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FINANCING OF ENERGY EFFICIENCY IN PUBLIC GOODS: THE CASE OF STREET LIGHTING SYSTEMS IN INDONESIA

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Abstract

Energy demand growth in Southeast Asian countries is predicted to be the highest in the world, with Indonesia having the highest urbanization rate. Along with growing urban areas, public infrastructures, such as streetlights, are also expanding. Unfortunately, energy conservation measures in public facilities are commonly constrained by the budget limitations of local governments, while the potential participation of an ESCO requires regulation reformation to settle the contradicting regulations. This study proposes several policy recommendations to modify existing guidelines for selecting ESCOs to manage energy efficiency of streetlights in Indonesia. A regulation review and several suggestions for potential improvements for selecting ESCOs are provided. In 2017, the Ministry of Domestic Affairs released a circular letter with a view to solving barriers to ESCO businesses in public sectors; however, the circular letter could be improved in several ways by eliminating the clauses on holders of intellectual property rights, revising the valuation of economic benefit bidding, and increasing the maximum contract period. Moreover, we propose the use of smart streetlighting technologies to improve the value-added services of streetlights and the establishment of a Super ESCO to accelerate ESCO business activity in all economic sectors.

Keywords: energy conservation, public–private partnership, energy service company, Super ESCO

JEL Classification: G18, H54, H57, H70, L94, Q48

Contents

1. INTRODUCTION

The global energy demand is expected to increase by one-third from now until 2040 (IEA 2017). Countries from the OECD will only contribute to 4% of this growth. Of the remainder, the largest share will come from the emerging economies of Asia. In the 2020s, the emphasis will shift to India and then the countries of Southeast Asia as the key drivers of demand growth, while the pace of Chinese energy demand growth slows (Liu, Park, and Zhong 2020). Among developing countries in Asia, Indonesia has the highest urbanization rate, which is the main factor escalating electricity consumption in the country (Al Irsyad, Halog, and Nepal 2018; WB 2016b). An urban area is linked to numerous home appliances and public amenity availability, including streetlights. As an integral component of city development, streetlights support economic activities in the evening, improve road safety, reduce crime, and improve the city aesthetic; consequently, energy consumed by streetlights grows with development, increasing from 3 terawatt-hours (TWh) to 3.6 TWh from 2010 to 2018 (PLN 2011, 2018).

Indonesia has the potential to reduce energy consumption by streetlights by 2.1 TWh per year, or by more than half of their existing consumption (Al Irsyad and Nepal 2016); however, most local governments have a limited budget and knowledge of energy efficiency. Cooperation with an energy service company (ESCO) is considered to be a solution and several ESCOs have an interest in energy conservation in streetlighting systems. An ESCO provides a broad range of energy efficiency measures or services, mostly under Energy Performance Contracting (EPC) – a financing technique that repays the cost of energy efficiency projects through the cost savings they produce. The global ESCO value in terms of EPC revenue expanded to nearly USD30 billion in 2017, with the People's Republic of China (PRC) (60%), the US (20%), and Europe (10%) representing the three main ESCO markets. Over one million people are now employed by ESCOs around the world.

In Indonesia, several local governments have experienced legal issues when using ESCO schemes, especially the shared-savings scheme. The problems related to a cost-saving share formula for the ESCO and a perception that presumes the cost-saving share is a loan, which is prohibited for the municipalities. The Ministry of Domestic Affairs (MDA) released a circular letter in 2017 regulating the cooperation between local governments and ESCOs in regard to energy efficiency (MDA 2017). The letter has regulated the main issues of the selection process and gives instructions to pay ESCOs for energy efficiency services and not for energy efficiency investments. Despite this change, there remains room for regulation improvement since the existing regulation is ineffective and may lead to a monopoly in the energy efficiency market for streetlighting. This study aims to review and improve the existing ESCO scheme for public utilities to maximize benefits for local governments as well as to expand ESCO business in countries that still struggle with financing energy efficiency.

