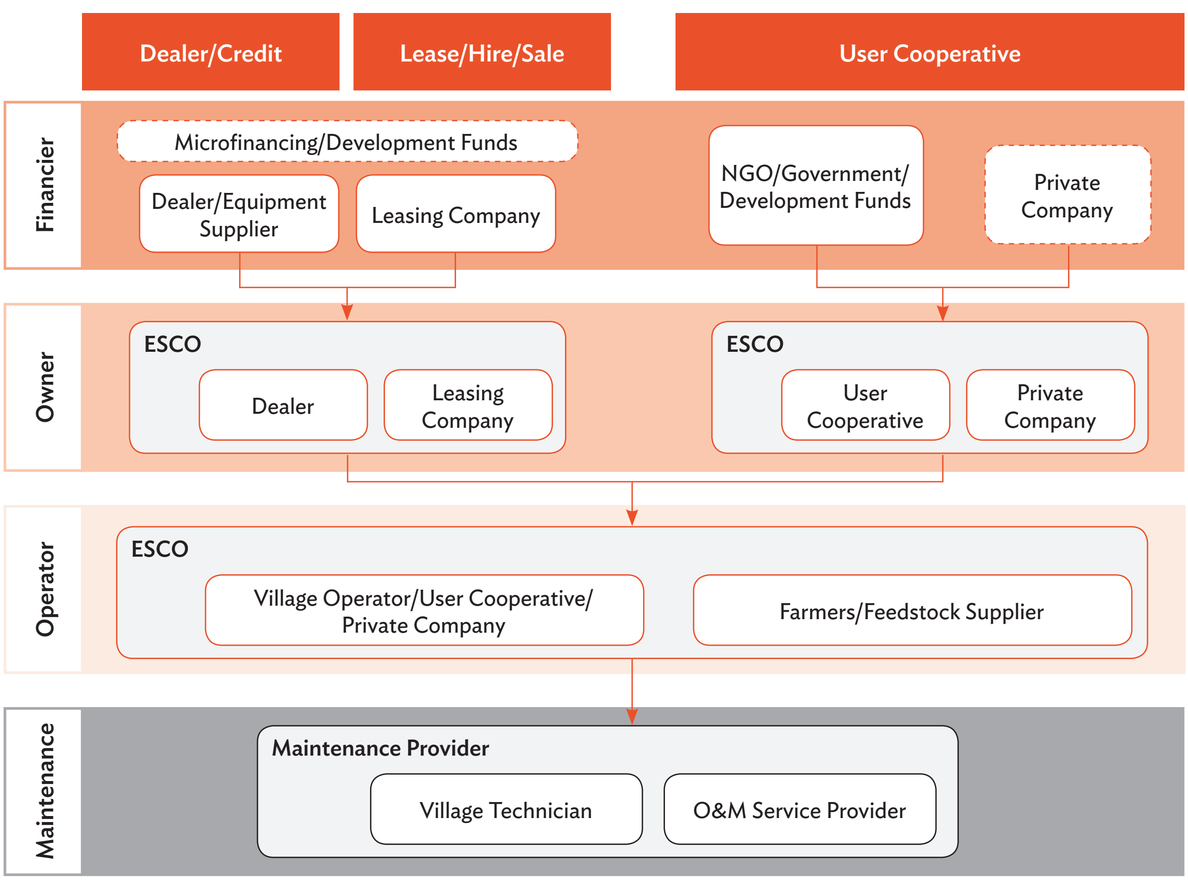
Biogas Plants and Biomass Gasifiers

Community biogas plants and biomass gasifiers offer a renewable energy option in areas with significant agricultural or animal waste. As generation sources connected to minigrid island systems (often producing electricity for 4–8 hours a day) or as independent power producers selling to the national grid, they can be sustainable projects. The primary benefit they provide is electricity, but there are additional benefits: heat from the generator (e.g., for drying applications), mechanical power for machinery, and the disposal of animal waste with fertilizer as a by-product.

Biogas plants and biomass gasifiers have been implemented in conjunction with micro- and minigrid systems. However, the generation portion of the project is complex and is therefore often addressed separately by business models. Such projects usually follow the fee-for-service model, charging fees based on the electricity used by each consumer. The complete systems can, however, incorporate several models that individually address gas production, electricity generation, and distribution, or some combination. As shown in Figure 5.4, the possible owner and operator structures are:

- private company (ESCO),
- user cooperative or farmer cooperative,
- dealer credit,
- lease or hire purchase, or
- a hybrid combining several aspects of the foregoing models.

