Chapter 3

Assessment of Instruments in Facilitating Investment in Off-grid Renewable Energy Projects Global Experience and Implications for ASEAN Countries

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Chapter 3

Assessment of Instruments in Facilitating Investment in Off-grid Renewable Energy Projects

Global Experience and Implications for ASEAN Countries

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Abstract

Renewable off-grid solutions play a critical role in giving people access to electricity. However, the challenges are enormous. Financing such off-grid renewable energy (OGRE) projects is one of the most significant challenges due to barriers such as limited financing access, low affordability for consumers, and high transactions costs. However, the benefits of electrification are beyond financial calculation, such as human development, improvement of life quality, generation of additional productive activities, access to information, and education. For these considerations, various instruments have been implemented to facilitate OGRE investment. However, which instruments shall be adopted is still a challenging question for policymakers. Answers to this question are practical and urgent for many Association of Southeast Asian Nations (ASEAN) countries that have the need to develop OGRE projects. This study assesses the effectiveness of those instruments from various perspectives and provides reference to further policymaking. Instruments that have been widely used are collected by this study through literature review and case study. The study proposes a framework consisting of three dimensions: feasibility, sustainability, and replicability for assessing the effectiveness of those instruments. The weights of each dimension were decided by surveying experts. Experts from various backgrounds, including policymakers, industrial players, and other relevant stakeholders evaluated each instrument from the three dimensions. Based on studying the literature and findings of the survey, policy implications for ASEAN policymakers were drawn.

Keywords: Off-grid renewable energy, rural electrification, investment facilitation

JEL code: Q28, Q47, I38

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1. Introduction

Energy lies at the heart of all countries' core interests, from education improvement to job creation, and from security concerns to full empowerment of women. Energy is also a necessary input for economic development that can be indicated by the whole supply chain, from growing crops, manufacturing, transport, and retailing, among others. Access to electricity is critical to human development as it is essential for certain basic needs, such as lighting and running household appliances. An individual's access to electricity is treated as the most important indication of a country's energy poverty status.

However, access to electricity, not only for meeting basic needs, but also for productive uses, is a significant challenge faced by policymakers and stakeholders in the developing world. A significant amount of the world's population has no access to electricity. According to the International Energy Agency (IEA), 18% of the world's population – 1.3 billion people – still don't have access to electricity, nearly 97% of them live in sub-Saharan Africa and developing Asia, and 80% of them live in rural areas (IEA, 2014).

Significant efforts are being made at various levels of governments and communities to increase a population's access to electricity. In September 2011, the United Nations (UN) Secretary-General, Ban Ki-moon, launched the Sustainable Energy for All initiative, which aims to make sustainable energy for all a reality by 2030. In order to achieve the goal of 'Energy for All', both mini-grid and off-grid electricity supply systems are suggested to be implemented together with on-grid solutions (IEA, 2013).

Off-grid solutions play a critical role in giving people access to electricity, especially in remote and rural areas, because it is more cost competitive compared to grid extension. In many remote non-electrified areas, grid extension is not sustainable not only due to the high capital cost of transmission infrastructure but also due to transmission losses and maintenance costs (Zhang and Kumar, 2011). The cost of grid extension in western or north-western China has been reported to range between $5,000 and $12,750 per kilometre (km) (Byrne et al., 2007), which makes grid extension

uneconomic. Byrne et al. (2007) further reported that the estimated cost of electricity per kilowatt hour (kWh) from solar–wind hybrid systems in China ranged from $0.26 to $0.89, while the unsubsidised cost of electricity from the grid was roughly $3.32 per kWh. Furthermore, low per capita electricity consumption in remote areas will also make grid extension not financially sustainable. While in many cases, mini-grids could provide an ideal intermediary or even long-term solution when a central grid is absent, especially for small towns or large villages where enough electricity can be generated to power household use, as well as local businesses (Rolland, 2011). It is estimated that nearly 60% of additional generation capacity for universal electricity access by 2030 will come from off-grid installations, including both stand-alone and mini-grids (IRENA, 2012b).

Many cases show that it is feasible to electrify remote areas by renewable energy (RE) technologies. In off-grid electrification, solar, small hydro, and wind power are frequently employed. Renewable off-grid could be the least cost option compared with diesel generation. Off-grid renewable energy (OGRE)[6] generation technologies are reliable and cost-competitive compared with fossil fuel-based generation systems in rural areas. Meanwhile, RE stand-alone systems (for example, solar home systems [SHS] are more cost-effective than kerosene lighting on a life-cycle basis.

Going forward, kilowatt-scale mini-grids (MG) can provide reliable electricity for productive uses on top of the basic electricity that is provided by stand-alone systems and can be further developed into larger mini-grids that have several sources of generation to serve diverse loads (IRENA, 2012b). Rolland (2011) claimed that diesel-fuelled MG are likely to be more expensive than RE and diesel hybrid ones on a lifetime basis, and less autonomous as fuel availability cannot be assured, so that a well maintained and managed hybrid system can run for over 25 years and be more attractive than diesel MG. IRENA (2012b) observes that the falling costs and increasing technology maturity make RE the most appropriate option for mini-grids in most rural areas.

[6] In this chapter, off-grid systems include stand-alone and mini-grid systems.

A renewable energy based off-grid solution is also more likely to be implemented to provide electricity access, especially to rural and remote areas as it doesn't put extra pressure on the existing generation, transmission, and distribution capacities. It is more favoured due to the environment friendly technologies, because it can avoid the environmental issues related with grid extension by efficiently utilising local RE sources like solar, wind, biomass, and run-of-river hydropower (Deshmukh et al., 2013).

Policymakers face the challenges of choosing appropriate policy instruments to support off-grid RE projects. The answers, however, would likely differ among regions due to their differences in factors such as government structure, public financial capacity, local culture, and so on. However, the evaluation of the effectiveness of policies in the literature mainly focuses on developed countries, in particular, the European Union (EU). The EU's assessment of financial instruments (European Commission, 2014) is a salient example. However, these methods may not applicable to the energy sector or to developing countries due to date or capacity limitation or both. Other research focuses on qualitative analysis of the effectiveness of government policies (Agnolucci, 2007; Dijk et al., 2003) often rely on the judgment of the research team itself. Furthermore, the evaluation of renewable energy policies often overlooks time dimension and geographical dimension. IRENA has recently released major publications for evaluating RE policy (IRENA, 2012a, 2014). These studies investigate indicators used to evaluate renewable energy deployment policies. The analysis framework of the assessment focuses on effectiveness, efficiency, equity, and institutional feasibility. They are also conducted on a micro level, consisting of performance-based assessment without directly considering how individual RE projects are developed and financed. More assessment on RE policy instruments are qualitative and not comparable, such as (IRENA, 2012b), which reports on the assessment of some OGRE policies without quantification.

To the best of our knowledge, there is no quantitative assessment of OGRE project supporting instruments from a project's financial perspective. The difficulty of selecting policy instruments suggests the need to study what instruments can be used to develop OGRE projects in the Association of Southeast Asian Nations (ASEAN) region.