This study is structured as follows. Section 2 reviews global challenges for financing energy efficiency while Section 3 examines a policy in Indonesia for financing energy efficiency in public utilities. Section 4 discusses an ESCO case study in Indonesia and Section 5 presents policy recommendations. Section 6 concludes this study.

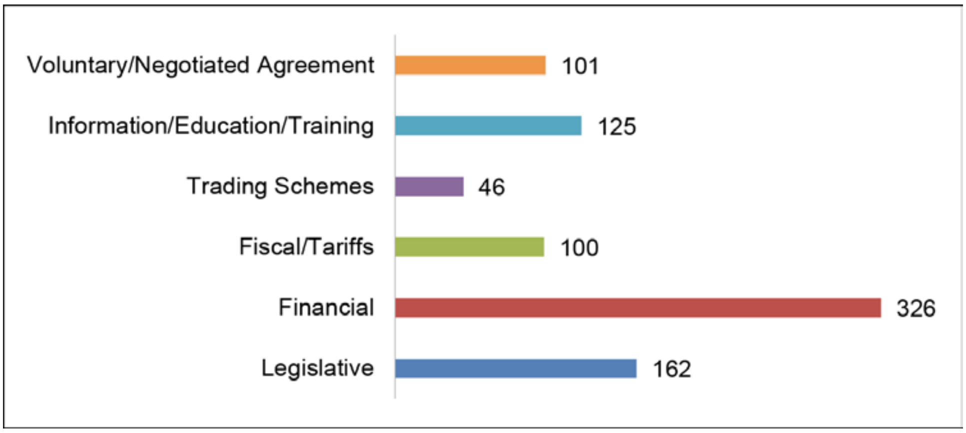
2. REVIEW OF GLOBAL INSTRUMENTS FOR ENERGY EFFICIENCY

The main database used for analysis is the Mesures d'Utilisation Rationnelle de l'Energie (MURE) database, which includes policy measures on energy efficiency (ISINNOVA 2020), as well as the International Energy Agency (IEA) policies and measures database (IEA 2020). These two databases have arguably the most comprehensive and updated collection of renewable energy and energy efficiency policies and measures across the world. In order to get an overview across the world, we integrated the policy measures from both the IEA and MURE databases.

The number of policy measures administered in the industrial sector is significantly smaller than in the buildings sector (about a third fewer). Overall, policy measures used in the industrial sector focus on more complex and capital-intensive technologies than those of other sectors. This corresponds to the fact that the industrial sector is inherently more complex regarding energy efficiency improvements, both in terms of the number of potential measures and the complexity of the technology itself. Many energy efficiency improvements cater to a particular subsector and cannot be standardized easily, as is the case in the buildings sector.

As of June 2019, the MURE and IEA databases contained a total of 860 industry measures, out of which 623 were in operation; the others (237) were either not active any more or were being planned out. Across the world, as shown in Figure 1, 326 financial measures (37.9%) form the core of the policy mix for the industrial sector, followed by legislative measures (162 or 18.8%) and information/education/training (125 – 14.5%). Voluntary/negotiated agreements (101 – 11.7%), fiscal/tariffs (100 – 11.6%), and trading schemes (46 – 5.3%) are implemented less often in the industrial sector.

Figure 1: Number of Energy Efficiency Policy Measures by Type (Across the World)



Compared to energy efficiency in the industrial sector, financing energy efficiency in the public sector is a challenge for both developed and developing countries due to the budget limitations of local governments. Even in developed countries like the US, Wang, Liu, and Hawkins (2017) found that the majority of US cities did not have energy efficiency financing (EEF) measures, while cities implementing EEF measures still lacked energy efficiency investments. These findings result from the high investment cost and benefit uncertainty, and a long return on investment (Du Can et al. 2014).

One solution is the involvement of technical expertise and professional companies, such as ESCOs, since this increases the confidence of citizens and local governments to implement energy efficiency measures (Wang, Liu, and Hawkins 2017). Appointing ESCOs through a bidding process is categorized as a market-based instrument (MBI) for energy efficiency (Rosenow, Cowart, and Thomas 2019). The aim of the bidding process is to obtain competitive tenders among ESCOs to provide either the lowest bid or the highest energy savings.