Figure 5.4: **Community Biogas Projects: Stakeholder Structure**



ESCO = energy services company, NGO = nongovernment organization, O&M = operation and maintenance.

Husk Power Systems (HPS), a private biomass-based energy company in India, has been active in the development of gasifiers for micro- and minigrid systems. HPS commonly applies one of three business models (UNDP 2013):

- **build–own–operate–maintain (BOOM) model**, where the dealer finances (often with the help of government subsidies), installs, owns, and operates the system, and the electricity is sold to users on a fee-for-service basis;
- **build–own–maintain (BOM) model**, which works like a lease or hire purchase model or dealer credit model, where the dealer finances, installs, and maintains the system for a contracted period of time, the entrepreneur operates the system and pays a significant up-front fee and monthly amounts over the contract period, and ownership passes to the entrepreneur at the end of the contract period; or
- **build–maintain (BM) model**, which works like a cash sale but with a maintenance contract, where the dealer builds and sells the system and the entrepreneur covers all capital costs (after government subsidies) and owns and operates the system, paying a maintenance fee to the dealer (or other service contractor).

A user cooperative can also take the place of the local entrepreneur.

Biogas Plants and Biomass Gasifiers: Lessons Learned

India has gained significant experience in biogas for rural electrification. A key issue in sustaining a biogas project is feedstock management, with the farmers or feedstock suppliers closely involved in the project through a user cooperative or through the payment of a regular fee, to ensure reliable feedstock supply. The use of locally available technology facilitates access to spare parts with which local maintenance personnel are familiar (PISCES 2012). A 5-year "all-inclusive" maintenance contract with the equipment manufacturer helps guarantee the reliability of installed equipment.

India also has extensive experience in building and operating biomass power plants using rice husks and other agricultural residues as feedstock. Over 60 such systems (32 kW each) have now been installed. Each system provides 6–8 hours of electricity daily to 300–400 households. Prepaid meters ensure payment of tariffs and help minimize overload. The systems were implemented under the build–own–operate–maintain and fee-for-service business models. Public funds paid for about 40% of the capital costs, and provide support for the distribution network and training. Households pay a fixed monthly fee for a package of one or two 15-watt compact fluorescent lamps, plus recharging of mobile phones and other devices. Commercial users and those using electricity for irrigation pumps are subject to a different tariff schedule (Khare 2012).

Biomass power plants in India have also adopted the user cooperative or village energy committee business model. The committee operates like an ESCO. It runs the plant and collects the tariffs (Khare 2012), and is responsible for all major decisions, including electricity charges, the up-front connection fee, feedstock supply, and plant security (Goel et al. 2006). The project design includes comprehensive training and capacity building for the village energy committees. The systems operate 4–6 hours a day. Users in many villages have asked for additional connections, for fans, television, and other uses. The initial capital costs for the projects were funded with government grants. The communities donated land for the plants and onetime connection charges were applied. The tariffs are set to cover O&M[3] and are comparable with kerosene lighting costs.

A key issue in biogas and biomass projects is proper sizing of projects to suit potential demand and users' ability and willingness to pay. Often, projects are too large in scale, such that tariffs exceed what users are willing or able to pay. Sustainability is thus compromised and the service deteriorates.

Centralized Grid-Scale Systems

Mid- to Large-Scale Wind or Solar Plants

Mid- to large-scale solar plants are usually grid connected and implemented according to the BOOT or PPP business model. A typical project involves a project company or local owners who build and operate the plant and sell the electricity to the local utility for a contracted period of time (e.g., for 20–30 years). The sale of electricity is governed by a PPA or feed-in-tariff agreement, specifying the terms and payment rates. The project company administers all other legal agreements, including development agreements, land purchase or lease agreements, and engineering, procurement, and construction (EPC) and O&M agreements (Figure 5.5).

Local or foreign investors can own the project company and divide the net revenues and tax incentives among themselves according to their equity shareholdings. Alternatively, the owner can be a local government or municipality, which sells power to a utility or directly to other municipal consumers (i.e., schools). A project located on municipal land may benefit from property tax exemption or other benefits. The municipal ownership model is most appropriate to small- to mid-scale systems.