This chapter provides an assessment of prevailing supporting instruments used in facilitating the investment in OGRE projects. It aims to update governments on which instruments could be used to facilitate the development of OGRE projects, what are the advantages and disadvantages of each instrument, what are the pre-requirements to adapt these instruments, and how likely they can be replicated in projects located in different countries and/or regions. Ultimately, this study is expected to help governments formulate their policies for developing OGRE projects and thus improve energy access under different national, regional, and community contexts. In particular, the chapter aims to draw lessons from international experiences for supporting OGRE project development in developing ASEAN. Given the fact that more than one-fifth of the ASEAN population still has no access to electricity, and many countries have abundant RE, using RE for electrification would be a real policy issue. This study can provide value to energy policy decisions in many ASEAN countries.

The chapter (1) proposes a holistic assessment framework of policy instruments, not only considering feasibility, but also taking into account time dimension (sustainable) and geographical dimensions (replicable) at project level; (2) reveals weights that can be used to integrate index policies into one score that is easy to be understood; (3) focuses on the OGRE projects, which are prevailing in many less developed countries and thus providing a simple index for their reference; (4) surveys a diversified range of players with a wide geographical coverage from different perspectives, which makes the assessment comprehensive and representative; and (5) discusses the assessment results that are comparable among instruments due to the consistent framework and quantitative results. The perspective from projects, in particular, OGRE projects, is different from other studies in the literature.

The chapter proceeds as follows. In Section 2, motivations of the study are justified by reviewing the challenges of universal electricity assess and limitations of current studies. Section 3 explains the methodology, including the analytical framework and the data. Section 4 reviews and presents the major instruments that have been used in the literature. Results of the survey are explained in Section 5. Discussions and policy

implications for ASEAN are further elaborated in Section 6. Section 7 concludes the chapter.

2. Supporting instruments in financing OGRE projects

2.1 Challenges

OGRE projects are necessary because they provide consumers who live in remote rural areas access to modern energy. Electricity access will not only provide modern energy per se, but also generate other benefits such as better education and health facilities, cleaner and more efficient appliances, and possibility for productive economic activities (that is, food processing) which have the characteristics of a 'public good'.

However, OGRE projects often face challenges from high initial costs, limited local financial resources, low return rates, and low affordability (due to high costs of electricity and low income) for consumers. Although many studies have shown that OGRE products cost less than conventional energy sources, such as kerosene and candles, they usually require much higher initial investment. On the contrary, people who live in rural or remote areas often have low incomes and small electricity demand, thus a unit cost of electricity may be more expensive than providing a large-scale electricity service in rural areas. Besides the challenges analysed above, there is also a poverty–affordability deadlock which cannot be broken down without external interventions. Table 3.1 presents a non-exhaustive list of institutional and market failures that OGRE projects face.

Table 3.1: Institutional and Market Failures in OGRE Projects

Type	Examples
Government failure	· Shortage of public investment due to budgetary constraints · Lack of clear and transparent plan on future central grid extension, causing uncertainty to investors · Lack of effective institutional arrangements to ensure reliable and efficient operation and maintenance over time · Lack of standards and rules · Lack of quality control and assurance
Allocation efficiency	· Shortage of capital from the indigenous communities and thus existing equity gap for risk finance · Lack of financing at different stages of project development, especially at initial stage · Lack of affordable financing access for consumers · High investment risk due to low willingness to pay high technological risks, culture differences in local communities, limited catalytic investment to generate economic activities, among others
Externalities, Public goods	· Meeting basic energy needs is the goal of social development · Emission reduction being a public good · Future benefits such as nursing of productive usage cannot be foreseen and compensated · Lack of compensation for non-economic benefits (i.e., providing education, entertainment, and health care)
Transaction costs	· Difficult to collect information about communities in rural areas during the project preparation stage · Hard to gain local communities' trust to build the project · Difficult and expensive to collect tariffs from local communities and provide maintenance service · Financial administrative costs are not affordable for small-size projects · Long payback period and low return rate for investment
Imperfect information	· High costs of project development as OGRE projects are often on greenfields · Lack of community awareness about benefits of OGRE projects, such as underestimation of heath costs caused by indoor air pollution resulting from use of traditional forms of energy · Asymmetric information among local communities, project developers, and potential investors
Local technical expertise	· Lack of technical skills such as maintenance skills at the community level, leading to suboptimal performance or premature breakdown · Lack of technical skills in the market to support scale up of OGRE projects

OGRE = off-grid renewable energy.

Source: Authors' deliberation based on information from various sources (European Commission, 2014; IRENA, 2012b).

Several financial challenges exist in OGRE projects and rural electrification that cannot be solved by the current market mechanisms. One of the key issues associated with rural electrification is the 'externality' of public goods. Many of the benefits for communities induced by electrification cannot be reaped by investors. On the contrary, missing visions of the benefits of electricity access will reduce the willingness to pay and discourage OGRE projects. The consumers' willingness and ability to pay signals the maximum price the operator can realistically charge (IRENA, 2012b) and thus play a determining role in financing OGRE projects. Local communities that have not had access to electricity, may not be able to assess the real benefits of electrification, and thus are reluctant to invest in OGRE.

Further, the unwillingness and/or the inability to pay can hinder OGRE development. Low-income residents may not be able to afford electricity fees. Specifically, if minimum monthly payments are required, consumers may find it hard to make payments due to their fluctuating income throughout the year (World Bank, 2008). In addition, consumers may fail to understand or respect the financing agreements and financing schemes that have been established and thus put OGRE projects at high risk (Gboney, 2009). Therefore, OGRE projects are generally not attractive to private investors, and the exiting lending terms set by lenders (or funders) are often unsuitable for OGRE projects.

Local communities are unlikely to address the above challenges by themselves. The communities may have limited financial strength to attract adequate investment to build an off-grid system. Policy intervention and government support is necessary for the development of an OGRE project, and in many cases, policy support from governments will need to be in place mid- and long-term until the project can be economically variable.

If scaled up, projects such as household solar panels, mini-hydro systems, local wind turbines, and biomass cooking could change the energy dynamics within ASEAN. Governments could design, finance, and operate policy facilities to provide enough financial viability to OGRE project developers. The financing issues concern not only sufficient funding for projects, but also the financial structure that can vary among

projects and thus could make OGRE projects commercially viable (Jager and Rathmann, 2008). Only when either the costs are reduced or local communities have benefited from access to modern energy, can their willingness and ability to pay for electricity be improved, which will make OGRE projects economically and commercially viable.

2.2 Key support instruments to finance OGRE project financing

Policy instruments that have been adopted to support OGRE deployment include financial incentives (soft loans, grants, and publicly backed guarantees, among others), fiscal incentives (exemptions from import duty and value-added tax, among others), and elimination of market distortions (for example, fossil fuel subsidies) (IRENA, 2012a).

Government grants and support are necessary as the costs of RE technologies are still high and difficult to be financed by the rural population, which indicates that those rural electrification projects are not commercially viable yet. While donor funding can play an important role in supporting rural electrification programmes, especially in the early stages, experience shows that the role of donor funding can be reduced as the programme reaches a certain scale and the local off-grid market matures – as seen in the case of Bangladesh. The major financial components – grants and concessional finance – of the solar home system (SHS) programme, which was started by the Infrastructure Development Company Limited (IDCOL) are designed in such a way that dependence on external finance gradually recedes (IRENA, 2012b).

In addition, appropriate electricity tariff mechanisms and subsidies could be efficient to address the issue, that is, setting up a special fund to broaden the finance channels for off-grid projects, providing preferential interest rates for the loan, designing the tariff which can cover the initial, operation, and maintenance costs incurred during the project's lifetime, using capital subsidies or levying low import duties as a strong and direct financial support, among others.