An ESCO works by using an EPC so the payment to the ESCO will be adjusted according to the achievement of energy-saving targets. In general, there are two types of EPC: guaranteed savings and shared savings; these are compared in Table 1 (Larsen, Goldman, and Satchwell 2012; Pätäri and Sinkkonen 2014; Sarkar and Singh 2010; Shang et al. 2017). In a guaranteed-savings contract, the ESCO acts as a contractor of an energy efficiency project, while the municipality will provide the investment costs. The ESCO will ensure the achievement of energy-saving targets; otherwise, the ESCO will receive a penalty, such as a payment reduction. In a shared-savings contract, the ESCO is responsible for investment and maintenance costs; consequently, the benefits of electricity bill savings will be shared between the ESCO and the municipality, with the share and period agreed beforehand. Both ESCO types have some common features, such as using a performance-based contract so the ESCO takes all the investment and technical risks. The period of the contract is determined by the municipality or road administrator as the project owner. Both municipality and ESCO have nontechnical risks, such as rejection from the state-owned electricity company (PLN) who want to keep their higher electricity tariff for unmetered streetlights in Indonesia (Al Irsyad and Nepal 2016).

Table 1: Comparison of the Two Types of EPC when Using an ESCO

Parameter	Shared Savings	Guaranteed Savings
Investor	ESCO	Municipality/road administrators
Investment risk taker	ESCO	ESCO
Technical risk taker	ESCO	ESCO
Nontechnical risk taker	ESCO and municipality/road administrators	ESCO and municipality/road administrators
Investment returns	Performance-based contract	Performance-based contract
The value of benefit sharing	ESCOs have a higher share than that of a guaranteed-savings contract	ESCOs have a lower share than that of a shared-savings contract
Contract period	Determined by municipality/road administrators	Determined by municipality/road administrators
Feasibility study	Funded by the ESCO or municipality/road administrators	Funded by the ESCO or municipality/road administrators

Sources: Larsen, Goldman, Satchwell (2012); Pätäri and Sinkkonen (2014); Sarkar and Singh (2010); Shang, Zhang, Liu, and Chen (2017).

EPC simultaneously helps companies to finance investments, through future energy savings, and to bear the financial, technical, and performance risk (E3P 2020). EPCs have been implemented in over 50 jurisdictions, including Brazil, the PRC, India, the Republic of Korea, and South Africa (WB 2016a). Developed and developing countries have different preferences when selecting the ESCO contract type. Developed countries mostly use the guaranteed-savings contract because it has lower transaction costs. In this case, the ESCO does not have to pay loan interest for financing the investment and therefore draws lower financing risks. In contrast, ESCO projects in developing countries mostly rely on a shared-savings contract since most developing countries have limited budgets and lack access to financing assistance.

The ESCO market remains undeveloped in many countries due to at least three main barriers. The first barrier is that the majority of ESCOs are not creditworthy enough to pursue the project pipeline (Larsen et al. 2017). Financing limitations are common among ESCOs and, at the same time, obtaining external funding encounters the problems of low awareness and motivation on the part of financial institutions, a lack of trust by stakeholders, and a lack of successful project experience (Bertoldi and Boza-Kiss 2017). An on-off financial subsidy from the government only worsens the market since an ESCO will only run the business if the subsidy exists, but the subsidy will also attract inexperienced and undedicated ESCOs, creating a poor image of ESCO credibility (Kangas, Lazareva, and Kivimaa 2018). Secondly, a lack of technical capability on the part of ESCO and EPC firms is a common barrier. Capability is categorized into basic capability (i.e., identify, prepare, and procure technology), production capability (e.g., quality control, operation, and maintenance), improvement capability (e.g., adaptation and modification), innovation capability (e.g., research, design, and development), and linkage capability (e.g., transfer of knowledge, skill, and technology) (Qiu 2018). Poor capability may occur in all process stages, from the planning stage to the monitoring and verification stage (Bertoldi and Boza-Kiss 2017; Kangas, Lazareva, and Kivimaa 2018). A failed ESCO project will have severe consequences in terms of public trust and, thereafter, ESCO markets (Bertoldi and Boza-Kiss 2017). Thirdly, uncertainty of earnings due to fluctuations in energy prices or electricity tariffs causes ESCOs to walk away from projects. Using a fixed energy price as the basis for savings calculations may hedge the price uncertainty with the consequence of a lower profit if there are higher energy prices in the future (Larsen et al., 2017; Stevens et al., 2019).