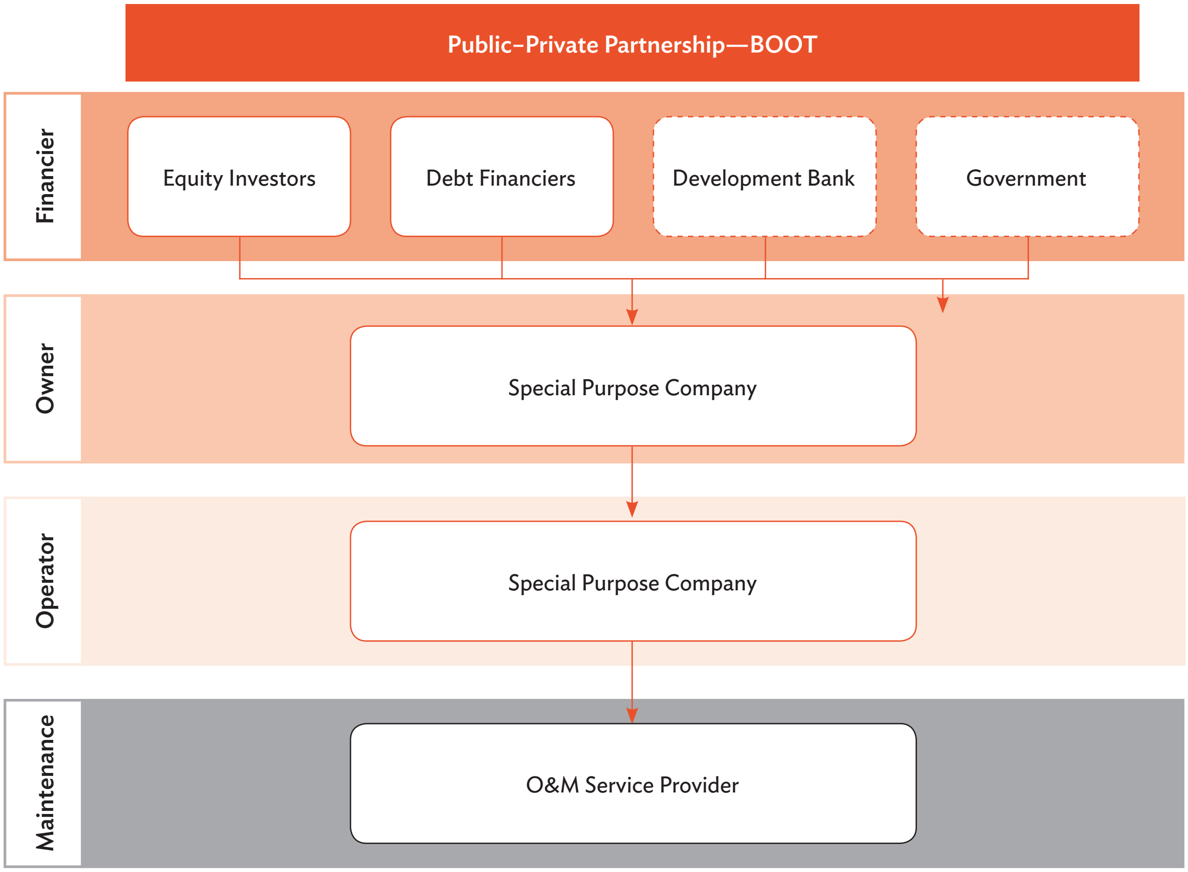
Unlike decentralized systems and rural electrification projects, large-scale grid-connected systems need to be more financially viable and recover their investment costs through consumption-based tariffs. The required level of tariffs may not be affordable and may call for government support, particularly if the national grid system is subsidized.

In the past 5 years, starting with the 6.1 MW Korat I project in April 2010, Thailand has gained considerable experience in larger-scale grid-connected renewable energy projects.[4] Korat I was followed by significantly larger plants, such as the Lopburi solar power plant (73 MW) in 2011 (Thammarak and Wonglimamornlert 2013). Korat I is part of a planned portfolio of 36 projects with a total output 260 MW. The projects use a PPP business model centered on special-purpose companies, whereby each plant sells power

3 Each household is required to pay an electricity tariff of Rs30 per light point per month.

4 Thailand's Renewable and Alternative Energy Development Plan (2012–2021) classifies Korat I as a very small power producer (VSPP), with operating capacity of 2–10 MW. The term "large-scale" is applied to the project to differentiate it from the micro- and minigrid rural electrification systems discussed previously.