Many instruments to strengthen the financial capability of an OGRE project have been widely adopted in many countries. Take the Philippines' case as an example. The Development Bank of the Philippines has provided low interest loans with the support from various overseas development assistance funds and the World Bank for renewable

energy and rural power projects. Particularly, the Philippines offers special privilege tax rates to developers of hydropower, which is 2% of their gross receipts. Further, an income tax holiday for 7 years from the start of commercial operations is provided. The importation of machinery, equipment, and materials for mini-hydropower projects is exempted from payment of tariff duties and value-added tax (VAT) within 7 years from the date of awarding the contract. Tax credit is given to developers who buy machinery, equipment, materials, and parts from local manufacturers. VAT on gross receipts derived from the sale of mini hydropower (10%) is exempted. These fiscal incentives for mini-hydropower development were introduced in 1990s (Pacudan, 2005).

In the context of the OGRE project lifecycle, it may be useful to classify the financial challenges in phases as the investment in the different phases correlates with different risks and barriers (European Investment Bank, 2014). Below presents a brief discussion of various instruments.

2.2.1 Plan and development phase

In this study, we define the initial stage of an OGRE project as the stage that covers the site selection, feasibility study, material and equipment purchasing, and project build-up. During the project planning and/or pre-investment phase, grants or subsidies can be provided for feasibility studies, business plan development, technical planning, and capacity building and transaction costs (EUEI PDF, 2014). In developing countries, rural electrification investment cannot totally rely on revenues from clients in the short and medium term. It needs subsidies – yet subsidy schemes have to be well-designed to support rather than hinder mini-grid roll-outs (EUEI PDF, 2014). In Senegal, the initial investment cost subsidy is provided to private operators in the RE and rural electrification projects (Kfw, 2005).

Capital subsidy is one of the most widely adopted policy instruments to assist off-grid projects overcome the initial investment barrier (Kfw, 2005). According to Deshmukh et al. (2013), Brazil has successfully operated 15 small hydropower plants and one solar photovoltaic (PV) plant in remote Amazon regions through a special project manual issued by the Ministry of Mines and Energy. The manual provides 85% capital

subsidy to the mini-grids, especially those based on renewable energy. The Indian Ministry of New and Renewable Energy also provided a large proportion for the capital subsidy as high as up to 90% (Palit and Sarangi, 2014). In the case of India and Sri Lanka, capital subsidy and soft loans succeeded to establish the market for solar home lighting installations, and a micro-credit system model succeeded in Bangladesh to develop the market in the rural sector (Mahajan and Garud, 2011).

Reiche et al. (2000) pointed out that reduced import duties on PV components can remove market distortions and make SHS more affordable for rural households. This method was used in the Comoros, a small island nation in the Indian Ocean. With the assistance of the UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), the government granted the firm a 3-year grace period for taxes and duties, that is, it could import equipment without any tax burden. Other tax related incentives can help promote renewable energy development by reducing the costs of investment, such as accelerated depreciation (Deshmukh et al., 2013; Sawin, 2004). It allocates a large proportion of the system costs to earlier accounting periods and a smaller proportion to later periods (Zhou et al., 2001). Accelerated depreciation is widely-used to help OGRE investors cut the equipment cost and increase the profit (by reducing tax) (EUEI PDF, 2014).

(Solar) crowdfunding is a new financing mechanism in which investment funds in solar systems are raised from individual investors through the internet (Tongsopit et al., 2013). It has developed fast in recent years, and has been considered as revolutionary given its scale and applicability, especially compared to mechanisms subject to the excruciating dynamics of the United Nations Framework Convention on Climate Change (UNFCCC) like the Green Fund (Guay, 2012). The companies that run solar crowdfunding platforms pool small investments from many individual investors, and the individual investors receive interest and are paid back in full over a specified number of years.

Through crowdfunding, people are able to provide zero-interest loans to organisations and products they support (Quinn, 2012), or pure donations in many cases of OGRE projects. It substantially expands the finance channel for OGRE projects.

Meanwhile, it is also gives easy access for investors or donors to find and approach the projects and project developers. In remote rural areas, the most effective means of delivering energy is through small-scale systems, and with distributed clean energy. Since crowdfunding is a financing model that mirrors this scale and distribution (Guay, 2012), it could be an ideal financial and business model for OGRE projects. The Sun Funder platform finances small solar projects and businesses in off-grid areas in African countries (Tongsopit et al., 2013).

2.2.2 Operation and maintenance phase

'Designing a grant and subsidy regime is challenging but essential. Grants and subsidies should be affordable for the country to allow scaling up beyond a few pilot projects and upgrading of existing mini-grids. In most countries, this means that subsidies should be as low as possible, and as high as necessary'.(EUEI PDF, 2014). In the operation and maintenance phase, incentives based on energy generation (feed-in tariffs [FIT]) or a fixed subsidy per connection can help cover maintenance and operational expenses and eventually profit gaps (Deshmukh et al., 2013).

In addition to the capital subsidy, some forms of operation and maintenance (O&M) subsidies are essential to sustain project operations over a long period, particularly in the case of extremely remote areas with a poor ability to pay. For example, in India, around 10% of the project cost is supported by various programmes (for example, the Ministry of New and Renewable Energy's Remote Village Electrification Programmes and Decentralized Distributed Generation Programme) for 2 to 5 years (Palit and Sarangi, 2014). In Thailand, the government has introduced a pricing subsidy for the capacity generated by renewable energy from small power producers (ACE, 2013). In China, small hydropower producers benefit from both a lower value-added tax and income taxes that are either lowered or forfeited altogether (Zerriffi, 2011). Furthermore, subsidies can also be made available to the mini-grid operator upon reaching certain milestones (results-based subsidies) (EUEI PDF, 2014).

Training and capacity development should also be taken into account as human resources are a key issue to promote OGRE deployment. Well-designed policies and

appropriate institutional arrangements along with effective financing mechanisms can address many of these challenges and enable the successful and sustainable deployment of OGRE projects (Deshmukh et al., 2013). Meanwhile, local involvement of operation and maintenance could save costs and create opportunities for income generation as well.

2.2.3 Energy use phase

The appropriate tariff scheme is complex and needs to consider the three following aspects: (1) to ensure energy affordability of low-income consumers, (2) to be cost-effective for private OGRE developers, and (3) to encourage consumers to manage their energy consumption more efficiently. From a private developer's perspective, tariffs must be cost-reflective. Otherwise, mini-grids cannot be run profitably, which prevents potential customers in rural areas from receiving high quality electricity at all (EUEI PDF, 2014). From a regulatory point of view, the critical issue of tariffs directly affects the business case for mini-grid deployment and the long-term sustainability of a project (IRENA, 2012b). Waddle (2012) also emphasised it is important to establish rational tariffs that allow full cost recovery of rural electrification programmes. There is no one-size-fits-all solution to tariff setting (IRENA, 2012b), thus, a balance needs to be achieved among these aspects.

In order to solve the challenges created by high initial costs of OGRE projects and low affordability of consumers together, governments and project developers try to convert the OGRE system from a system with high initial cost to one with long-term energy service. The World Bank Group has implemented the 'long-term consumer credit' to overcome the 'first-cost barrier' (the high initial system cost relative to conventional alternatives), and provided means that consumers can continue to pay what is roughly equivalent to their conventional energy purchases (Reiche et al., 2000). Recently, thanks to the fast technological improvement and the large-scale of RE applications worldwide, the costs of RE have been substantially reduced. Therefore, consumers are more likely to face smaller expenses under the consumer credit scheme.