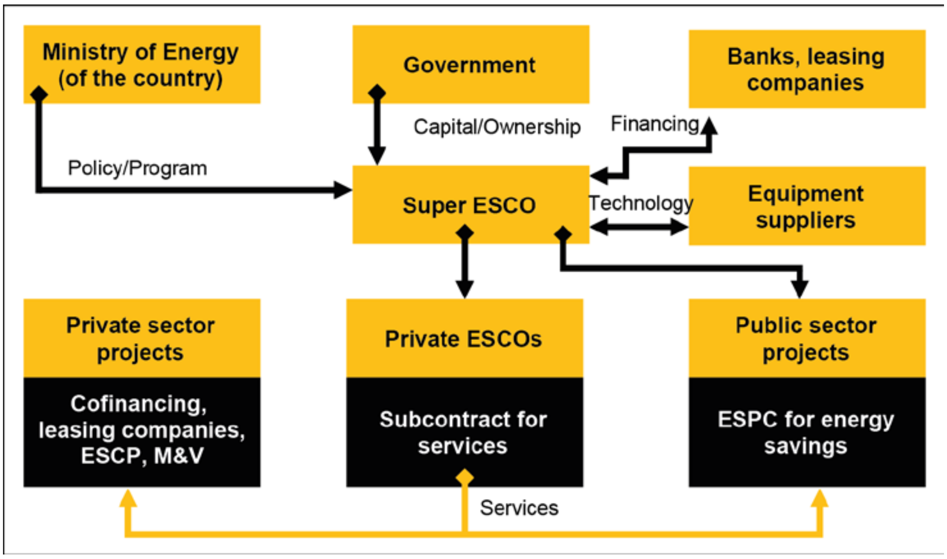
Other EEF measures are continuously being developed globally. In developing countries, among the five EEF measures implemented in Malaysia, the rebate program is suggested to be the most cost-effective (Hor and Rahmat 2018). Nevertheless, the rebate program could be improved by implementing on-bill financing (OBF), argued to be a more effective and efficient measure for a monopoly electricity market (Hor and Rahmat 2018). However, OBF is not suitable for Indonesia. PLN monopolizes the electricity retail market in Indonesia and could act as a Super ESCO that simultaneously provides electricity and energy conservation services. In this case, energy conservation service charges are included in electricity bills, although this will contradict PLN's main business interests, which are geared towards maximizing investment returns from PLN's existing power plants.

In this paper, we define a "Super ESCO" as an organization established by the government to implement energy efficiency projects in the public sector (e.g., hospitals, schools, municipalities, and public facilities) but also, simultaneously, to promote the development and growth of ESCOs in the private sector through capacity building, project development, facilitation, or financing, as well as creating new ESCOs (Limaye and Limaye 2011). As shown in Figure 2, the government capitalizes Super ESCOs with sufficient funds to undertake energy performance contracting in the public sector, as well as to leverage on commercial financing. As our priority is to build up the technical and financial capacity of ESCOs and to grow the ESCO industry in Indonesia, neither a large ESCO nor a public ESCO is sufficient for meeting these requirements.

Most of the current Super ESCO models are designed to undertake public sector energy efficiency projects, such as public building, public streetlighting, etc., to overcome the difficulties that traditional ESCOs face in working with the public sector (e.g., limited incentives for the public sector to lower energy costs, and complex and strict budgeting and procurement procedures). The main roles of Super ESCOs are twofold: being an ESCO for the public sector and being an enabling partner for private ESCOs. A Super ESCO can work directly with the public sector and industries to fill the gap in the following areas:

- performing data analysis and benchmarking;
- identifying energy-saving opportunities;
- designing technical solutions and specifications, ranging from simple equipment replacement to industrial energy management;
- aggregating the demand for energy efficiency measures, entering into shared- or guaranteed-savings contracts through a pay-as-you-save approach with end-users;
- conducting joint or independent M&V of energy savings;
- recovering investments from end users' monetized energy savings;
- Operating and maintaining equipment and processes in the contract period as agreed with the end users.

