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Assessment of instruments in facilitating investment in off-grid renewable energy projects

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HIGHLIGHTS

- Assess the effectiveness of instruments for promoting financing for OGRE projects.
- A three-dimension assessment framework: feasibility, sustainability, replicability.
- Use online surveys and the Delphi method to collect experts' assessment.
- The most effective instruments: local engagement, loan guarantee, and start-up grant.

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ABSTRACT

Renewable off-grid solution plays a critical role in supporting rural electrification. However, off-grid Renewable Energy (OGRE) project financing faces significant challenges due to limited financing access, low affordability of consumers, high transactions costs and etc. Various supporting instruments have been implemented to facilitate OGRE investment. This study assesses the effectiveness of those instruments with a framework consists of three dimensions: feasibility, sustainability and replicability. The weights of each dimension in the framework and the scores of each instrument are assessed by expert surveys based on the Delphi method. It is suggested that all the three dimensions should be taken into consideration while assessing the instruments, among which feasibility and sustainability are considered as the most important dimensions in the assessment framework. Furthermore, the top-5 most effective instruments in facilitating OGRE investment are local engagement in operation and maintenance, loan guarantee, start-up grant, end user financing, and concessional finance. Developing countries that need to increase electrification, such as most of the ASEAN member states, could use these top scored instruments despite of their limited amount of public finance.

1. Introduction

Access to electricity, not only for meeting basic needs, but also for productive uses, is a significant challenge faced by policy-makers and stakeholders in the developing world. According to the IEA, 18% of the world's population—1.3 billion people— still do not have access to electricity; of these, nearly 97% of them live in sub-Saharan Africa and developing Asia, and 80% of them live in rural areas (IEA, 2014).

Both mini-grid and standalone electricity supply (hereafter off-grid[1]) systems can be implemented together with on-grid solutions to provide universal access to energy (IEA, 2013). In many remote un-electrified areas, grid extension is not a suitable solution due to its high capital cost of transmission infrastructure, as well as high transmission losses and maintenance costs (Zhang and Kumar, 2011). Byrne et al. (2007) reported that the estimated cost of electricity per kWh from solar–wind hybrid systems in China ranged from US$0.26 to US$0.89, while the unsubsidized cost of electricity from central power grid was roughly US$3.32 per kW h. In many cases, mini-grids could provide an ideal intermediary or even long-term solution when the central grid is absent, especially for small towns or large villages where enough electricity can be generated to power households and local businesses (Rolland, 2011). It is estimated that by 2030, nearly 60% of additional power generation capacity for universal electricity access will come from off-grid installations (IRENA, 2012b).

Off-grid RE (OGRE) generation technologies, such as solar, small

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[1] In this paper, off-grid systems include both standalone systems and mini-grids.

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hydro, geothermal, and wind power, are more reliable and cost-competitive compared to fossil fuel-based generation systems in rural and remote areas. Therefore, they are more likely to be implemented in off-grid electrification systems. Rolland (2011) showed that a well-maintained and managed hybrid system which uses both RE and diesel can run for over 25 years, thus it is more attractive than a diesel-fueled mini-grid.

IRENA (2012b) observes that the falling costs and increasing technology maturity have made RE the most appropriate option for mini-grids for most rural areas. OGRE also avoids the environmental issues related with grid extension by efficiently utilizing clean resources such as solar and wind energy (Deshmukh et al., 2013). RE stand-alone systems (e.g. Solar Home Systems, SHS) may be more expensive than kerosene lighting on a life-cycle basis, but can avoid the pollution issues caused by using kerosene.

However, rural electrification and OGRE projects face challenging financial obstacles which cannot be addressed by current market mechanisms such as high initial costs, limited local financial resources and low return rates. Furthermore, low-income residents in remote and rural areas may not be able to afford electricity fees (World Bank, 2008), they may also fail to understand or respect the financing agreements and financing schemes that have been established, leading high potential risks to investors (Gboney, 2009). Investors can hardly enjoy the additional benefits that electrification brings to local communities, e.g. improvement of living and education conditions. In addition, local communities may underestimate these benefits before electrification is realized, thus have less willingness to pay for electrification services (IRENA, 2012b). More importantly, rural electrification often faces a poverty–affordability deadlock that cannot be tackled without external interventions. Therefore, OGRE projects can hardly be attractive to private investors, and the exiting lending terms set by lenders (or funders) are often unsuitable for OGRE projects.