Demand-side subsidies often incorporate the off-grid electricity tariff settings to support consumers of OGRE projects. For instance, consumption subsidies can operate through the tariff structure as a percentage discount applied to residential end-users' bills, and users with electricity consumption below a certain level could be considered as 'low-income' consumers and had the right to pay reduced tariffs in Brazil (Gómez and Silveira, 2012). The use of tiered electricity tariffs can be an effective method to address energy poverty, improve energy efficiency, and achieve financial viability, as the Tier 1 tariff could be set low so that low-income consumers can also have access to electricity (to meet their basic needs), while the tariff could increase at higher tiers to achieve higher efficiency. The tariff design also needs to consider the feasibility and costs of tariff collection.

A system of tariffs and subsidies is required to complement – but not replace – the limited contribution by low-income consumers and ensure the sustainability of the service (World Bank, 2012). While a large part of capital costs is usually subsidised through special-purpose funds, many low-income households cannot pay the full cost of operation. In addition, as Salih (2012) has also pointed out, in Sri Lanka the institution's financial viability and fragmented and complicated regulation and supervision are the major weaknesses in providing consumer credit.

Microfinance to rural households for SHS has been successfully implemented by Bangladesh's Infrastructure Development Company Limited (IDCOL) and Sarvodaya Economic Enterprise Development Services (IRENA, 2012b). In some cases in China, electricity was distributed free of charge at the beginning of the projects. However, the township government soon found that many village-level power stations went into bankruptcy and thus started to collect tariffs, but hospitals and schools were exempt (Cao, 2006). In Lao PDR (Lao People's Democratic Republic, interest free loans were provided to poor households to be paid back in a 3-year period (Bambawale et al., 2011).

In practice, consumer credit can be provided through: (1) local development finance institutions, (2) microfinance organisations, or (3) equipment dealers (IRENA, 2012b; Reiche et al., 2000). For instance, in Sri Lanka, a microfinance organisation provides consumer credit to reduce the amount of monthly credit repayments by a

share of the per-system (Reiche et al., 2000). In Argentina, the energy-service concessions are given a variable grant amount (a one-time payment for each system installed), which declines for installations made in later years of the project and also depends upon system size (Reiche et al., 2000).

It is advised that results-based subsidies, which aim to subsidise connection fees for consumers are more efficient than operational subsidies or investment subsidies to investors. For instance, results-based connection subsidies of €380 for each new connection is offered in a private mini-grid in Tanzania (EUEI PDF, 2014). In addition, in diverse types of institutions such as banks and non-banks, the inclusion of an implementing organisation and direct access for loans for consumers are some of the strengths identified in the microcredit financial model (Salih, 2012).

2.2.4 Total lifecycle

In addition to appropriate instruments, various business models can also be adapted to support the establishment of OGRE projects and to improve their financial viability. Rolland (2011) summarised the business models in OGRE projects as four types: utility, community, private, and hybrid models. Utilities have more experience, financial resources, and technical capabilities to carry out rural electrification projects. The private model operates more efficiently, yet requires higher rates of return. Local communities have the best knowledge of the local conditions and could work more efficiently after appropriate training and capacity development. Further, cooperation with local governments can also be a more effective method compared with central governments. The hybrid model combines different players (or models) so that they can play different roles during the project's lifetime, that is, introducing the utility as the investor, combining the community as the operator and maintainer with the private organisation's technical (or financial) support.

Private operator models, where private investors build, operate, and maintain the off-grid system, have a high potential for scale up, for attracting private investments, and for mobilising the know-how of the private sector. However, it is rare to see those models based on pure private investment. Various forms of assistance should be offered

to promote their development, that is. a publicly backed debt or credit enhancement facility may provide or facilitate long-tenor, low-interest loans that commercial lenders would not offer on their own. EUEI PDF (2014)EUEI PDF (2014). It is pointed out that loan guarantees provided by national banks or special facilities to commercial lenders may compensate the lender in the event of default, and such a loan guarantee may cover 50% of the loan on a shared-loss (rather than first-loss) basis (EUEI PDF, 2014).

Besides, public–private partnerships (PPPs) are also used to implement the de-politicisation of rural electrification, attract private investors, implement priority projects, and allocate capital subsidies through competition between public utilities and private investors (Salih, 2012). Palit and Sarangi (2014) studied a case in India where private companies such as Husk Power Systems has developed a franchisee-based business model for setting up mini-grids. Husk Power Systems follows the build, own, operate, and maintain; build, own, maintain; and build and maintain models for providing electricity services.

There are also instruments to address concerns about the consumer credit mechanism, specifically focusing on the credit risk issues. Financiers tend to be reluctant to extend credit to rural consumers with little credit history. In addition, credit administration and collection could also be costly. Three ways can be adopted to mitigate the risk, namely partial credit guarantee schemes, microfinance lending, and partnering promise via models (Reiche et al., 2000). Credit risk should be lowered from two perspectives, short term and long term. In the short term, governments or funding organisations can provide the credit guarantee for consumers. Guarantee schemes cannot only smooth the credit application from financiers or dealer, but also help prove consumers' affordability to the project developers or investors, so as to attract the investment.

In the long term, effective income creation of local communities is the key solution. By establishing local productive enterprises that can produce high-value added agricultural and rural industry products for export to national and international markets, local consumers' affordability can be strengthened, and the electricity demand may also increase so that unit cost of electricity could be reduced. In India, SELCO's experience of

selling, servicing and financing over 135,000 SHS has shown that access to customised long-term affordable financing has made OGRE products available to rural households with limited income, mostly without grant support (IRENA, 2012b).[7] In addition to using supporting instruments, the sustainability of rural electrification projects could also be enhanced through joint development with other industrial activities (Cao, 2006) .

3. Methodology and data

3.1 Overview

This chapter uses both qualitative and quantitative methods to review the key supporting instruments that have been used globally to facilitate OGRE investment, assess their performance within a dedicated framework, and identify their applicability under various circumstances. Section 2 provided a critical review of policy instruments for facilitating OGRE project development through reviewing the literature. These instruments are then evaluated by a holistic assessment framework that integrates three dimensions. Each of these dimensions represents major challenges in OGRE project investment. The weights for each dimension and qualitative levels of effectiveness for each instrument are assigned by both experts and practitioners who work on OGRE projects across the world. The survey was conducted online and the respondents were invited individually. The level of effectiveness will then be further quantified and aggregated to generate a unified score for each instrument combining the different evaluation results at each dimension from the survey.

3.2 A holistic three-dimension assessment framework

This study assesses the prevailing instruments used to support OGRE projects from three dimensions: feasibility, sustainability, and replicability. According to the current European practice, in *ex ante* assessment of financial instruments (European Commission, 2014), major concerns for policy instruments will be their ability in addressing market failures, value added, and leverage of other public or private financial

[7] SELCO Solar Pvt. Ltd. is a for-profit social enterprise established in 1995. It provides sustainable energy solutions and services to under-served households and businesses in rural areas.

resources. These three perspectives are also embedded in the life cycle of OGRE policymaking: from building up a project to sustaining the operation and to replicating it in other circumstances to address the wide electrification challenges. Building up a project and achieving its long-term economic viability are two major challenges for any specific OGRE project, while replicating it would be a general challenge for policymakers who need to think beyond project level.