Figure 2: An Illustrative Model of a Super ESCO



Source: Sarkar and Moin (2018).

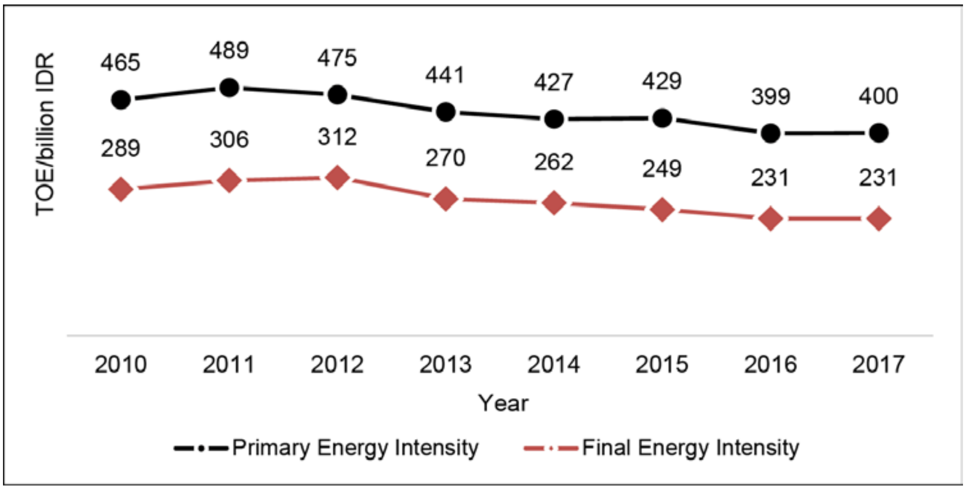
A Super ESCO will also help create an enabling environment for private ESCOs with the following measures:

- accrediting domestic ESCOs and the energy management profession;
- engaging private ESCOs as key delivery partners;
- arranging access to financing and risk-sharing facilities;
- demonstrating the viability of ESCO business models and helping end users become more familiar with ESCOs;
- standardizing technical specifications and transaction templates and tools to reduce the perceived risk of working with ESCOs;
- raising consumer awareness of energy efficiency and enabling market demand for energy management.

3. POLICY CHALLENGES IN INDONESIA

The Indonesian government has mandated energy efficiency measures in all sectors through Law 30/2007 on Energy (GOI 2007). Moreover, Government Regulation 70/2009 on Energy Conservation obligates energy users consuming 6,000 tonnes of oil equivalent (TOE)/year to conduct energy management and report its results (GOI 2009). These regulations and other forcing factors, such as energy price increases, have decreased energy intensity, as shown in Figure 3. Final energy intensity decreased, on average, by 2.8% per year from 2010 to 2017, exceeding the target of 1% per year (GOI 2014); as a result, Indonesia is ranked as having the third-lowest energy intensity among ASEAN members (Fitriyanto and Iskandar 2019).