Figure 5.5: **Large-Scale Grid-Connected Systems: Stakeholder Structure**



BOOT = build–own–operate–transfer, O&M = operation and maintenance.

to government utilities under long-term contracts and is project-financed as a stand-alone entity involving the parent firm and outside investors (IFC 2010).

Energy Efficiency

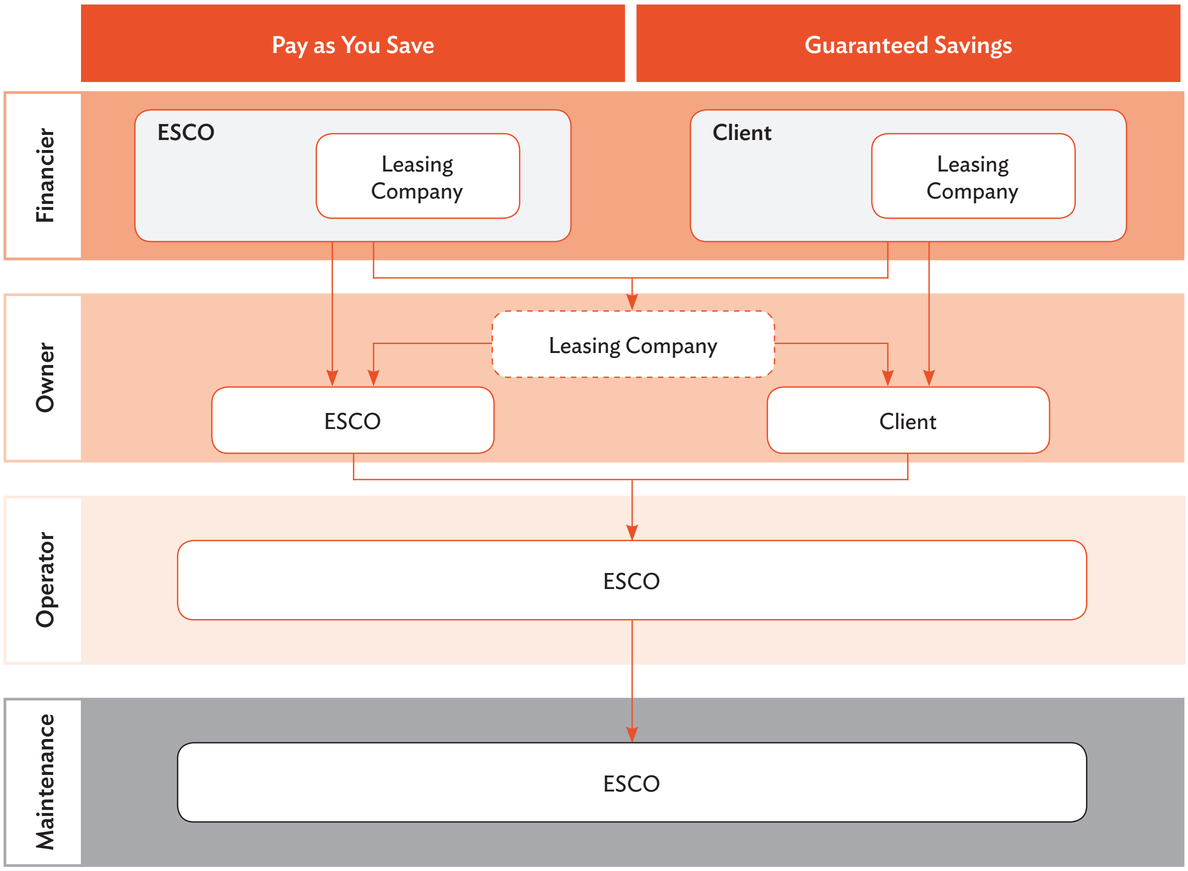
Demand-side energy efficiency projects can take many forms, most commonly centered on industrial and building energy efficiency improvement measures. The value added for energy efficiency projects is the value of electricity saved compared with the consumption levels without the projects. Energy efficiency improvements are most suitable in areas where energy tariffs are not subsidized, as they strengthen the incentive for building owners, industrial producers, and other electricity users to invest in energy efficiency. Other reasons for implementing energy efficiency measures may include compliance with new building or energy standards. In these cases, the primary value added may be compliance with local or national regulations, rather than the energy savings. Energy performance contracting is usually limited to larger-scale public and private buildings, such as hospitals, universities and school buildings, and large buildings housing corporate headquarters. Economies of scale are taken into account in deciding on the appropriate business model.