From a policymaker's perspective, while feasibility is a major concern, the long-term operation of a project should be a key of success. One of the key challenges for OGRE projects is to achieve the long-term sustainability, as many of the projects are set up by governments' or donors' support and face challenges of sustaining themselves. Many OGRE projects failed beyond the assisting stage due to financial difficulties, lack of technical resources, and limited capacity. A project cannot be considered successful or even completed if it fails beyond the assisting phase.

Furthermore, replicability should be taken into consideration as an assessment dimension. Even though OGRE projects often have unique features due to various local environments, resources, and communities, a supporting instrument or even a project which can be replicated in other projects or other regions would be more important and effective for policymakers compared to those that cannot be widely replicated.

The supporting instruments on OGRE projects should be assessed from the three dimensions with each instrument having different impacts on these dimensions. It has been found in the literature (IRENA, 2012b) that some supporting instruments, such as public and/or external support (for example, financial, and human, among others) make OGRE projects unsustainable and difficult to be scaled up. Therefore, each instrument will be scored by an integrated assessment framework, which covers various dimensions including feasibility, sustainability, and replicability. Considering the potential diversified views in policy assessment, we also keep a fourth dimension as optional for surveyed experts to decide. The assessment framework is presented in Table 3.2.

Table 3.2: Integrated Framework for Assessing Supporting Instruments

Dimension	Definition	Weight
Feasibility	Make the project possible to take off	(decided by survey)
Sustainability	Achieve long-term commercial viability (even beyond the assistant phase)	(decided by survey)
Replicability	Possible to be replicated elsewhere in other projects	(decided by survey)
Others	Other factors that are important to the assessment. Please specify	(decided by survey)

Source: Compiled by the authors.

For each policy instrument, surveyed responders are asked to assess the effectiveness on each of the three dimensions. The effectiveness is presented at five levels: very effective, effective, moderate, slightly effective, and not effective. The answer is then further translated to numerical results from 5 to 1, with very effective to be 5 while not effective to be 1. Table 3.3 presents the scaling.

Table 3.3: Quantifying the Effectiveness of Instruments

Performance	Very Effective	Effective	Moderate	Slightly Effective	Not Effective
Score	5	4	3	2	1

Source: Compiled by the authors.

A weighted average of each score across all three dimensions will produce an integrated score, or policy effectiveness index for an instrument. The method of measuring OGRE supporting instruments by means of different dimensions offers flexibility for policymakers to choose policies that suit different situations. This flexibility also implies that the index is adaptable to different institutional settings, which are often diversified in developing countries.

3.3 Data and information

Information is collected from reviews of existing literature, interviews and discussions with relevant stakeholders, a survey of experts and stakeholders, and case studies. The list of instruments is collected through a literature review. Those instruments that are frequently used in the literature are put into the list for assessment.

The assessment of the policy instruments is conducted through a survey, which draws on experts from academia, government agencies, the private sector, international institutions, nongovernment organisations (NGOs), and other OGRE project stakeholders. The experts are recruited from the energy policy, renewable energy, and off-grid energy systems fields at international conferences and workshops, as well as contact via email. The research team then internally reviewed the results of the assessment to ensure their consistency, and discussed them with experts in a workshop for refinement.

4. Empirical results and discussion

In total, this survey received 101 responses, with and 71 of them being complete. The following analysis is based on the complete responses only. Even though experts from academia and research institutions account for the largest share of participants (above 70%), the survey managed to investigate most of the perspectives of investment in the OGRE projects. A summary of survey results is presented in the Appendix.

4.1 Assessed weights of each dimension

As explained earlier, this study selects three dimensions: feasibility, sustainability, and replicability. Respondents are asked to give a score for each dimension based on their importance in the whole assessment framework, so that each instrument can have a weighted assessment score for its overall performance. There is also an option for adding 'other dimension' if experts believe that there should be other assessment dimension(s). The result of the weights of each dimension is shown in Table 3.4.

Table 3.4: Results of the Assessed Weights for Each Dimension

Assessment dimension	Response Average	Response Count
Feasibility	39.90%	71
Sustainability	35.96%	71
Replicability	24.14%	71
Total	100%	

Note: Other dimensions only account for 3.66%. They are timeliness, cost effectiveness, accessibility, safety and security, and implications on local communities (for example, social benefits, and job creation, among others), which actually cover the three dimensions above (cost effectiveness is related to all three dimensions). Therefore, the score of 'other dimension' is proportionally assigned to each of the three dimensions above.
Source: Compiled by the authors, data from the survey.

As shown in Table 3.4, 'feasibility' is considered the most critical assessment dimension, scoring 40%. In other words, the most important perspective in evaluating any instrument's performance in OGRE investment is that, it should be effective in establishing OGRE projects. Secondly, whether the instrument is effective in supporting the OGRE projects to achieve the long-term commercial viability (even beyond the assistant phase) – sustainability – is given a weighted score of 36%, showing that both feasibility and sustainability are key concerns of supporting investment on OGRE projects. Lastly, 'replicability' accounts for around 24%, which assesses whether the instrument can or has the potential to be replicated in other projects. The result is reasonable given the fact that OGRE projects are usually located in remote areas with varying features in resource endowment and local communities, among others, therefore, an instrument which is effective in one project may not necessarily work well in another. However, from the perspective of policymakers, instruments that can easily be replicated are not only favourable but also effective.

4.2 Scores of instrument assessment

4.2.1 Summary of the assessment

After building up the weighted assessment framework (Table 3.4), respondents were asked to evaluate instruments' performance from each dimension – feasibility, sustainability, and replicability (Table 3.5). Table 3.5 also shows the final weighted score of instruments based on the scores and the weights of each dimension.

According to the final weighted assessment score, the instruments with the five highest scores are PPP, loan guarantee, FIT and/or feed in premium (FIP), start-up grant, and power purchase agreements (PPA). PPP, FIT and/or FIP, and PPA are usually adapted in the mini-grid systems where generators sell all or part of electricity to the mini-grid. While for small-scale off-grid systems, such as those used for individual houses or small villages only, PPP, FIT and/or FIP, and PPA may not be applicable. In those cases, start-up grants and loan guarantees are more helpful because they can smooth the establishment process by reducing upfront costs and support sustainability by reducing operation costs.

Further, other instruments that also get high assessment scores on their overall performance include local engagement, tax concession and exemption, end-user subsidy, and end-user financing. For potential investors, especially those in the private sector, high risks of OGRE projects arise from various perspectives, including it is beyond their traditional investment sectors, and local communities have limited income sources and affordability of electricity consumption. Therefore, engaging local communities and strengthening their capacity through subsidies and end-user financing could be effective in attracting more investment and sustaining the projects over a longer time.