Figure 3: Energy Intensity in 2010 to 2017

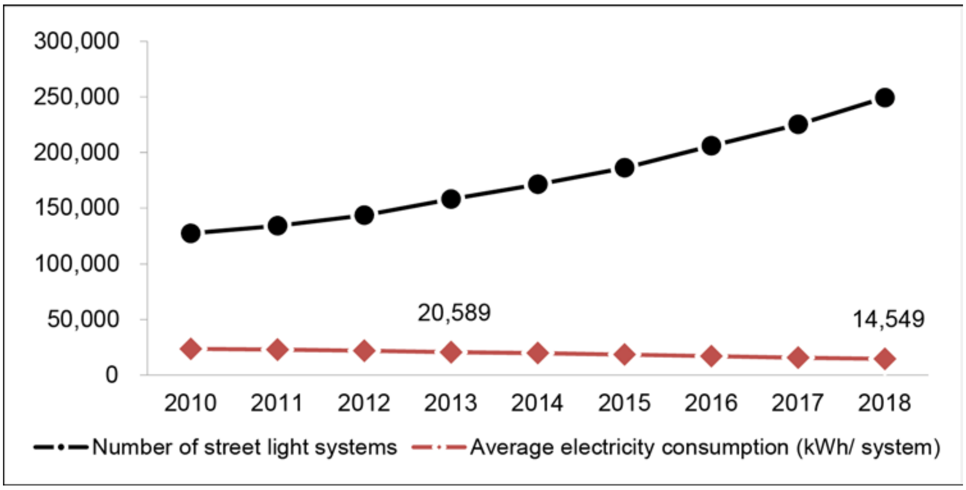


Source: DEC (2018).

Significant and massive energy efficiency measures started in the public sector between 2012 and 2014 when the Ministry of Energy and Mineral Resources (MEMR) conducted an energy audit on streetlight systems in nine municipalities and deployed pilot projects of high-efficiency streetlights in seven cities (Ahadi, Al Irsyad, and Anggono 2018; Al Irsyad and Nepal 2016; Berlian et al. 2014). One of the measures is to use white-colored light-emitting diode (LED) lamps, whose reliability in foggy conditions is doubted. Replacing high-pressure sodium (HPS) lamps with LED lamps potentially reduces energy consumption by 50% (Ahadi, Al Irsyad, and Anggono 2018). Successful pilot projects were then adapted to other municipalities, so the average electricity consumption of a streetlight system reduced from 20,589 kWh/year to 14,549 kWh/year, as shown in Figure 4.

ESCOs are considered to be an effective measure for accelerating energy efficiency in streetlights. The Ministry of Domestic Affairs (MDA) released a circular letter regarding an energy efficiency partnership to support the ESCO scheme for energy conservation in public sectors (MDA 2017). The letter aims to resolve the allegation by the Supreme Audit Agency, or Badan Pemeriksa Keuangan (BPK), who views the payment of shared savings as an installment of a loan for energy efficiency investments while the local government is prohibited from having a loan from a private company (Al Irsyad and Nepal 2016). Similar problems have hampered EU countries (Bertoldi and Boza-Kiss 2017). In addition, BPK questioned the ESCO selection process and the calculation of the percentage of savings shared between the ESCO and the local government. The problems were caused by the lack of ESCO regulations in the public sector. Regulation of public–private partnerships (PPPs) is available but is designed for infrastructure projects generating revenues and not for reducing costs in public services.

Figure 4: Number of Streetlight Systems and Average Electricity Consumption
(PLN 2019)



The circular letter is basically a modification of the PPP regulation. The purposes of the letter were to ensure energy efficiency sustainability and to optimize the value added to the local government budget by implementing a performance-based budget. Local governments could then cooperate with an individual or a company holding intellectual property rights on energy efficiency. The process of cooperation is shown in Table 2. First, an ESCO submits a proposal offering energy conservation services to the local government. The government must respond to the proposal within 30 days. Once the local government agrees with the proposal, both parties sign a letter of intent (LOI) and a memorandum of understanding (MOU).

Table 2: Flowchart of the Cooperation Process of an ESCO with the Public Sector

No.	Activities	ESCO	Municipality	Due Days
1	Proposal submission			
2	Letter of intent (LOI) and memorandum of understanding			30
3	Identification and analysis of energy efficiency potentials			90
4	Procurement process of ESCO services			30
5	Contract signatory			30
6	Budget preparation			
7	Designs and constructions			365
8	Performance evaluation			90
9	Payment of ESCO services			*

* Up to 3 years.