Energy Efficiency Projects: Smart Buildings

Most buildings offer significant potential for energy saving through energy efficiency measures, such as improving the efficiency of lighting and heating and cooling systems. Energy efficiency measures often follow the energy performance contracting business model, whereby an ESCO carries out an energy audit of the premises and recommends ways of improving energy use. Normally both technology and behavioral issues are addressed.

The ESCO is responsible for implementing and operating the energy efficiency package, but the building owner normally remains responsible for fuel and electricity purchases. The required equipment can be either bought directly by the building owner or provided by the ESCO and leased to the user under the guaranteed-savings or pay-as-you-save variant of the energy performance contracting business model (Figure 5.6). ESCO remuneration

Figure 5.6: **Energy Performance Contracting Model**



ESCO = energy services company.

is generally performance-based and related to actual energy savings. Often, the ESCO will guarantee a minimum level of energy savings.

Lessons learned from energy efficiency measures applied to buildings are comprehensively reviewed in the reports of the World Energy Council, the International Energy Agency, and other lead organizations. In addition to assessments of actual energy efficiency investment projects, the reports contain extensive information on the effectiveness (or ineffectiveness) of incentives for the development of awareness programs, the imposition of energy standards, and energy efficiency labeling.

6 Conclusions

Business models are a means to an end. The two other reports that accompany this report on business models review the potential for renewable energy and energy efficiency savings in five GMS countries: Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam. Those other reports document the extensive potential for solar, wind, biofuel, and biogas forms of renewable energy in the five countries, together with the extensive potential for energy savings if long-term energy efficiency targets are met. The business models outlined in the present report are applied methods of promoting and implementing renewable energy and energy efficiency projects. More needs to be done to understand better the various components of the models discussed, and a fuller understanding is needed of yet other forms of business models that may be best suited to developing-country situations.

The renewable energy report notes the imperatives driving the development of renewable energy—primarily the need to reduce greenhouse-gas emissions. While the five GMS countries have minor roles in this global problem, their governments are well aware of their responsibility as well as self-interest in helping to contain the problem. They are also well aware of the need to reduce their countries' heavy reliance on imported fossil fuels and the foreign exchange costs of this reliance. Further, they are striving to eliminate poverty, one vital requirement for which is rural electrification. Renewable energy alternatives address these concerns, an important step in the right direction toward sustainable and inclusive growth. To varying degrees, the five GMS countries have promoted solar, wind, biofuel, and biogas forms of renewable energy, some successfully and others with insufficient public sector direction, technical leadership, and maintenance support. However, except for Thailand and to a lesser extent Viet Nam, their collective renewable energy potential has only begun to be tapped.

The renewable energy report also points out that renewable energy is a public good, as is energy efficiency, and that less-than-full capture of the benefits (including reduced greenhouse-gas emissions) by the investor or user leads to underinvestment or use relative to the socially desirable level. There is thus a strong rationale for public sector support for the development of renewable energies and energy efficiency projects, including research and pilot projects. While renewable energy and energy efficiency are increasingly indispensable public goods, the tools needed for their rapid development are lacking. Most obvious is the gap in knowledge, including about business models—what works and what does not. The public also needs to be more fully informed about the urgent need for renewable energy and energy efficiency. The main deficiency could be lack of technical knowledge and maintenance backup.

Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam each have renewable energy targets ranging from 6% to 20% of total energy supply, for the period up to 2020 and beyond. In some cases, these targets understate what is possible and likely; in other cases, the targets may be difficult to achieve. Knowledge sharing among GMS countries could prove very helpful in charting the course ahead. Regional economic cooperation in energy supply, management, and use facilitates the identification of the most cost-efficient and effective way of meeting energy security in an environment-friendly manner. The renewable energy report concludes that, just as the GMS countries have made groundbreaking progress over the past 20 years in regional cooperation and integration, they must now make similar progress in the transition to the development and use of renewable energy.