Table 3.5: Scores of Each Instrument

Instruments	Weighted Average Score	Assessed Score of Each Dimension		
		Feasibility	Sustainability	Replicability
Public–private partnerships	**4.16**	**4.20**	**4.20**	**4.06**
Local engagement in operation and maintenance	**4.10**	4.04	**4.15**	**4.11**
Feed-in tariffs/premiums	**4.06**	**4.14**	**4.08**	3.89
Start-up grants	**4.02**	**4.31**	3.82	3.86
Power purchase agreements	**4.02**	3.97	**4.11**	**3.96**
Loan guarantees	3.97	4.08	3.83	**4.00**
Tax concessions and exemptions	3.94	4.00	3.85	**4.00**
End-user subsidies	3.93	**4.23**	3.73	3.73
Grants/subsidies to cover operation and maintenance costs	3.90	**4.11**	3.69	3.85
End-user financing/microfinance/consumer credit	3.90	3.97	3.90	3.76
Concessional finance	3.86	3.89	3.85	3.85
Revolving funds	3.84	3.82	**3.92**	3.76
Tiered electricity tariffs	3.83	3.80	3.90	3.76
Capital subsidies	3.79	3.97	3.62	3.75
Leasing	3.75	3.70	3.89	3.63
Accelerated depreciation	3.70	3.73	3.65	3.70
Import duty exemptions for equipment	3.57	3.58	3.48	3.70
Crowdfunding	3.38	3.32	3.39	3.45

Source: Compiled by the authors, data from the survey.

From the perspective of feasibility, the five most effective instruments are start-up grants, end-user subsidies, PPPs, feed-in tariffs, and grants and/or subsidies to cover operation and maintenance costs. These selected instruments are helpful in reducing the financing costs or expanding the financing channels to overcome the barrier of high upfront costs. Start-up grants are a direct method to lower the initial cost of the project developer, feed-in tariffs and loan guarantees try to strengthen the financing capacity from the supply side, while end-user subsidies strengthen it at the demand-side which in turn will support project developers when they are seeking investment sources.

In terms of sustainability, PPPs, local engagement in operation and maintenance, PPAs, feed-in tariffs, and revolving funds score the highest values. Building up local

capacity in techniques, skills, and financing is one of the key solutions to sustain the OGRE projects in the long term. As OGRE projects are often located in remote rural areas, it is critically important to seek local solutions to achieve sustainability of a project. Experience has shown that giving out equipment to local communities for free is usually the least efficient method, especially without proper training on how to use the equipment. Comparatively, helping them obtain the ownership of off-grid energy systems and letting them bear the responsibilities for operating and maintaining those systems have proven to be useful lessons learnt from the successful cases. Revolving funds have been used in several successful cases. It is a mechanism that saves part of the collected electricity tariff into a 'community owned fund', and uses this fund to maintain, operate, and even expand the off-grid energy system in the future. Therefore, local communities are able to strengthen their financial capacity over a longer time. Revolving funds work more efficiently when they can be combined with the productive activity as they generate more sources for the fund.

Finally, instruments that have the highest potential to be replicated in many projects are local engagement in operation and maintenance, PPPs, tax concessions and exemptions, loan guarantees, and PPAs. For policymakers and OGRE project developers, it could be an efficient message as they can try to adapt these instruments in many projects. However, each case may need special techniques and formats to seek local communities' trust to build up the project and keep it variable in the long term.

4.2.2 Comparisons of results from different groups of experts

This survey covered different groups of respondents, including academia and industry, and the results show different opinions. Academia, industry, and NGOs are three biggest groups of respondents. The results from these three groups are compared and listed in Tables 3.6 and 3.7.

Table 3.6: Comparison of Assessment Weight from Academia and Industry and Nongovernment Organisations

Academia (No = 54)		Industry and Nongovernment Organisations (No = 11)	
Assessment dimension	Assessment weight, %	Assessment dimension	Assessment weight, %
Feasibility	40.15	Feasibility	35.56
Sustainability	35.59	Sustainability	36.11
Replicability	24.26	Replicability	23.89
Total	100.00	Total	100.00

Source: Compiled by the authors, data from the survey.

Both feasibility and sustainability are considered as the most important dimensions when assessing the instruments' performance in facilitating OGRE investment. However, practitioners evaluate sustainability slightly higher than feasibility, while academia considers feasibility more important than sustainability. Both groups give the dimension of replicability the same score, around 24% in the total assessment system.

Table 3.6: Comparison of Assessed Scores from Academia and Industry and Nongovernment Organisations (top 10)

Academia (No = 54)		Industry and Nongovernment Organisations (No = 11)	
Instruments	**Final Weighted Assessment Score**	**Instruments**	**Final Weighted Assessment Score**
Public–private partnerships	4.12	Local engagement in operation and maintenance	4.47
Feed-in tariffs/premiums	4.03	Public–private partnerships	4.41
Power purchase agreements	3.99	Loan guarantees	4.24
Start-up grants	3.98	Start-up grants	4.20
End-user subsidies	3.96	Grants/subsidies to cover operation and maintenance costs	4.17
Local engagement in operation and maintenance	3.95	Concessional finance	4.11
Loan guarantees	3.91	Tax concessions and exemptions	4.10
Tax concessions and exemptions	3.90	Feed-in tariffs/premiums	4.06
End-user financing/microfinance/consumer credit	3.88	End-user subsidies	3.96
Grants/subsidies to cover operation and maintenance costs	3.86	Power purchase agreements	3.85

Source: Compiled by the authors, data from the survey.

Among the top 10 most effective instruments from two groups, seven of them are the same, however, they have different rankings. Experts from industry and NGOs value start-up grants, local engagement, tax concessions and exemptions, and loan guarantees more than academia. Given their field experience, it has proven the effectiveness of these instruments in practice.

In addition, detailed assessment results (top five) in different dimensions are shown in Table 3.7. An unexpected result is that several instruments, which are designed to be used in the operation stage of OGRE projects and support the sustainability in the mid and long term, are chosen to be the most effective tools to establish projects. Our explanation is that project developers and investors look beyond the establishment stage of a project while they are actually at this stage, therefore, instruments that facilitate future investment can effectively support OGRE projects to be built up.

In order to explain the results of the survey clearly, each instrument is analysed individually in the previous sections. However, it is important to point out that various instruments need to be combined and utilised together in complex systems like OGRE projects. Diverse stakeholders are involved in OGRE projects, therefore, it is critical to balance the costs and benefits among them, so that they are willing to cooperate and collaborate with each other efficiently. That is also the reason why this study provides a framework of supporting instruments together with a weighted assessment framework. It is helpful for both policymakers and other stakeholders to understand OGRE projects and the relevant investment process comprehensively.

Table 3.7: Top Five Scored Instruments, by Dimension

Feasibility		Sustainability		Replicability	
Academia	**Industry and NGO**	**Academia**	**Industry and NGO**	**Academia**	**Industry and NGO**
Start-up grants	PPP	PPP	Local engagement in operation and maintenance	PPP	PPP
End-user subsidies	Local engagement in operation and maintenance	Feed-in tariffs/premiums	Loan guarantee	Local engagement in operation and maintenance	Local engagement in operation and maintenance
PPP	Start-up grants	PPA	PPP	Tax concessions and exemptions	Loan guarantees
Feed-in tariffs/premiums	Grants/subsidies to cover operation & maintenance costs	Local engagement in operation and maintenance	Concessional finance	Loan guarantee	Concessional finance
Grants/subsidies to cover operation and maintenance costs	Tax concessions and exemptions	Tiered electricity tariffs	Start-up grants	PPA	Start-up grants

NGO = nongovernment organisation; PPA = power purchase agreement; PPP = public–private sector partnership.
Source: Compiled by the authors based on survey.