Policy intervention and government support are necessary for further development of OGRE projects. Deshmukh et al. (2013) proved that well-designed policies, appropriate institutional arrangements and effective financing mechanisms can address many of these challenges, and establish and sustain the OGRE projects. However, it is challenging for policymakers in developing countries to choose appropriate policy instruments to support OGRE projects and rural electrification.

To the best of the authors' knowledge, there is to date no study that provides quantitative assessment on the effectiveness of support instruments in facilitating OGRE investment. Evaluation of policy effectiveness in existing literature mainly focuses on developed countries—in particular, the EU's assessment of financial instruments (European Commission, 2014) is a salient example. However, these methods may not be applicable to off-grid and renewable energy sector, or to developing countries due to limited data, knowledge and skills. Other research which conducts qualitative analysis on policy effectiveness (Agnolucci, 2007; Dijk et al., 2003) often highly relies on the research team's judgment. Furthermore, evaluation of RE policies studies seldom addresses the potential differences over time and in different regions.

Major work of evaluating RE policies were recently published by IRENA (2012a, 2014), in which the assessment framework focused on effectiveness, efficiency, equity and institutional feasibility. This study was conducted on a macro level consisting of performance-based assessment, yet without considering how individual RE projects were developed and financed. More assessment on RE policy instruments are qualitative and not comparable (IRENA, 2012b). The difficulty of selecting and assessing policy instruments for the purpose of financing OGRE projects in developing countries suggests the importance of more thorough and quantitative research.

This paper uses both qualitative and quantitative methods to review the prevailing supporting instruments that have been used globally to facilitate OGRE investment. It assesses the performance of these instruments within a dedicated framework, and analyses their applicability under various circumstances. The objective of this study is to inform policymakers of the following information: 1) which instruments could be used to facilitate the development of OGRE projects; 2) what are the pros and cons of each instrument against the three different policy purposes–feasibility, sustainability and replicability; and 3) how likely the instruments can be replicated in projects located in different countries/regions. Ultimately, this study aims to help governments formulate their policies to develop OGRE projects, for the purpose of improving energy access in different national, regional and even community contexts.

The contribution of this study will also include: 1) propose a holistic assessment framework of policy instruments, considering not only feasibility, but also time dimension (sustainable) and geographical dimension (replicable) at project level; 2) reveal weights of each dimension to generate integrated index for evaluating policy instruments; 3) focus on the OGRE projects in the context of less developed countries to provide them practical indices; 4) collect and review a large number of instruments worldwide to provide comprehensive and representative results; and 5) compare the assessment results among instruments based on the consist framework and quantitative results. The focus on the level of projects, in particular, on OGRE projects, is different from any other studies in the literature.

In particular, the results of this study can provide immediate value to energy policy decisions in many developing countries. For example, 23% of the ASEAN region's total population—about 140 million people—had no access to electricity as of 2012. Cambodia and Myanmar have the lowest rural electrification ratio. Indonesia has the highest population without access to electricity, and 103 million Indonesian people still rely on traditional biomass for cooking. Furthermore, there are close to 50 million people in Myanmar, the Philippines and Vietnam without electricity access (ASEAN Secretariat, 2014; IEA, 2014). Given the fact that more than one-fifth of ASEAN population still has no access to electricity, and many of them have relative abundant RE resources, facilitating OGRE project investment would be real policy issues.

The present paper is organized as follows. The prevailing instruments for facilitating OGRE project investment in both practice and literature are reviewed in Section 2; the methodology and data are discussed in Section 3; results of the survey are summarized and explained in Section 4; and discussions and policy implications are further elaborated in Section 5.

2. Key support instruments in financing OGRE projects

In order to address the investment barriers faced by OGRE projects, various “support instruments” have been widely adopted worldwide. This study aims to build up an assessment framework, by first selecting the most prevailing instruments, and further through a general literature survey covering both theoretical analysis and practical case studies. The review of these policy instruments is conducted based on academic papers published in journals, and research reports issued by international organizations such as IRENA, European Investment Bank, Asian Development Bank and so on.

Support instruments that are examined include financial incentives (e.g. start-up grant, loan guarantee), fiscal incentives (e.g. exemption of import duty, value added tax), and elimination of market distortions (e.g. reducing fossil fuel subsidies) (IRENA, 2012a). Government grants are often used because the costs of RE

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