The energy efficiency report focuses on the potential energy savings available to Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam from greater energy efficiency. These five countries expect their energy consumption to at least double or triple over the next 15–20 years. To meet the increased demand, they will need to do more than simply add to energy supplies—underscoring the vital importance of energy efficiency and conservation. Their governments envisage energy efficiency savings of at least 10% over the next 15–20 years; Thailand looks forward to savings of 20%. According to the 3rd ASEAN[5] Energy Outlook (2011), almost 30 million tons of oil equivalent could be saved annually by 2030. The countries' national energy efficiency action plans identify areas where savings of around 40% could be achieved, especially in energy-intensive industries like cement and steel.

However, while Thailand has a well-advanced policy, institutional, and regulatory framework for pursuing its energy efficiency targets, Cambodia, the Lao PDR, Myanmar, and to a lesser extent Viet Nam are much less well prepared. The four countries, and also Thailand in some respects, must strengthen their institutional, technical, and financial capacity to design and implement best practices in energy efficiency. Most importantly, the nongovernment sector must be at the forefront of energy efficiency initiatives, as it is the main energy consumer. In general, GMS countries need better-defined action plans to mainstream investment in energy efficiency throughout their economies. Subsidies and regulations, together with pilot projects and government programs, may be important elements of effective action plans but economic instruments—most importantly energy pricing—are likely to be the main contributors to improved energy efficiency. GMS energy efficiency action plans need to incorporate both supply-side and demand-side measures and incentives, based on a diagnostic analysis of the primary sources of inefficiency. The right incentive structure is critical to mainstreaming energy efficiency throughout the economy.

In 2013, the World Energy Council released the results of a wide-ranging survey of energy efficiency policies: what works and what does not (World Energy Council 2013). According to the survey, an increasing number of countries are adopting quantitative energy efficiency targets and laws, and establishing energy efficiency agencies. Regulations are being widely used to lower the energy consumption of specific appliances and equipment and to hasten the spread of energy-saving investments and practices. Economic incentives

5 Association of Southeast Asian Nations.

increasingly involve the private sector, notably through energy service companies, which undertake to provide energy savings to consumers. Industrial energy efficiency policies are highlighting mandatory energy audits, energy management, and flexible instruments, such as voluntary agreements combined with performance-based tax benefits. Transport energy efficiency measures emphasize mandatory fuel efficiency standards, while tax policies reinforce the use of more efficient vehicles and trucks. Among residential and nonresidential buildings, the largest end-use sector, tighter building codes and minimum energy performance standards for appliances, accompanied by appliance labeling and an explicit communication campaign, have proven effective, and financial incentives in the form of subsidies and low-interest loans have promoted extensive retrofitting. Energy prices should reflect real costs—this was among the recommendations of the World Energy Council 2013 report.

To realize the considerable potential of the GMS countries for energy efficiency savings, their technical know-how and resources for realizing that potential must be strengthened. Cambodia, the Lao PDR, and Myanmar are at preliminary stages of energy efficiency, and Viet Nam, despite having adopted proactive measures more than a decade ago, has made slow progress. Thailand is more advanced but is still lagging behind its potential, especially with regard to energy-intensive industries. Supply and demand management for energy efficiency must be made a priority at the regional and national levels.

Complementing the renewable energy and energy efficiency reports, with their estimates of the potential for renewable energy and energy efficiency projects in the five GMS countries, this business model report provides outlines of business models for investing in such projects. The outlines, however, are too limited and the examples too few. More needs to be done to help guide investors—at the community and higher organizational levels—in formulating successful renewable energy and energy efficiency investments. And more needs to be learned about the necessary policy and other support from the national, provincial, and local governments. As noted above, renewable energy and energy efficiency are public goods. Public support is vital; otherwise, the GMS countries will continue to rely unduly on fossil fuels and waste scarce energy through inefficiency and poor consumer habits. GMS countries, together with their development partners, should collaborate in forming an information foundation for promoting and investing in renewable energy and energy efficiency. Business models should feature in this foundation.

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Business Models to Realize the Potential of Renewable Energy and Energy Efficiency in the Greater Mekong Subregion

This report was produced under the technical assistance project Promoting Renewable Energy, Clean Fuels, and Energy Efficiency in the Greater Mekong Subregion (TA 7679). It provides outlines of business models relevant to pursuing the renewable energy and energy efficiency targets adopted by the five Greater Mekong Subregion countries: Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam. Business models for investments in renewable energy and energy efficiency provide policy makers and investors with alternative business methods for the deployment of new technologies, or for the application of well-established technologies and practices in new settings.

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