5. Policy implications for ASEAN

5.1 The need for off-grid renewable energy in ASEAN

These challenges are particularly significant to ASEAN countries. Several ASEAN member states still have low electrification rates. As of 2012, 23% of the region's total population – about 140 million people – had no access to electricity. Cambodia and Myanmar are the two countries that have the lowest rural electrification ratio. Indonesia has the highest number of people without access to electricity. In Indonesia alone, 103 million people still rely on traditional biomass for cooking, while it is close to 50 million in Myanmar, the Philippines, and Viet Nam (Table 3.8).

Table 3.8: Access to Modern Energy Services in ASEAN, 2012

Country	Population* (million)		Electrification Rate (%)			Population Relying on Traditional Use of Biomass for Cooking	
	Total	Without electricity	National	Urban	Rural	Total (million)	Percentage (%)
Brunei Darussalam	0.4	0	100	100	99	0	0
Cambodia	14.7	10	34	97	18	13	89
Indonesia	245.4	60	76	92	59	105	42
Lao PDR	6.5	1	78	93	70	4	65
Malaysia	29.5	0	100	100	99	0	0
Myanmar	61.0	36	32	60	18	49	93
Philippines	97.6	29	70	89	52	47	49
Singapore	5.3	0	100	100	100	0	0
Thailand	67.9	1	99	100	99	16	24
Viet Nam	88.8	4	96	100	94	45	51
ASEAN	617.2	140	77	92	64	280	46

ASEAN = Association of Southeast Asian Nations; Lao PDR = Lao People's Democratic Republic.
Note: * mid-year population data.
Sources: ASEAN Secretariat (2014); IEA (2014).

Since many local communities are located far away from central electricity grids, off-grid renewable energy can bring immediate and cost-effective (lifetime cost) solutions for rural electrification. Several ASEAN countries have counted on off-grid renewable energy, especially micro- hydro power projects, to substitute fossil fuel for power generation and to electrify the remote rural areas. In 2013, the ASEAN Centre for Energy (ACE) issued the 'ASEAN Guideline on Off-grid Rural Electrification Approaches', which gives concrete recommendations for the development and implementation of effective, efficient, and sustainable rural electrification approaches with renewable resources (ACE, 2013).

The ASEAN member states have used both fiscal and non-fiscal policy instruments to develop OGRE. Fiscal instruments include income tax holidays, equipment duty exemptions, and property tax exemptions, which have been adopted by the governments of Malaysia, the Philippines, Singapore, and Thailand. Non-fiscal instruments include easy repatriation of capital investments, remittance of earnings, subsidies to generators, and so on (ACE, 2013). Both direct and indirect subsidies are applied in ASEAN mini-grid electrification. Direct subsidies are in the form of capital

subsidies targeting the initial investment; and non-fiscal instruments such as one-time subsidies granted according to the number of connections, topping-up kilowatt hour (kWh) premiums to the project investors, and subsidies supporting the operational costs of the power system. Indirect subsidies include technical assistance and some fiscal instruments such as VAT exemptions, import duty exemptions and income tax holidays, and so on (ACE, 2013).

Public-private partnerships were introduced to overcome capacity limit. In Lao PDR, since the government did not have the capacity to support the installation and implementation of off-grid electrification, the equipment was released to the households for a monthly fee (consumer loan) through provincial electrification service companies (PESCOs).[8] A village off-grid promotion scheme (VOPS) was established to manage the PESCOs, who worked with the village electricity managers (VEMs) to manage the off-grid systems. The monthly lease income was used to pay the PESCOs and the VEMs, among others. The remainder was put into a fund to further promote the development of off-grid systems. Finally, 80% of households had adopted the mini-grid systems in villages where it was available.

Engagement of the local community was institutionalised in Viet Nam. Viet Nam has developed a collaboration-based approach to electrify remote rural areas. The task of planning and promoting mini-grid rural electrification is assigned to local governments, which are requested to support the project developers to conduct site surveys and prepare proposals for target communities. Provincial governments are entitled to approve the proposals unless a grant and/or national budget support are needed, in which case the proposals will be passed to the central government for appraisal and approval (ACE, 2012).

In addition to those common challenges presented before, ASEAN countries still face many specific challenges. First, most ASEAN countries only have general policies and plans regarding off-grid electrification instead of specific policy frameworks (ACE, 2013). Second, existing technologies may also be insufficient to settle problems due to

[8] PESCOs are local private companies and key implementers who are responsible for the off-grid systems.

ASEAN's geological and/or weather features. For instance, mountainous terrain can result in higher costs for infrastructure; and seasonal resource fluctuations – wind speed and river flows – may bring more technological challenges. Third, there is a lack of local expertise to guarantee long-term sustainability of these projects in remote rural areas in ASEAN countries. Fourth, several ASEAN countries are still economically less developed and have limited budgets.

However, the efforts of governments are not enough to electrify the rural areas. In the Philippines case, only modest investments were attracted from the private sector (Pacudan, 2005). Policies specifically designed for OGRE projects are needed. Even though OGRE projects could be more economically reasonable and attractive than centralised grid extension to remote areas, they usually have high upfront costs (compared with the limited financial resources in less developed countries, in particular their rural communities). Building sustainable financing mechanisms can be challenging. More effective and flexible financial tools need to be in place to address the challenges to build sustainable financing mechanisms.

5.2 Implications for ASEAN policies

ASEAN could use those top scoring instruments despite the limit of public finances in those countries that need electrification. PPP, if applied in the case of mini-grid projects, can offset the weakness of public finance while increasing efficiency. Although those ASEAN countries that need electrification often have weak fiscal capacity, the utilisation of tax concessions and exemptions will not comprise current tax revenues because without the projects, there would be no such revenue. Similarly, loan guarantees that are effective in promoting OGRE finance cost governments nothing.

In the process of PPP, clear prioritisation between social and commercial objectives of OGRE projects should be provided. While governments can fulfil social objectives of rural electrification through commercially viable entities aided by various support instruments, the conflict of interests within the entity could comprise the government's intention. However, as the case of Lao PDR, the entity could separate its

social functions, or at least unbundle to various costs centres to minimise the conflicts (Bambawale et al., 2011).

Other effective policies, such as end-user subsidies, end-user financing and/or/ microfinance and/or/ consumer credits, grants, and subsidies, all need the use of public finance. Their application will depend on each country's specific conditions and may be limited due to limited public financial resources. However, the ASEAN countries could collaborate and cooperate with outside players, including international development financial agencies, donor agencies, NGOs, and technical experts, in order to expand access to finance and improve project management.

In addition to those supporting instruments, some other relative policies are also noteworthy. Governments should carefully protect the legal interests of the private sector that have contributed to the sustainable and replicable development of OGRE projects. For example, there needs to be an awareness of the shortcomings of the principle of affordable and accessible financing in OGRE project development. (Bambawale et al., 2011). In the case of off-grid electrification in Lao PDR undertaken in the form of solar home systems (SHS) (Rural Electrification Project Phase I), as the tariff was fixed and the PESCOs were not able to freely set the lease terms of SHS, their operation was limited. The percentage of the tariffs retained by some PESCOs was not enough to sustain their operations. While subsidies can facilitate electrification, the negative impact on the private sector that contributes to the electrification should be carefully managed. For example, Sunlabob, a private company that rents solar systems to rural households, was made uncompetitive by the Rural Electrification Project, which rents out systems at less than half of the Sunlabob's rentals. An unclear grid extension plan would add significant uncertainties and risks to OGRE projects and deter investment. The Mae Kum Pong 1 and 2 Projects in Chiangmai Province in largely used the free electricity from the state grid. Fortunately, there is no dispute from the private sector in this case, as the small hydro project is also owned by the state utility company. Grid extensions should be predictable, and if unexpected changes happen, the private investors should be properly compensated.

Information technology tools for remote fee collection and for metering, monitoring, and regulating consumption such as smart metres, prepaid systems, and mobile commerce, could be integrated into business models to address the high operational costs that are often incurred during metering and fee collection activities (IRENA, 2012b). In recent years, micro-grid developers in India are turning to advanced pre-paid metres to solve problems of customer over-use and poor tariff collection, this method can also improve the sustainability of the micro-grid system (Buevich et al., 2014). An acceptable and robust fee collecting system is crucial for the long-term sustainability of the projects.

Local community engagement in operation and maintenance is another support that ASEAN governments can introduce due to low, if not zero, cost characteristics. Local communities often make decisions by consensus within themselves, some of them may try to block development plans, because they cannot foresee the benefits of electricity access, as mentioned above. Even though they are supportive, they may not have the technical resources to sustain the projects, while it is cost prohibitive to outsource maintenance. Local communities could get involved not only in low-level functional roles, such as technical operating and monitoring activities, but also in the high-level decision-making processes before and during the operation of OGRE projects. It is critical that the local communities' actual and potential needs must be understood before a project starts, as they play a crucial role in supporting construction, operation, and maintenance of projects. For instance, Lao PDR has introduced community selection criteria to select suitable villages for mini-grid rural electrification. It is requested that at the initial stage, the project developer should visit the village and explain the technical features, the applications, and the payment schemes to the villagers before potential customers are listed. If the potential customers that are able to pay for the project are less than 50% of total households, then the village will be regarded as unsuitable for mini-grid electrification (REMP, 2010).

Capacity building, training, and setting-up of local service networks are fundamental conditions to guarantee long-term success and sustainable development of OGRE projects. Capacity building should be carried out to cover all the stakeholders:

public institutions, financing agencies, communities, and the private sector, among others (IRENA, 2012b). It should be kept in mind that as cultural and socioeconomic conditions vary among different local communities, it is important to ensure that any RE off-grid expansion does not destroy the cultural and socioeconomic circumstances.

6. Conclusion

OGRE projects play a critical role in giving people access to electricity. However, the challenges are enormous. Financing such OGRE projects is one of the most significant challenges due to barriers such as lack of access to finance, low affordability by consumers, and high transactions costs. However, the benefits of access to electricity are beyond financial calculation, including human development, improvement of life quality, generation of additional productive activities, access to information, and education.

Mindset has to be shifted away from grant-based approaches to more sustainable frameworks. For this purpose, various supporting instruments have been implemented to facilitating OGRE investment. Those supporting instruments, however, may have different impacts on the projects when assessed from different perspectives. For individual countries, which instruments should be adopted is still a challenging question for policymakers. Quantifying the effectiveness of those policy instruments could improve policy decisions in the future since policymakers will have information on each instrument and thus could select those that best meet their needs to make OGRE development successful.

This study assesses the effectiveness of those instruments from various perspectives and provides references for further policymaking. This chapter proposed a three dimensional framework to assess the effectiveness of supporting instruments. Those three dimensions are feasibility, sustainability, and replicability. Each of these three dimensions reflect some particular aspect of a project. The supporting instruments that have been recorded in the literature are tabulated for assessment.

The weights of each dimension and the scores for each instrument were quantified by experts. All the tabulated instruments are assessed to be at least modestly effective. The top seven scored instruments have little difference in their effective level. As expected, the rank of effectiveness among the overall weighted score and the dimensional scores are different, but the level of difference is not significant.

Although we have aggregated a single score from the three dimensional score, this, does not mean that the overall score is superior to the dimensional score. As policymakers often have different priorities, their preferences could be different and thus their choice of instruments would be decided case by case.

Based on a study of the literature and findings of the survey, policy implications for ASEAN policymakers were drawn. ASEAN should set priorities among various goals including social development and commercial development, balance affordable and accessible energy, engage local communities, and conduct capacity building during the process of OGRE development. It should also be kept in mind that OGRE development is often dealing with poor people from remote and rural areas. Therefore, it is critically important to identify efficient and effective support instruments. In this research, we find that the instruments with the five highest scores include PPPs, loan guarantees, FITs and/or FIPs, start-up grants, and PPAs. While for small-scale off-grid systems, such as those used for individual houses or small villages only, PPPs, FITs and/or FIPs, and PPAs may not be applicable. Start-up grants and loan guarantees are more helpful because they can smooth the establishment process by reducing upfront costs and support sustainability by reducing operational costs.

While the focus on the current study is on supporting instruments, it, however, does not undermine the role of other factors in promoting successful OGRE projects. Policy and regulatory barriers could hamper off-grid development. Corruption, political lobbying by more powerful energy companies, or even a lack of understanding on off-grid systems among policymakers could damage off-grid development. Low salaries will lead to high turnover of technical operators, and the quality of the operation will be reduced to a lower level that cannot meet the requirements of the operating needs. It is also very important that the process of OGRE development not be left to one or two

parties alone, such as the government or energy companies. It should involve all the players, including governments, companies, public institutions, local communities, and NGOs. All the players shall cooperate to address barriers to OGRE project development. Only by this, can local economies be strengthened and communities be empowered along with OGRE project development.

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Appendix: Description summary of survey results

Table A1: Classification of Affiliations

Answer Options	Response (%)	Response (Count)
Private company (renewable energy related)	7.0	5
Government institution	4.2	3
International organisation (including Asian Development Bank)	2.8	2
Social enterprise	2.8	2
Nongovernment organisation	7.0	5
Academia/research institution	76.1	54
Answered question		71

Table A2: Basic Statistics of Scores of Instrument Assessment – Feasibility Dimension

Instruments	Minimum	Maximum	Median	Mean	Standard Deviation
Start-up grants					
	1	4	2	1.69	0.7
Capital subsidies					
	1	4	2	2.03	0.8
Import duty exemptions for equipment	1	4	2	2.42	0.85
Crowdfunding	1	5	3	2.68	0.95
Feed-in tariffs/premiums	1	5	2	1.86	0.79
Power purchase agreements	1	5	2	2.03	0.98
Grants/subsidies to cover operation and maintenance costs	1	5	2	1.89	0.94
Subsidies to cover operation and maintenance costs	2	3	2	2.2	0.4
Accelerated depreciation	1	4	2	2.27	0.73
Tax concessions and exemptions	1	4	2	2	0.8
Local engagement in operation and maintenance	1	4	2	1.96	0.74

Public–private partnerships	1	3	2	1.8	0.7
Loan guarantees	1	4	2	1.92	0.73
Concessional finance	1	4	2	2.11	0.8
End-user subsidies	1	4	2	1.77	0.79
End-user financing/microfinance/consumer credit	1	4	2	2.03	0.71
Leasing	1	4	2	2.3	0.7
Revolving funds	1	4	2	2.18	0.68
Tiered electricity tariffs	1	5	2	2.2	0.9

Note: The scores of 'feasibility' dimensions are taken as an example to show the variation of assessment, given the space constraints, other data could be provided upon request.
Source: Compiled by the authors based on survey.