In the next stage, the ESCO conducts an energy audit to analyze energy efficiency potential and reports the results within 90 days after the signing of the LOI and MOU. The local government uses the report as a basis for making the term of reference (TOR) for ESCO procurement. The process of procuring ESCO services should be completed within 30 days. The local government can directly select the ESCO if only one ESCO applies; otherwise, previous experience in another three municipalities, higher economic benefits, and the proposal's originality should be taken into consideration in the selection process. The Energy Saving Performance Contract (ESPC) should be signed within 30 days after the procurement process ends. The maximum term of the ESPC is three years.

Following the signing of the ESPC, the local government should prepare the budget for ESCO services. The budget is allocated from energy cost savings and additional funds required to pay all energy efficiency service costs within three years, which is the maximum payment period. The circular letter emphasizes that the budget is not for paying the energy efficiency investment but rather the energy efficiency services. The directive is to underline that the payment is not an energy efficiency investment loan installment; for that, the local government should allocate the budget on a special expenses account for third-party services. The budget should be approved by the regional House of Representatives. On the other hand, the ESCO should complete the energy efficiency measures within a year. Subsequently, the energy efficiency performance will be evaluated for three months before the local government pays the energy cost-saving share to the ESCO.

Since their launch in 2017, the Circular has not yet been used for energy conservation projects in municipalities. According to interviews with staff of the Ministry of Domestic Affairs and the Agency of National Development Planning (BAPPENAS), several projects based on the Circular are still in the planning stages. Several municipalities have difficulties obtaining budget approvals from the regional House of Representatives. One of the questions raised by the House is whether the ESCO scheme is like a double payment to both PLN and the ESCO.

4. ESCO CASE STUDY IN INDONESIA

Beyond the concern of the House, there are several other questions concerning the efficiency of the Circular. First of all, the Circular sets the criteria for the ESCO to have intellectual property rights to energy conservation measures (MDA 2017). Al Irsyad and Nepal (2016) argued that energy conservation measures for public infrastructures such as streetlights are common and easily adapted to other locations without the need for specific and detailed energy audits. Those measures, in sequential order, are installing power meters on unmetered streetlights, using LED lamps or other high-efficiency lamps, and applying dimming features in smart streetlighting (SSL) technology. The first measure may need rewiring of streetlights to give them a balanced load in a three-phase system as one of PLN's requirements. The measure may only require a small investment amount but can save 50% in electricity bills since unmetered streetlights are charged at a fixed (and twice higher) tariff than the normal tariff (Al Irsyad and Nepal 2016). Therefore, the Circular requirement to have intellectual property rights is unnecessary and may lead to an inefficient monopoly market. As a substitute, the MEMR could introduce an ESCO certification program to ensure the credibility of the ESCO. While avoiding a monopoly market, the municipality should also consider the economic scale of an ESCO's services. An ESCO has fixed investments, such as operational vehicles, an office, and its equipment, regardless of the number of streetlights managed.

The second issue is that giving priority to an ESCO with experience in three other cities may also lead to the monopoly market discussed above. The provision is designed to obtain an experienced ESCO that increases the confidence and security of municipalities when implementing the Circular. On the other hand, the regulation gives less opportunity to new ESCOs that may have new and more effective measures. The Ministry of Domestic Affairs would do better to change the provision to apply the Indonesia National Standard (SNI) for the bidding ESCO. The relevant standards are SNI ISO 50001:2012 for energy management and SNI ISO 50002:2014 for energy audits. These standards have been implemented as Indonesian National Work Competency Standards (SKKNI) to ensure the competency of energy auditors and energy managers in Indonesia. Moreover, the circular letter does not mention either who will do the verification of actual energy savings as a condition for ESCO payment. Municipalities mostly do not have capable personnel and therefore should appoint a company holding SNI ISO 50015:2014 for the calculation and verification of energy performance. Hopefully, using these SNIs would convince the regional House of Representatives as well as minimizing issues regarding legal auditing by the BPK.

Other priority criteria are ascribed to ESCOs offering higher economic benefits and proposal originality. However, the MDA (2017) does not regulate directly how to determine the economic benefits and proposal originality, potentially causing new disputes among municipalities, ESCOs, and the BPK. Higher economic benefits may require higher costs, i.e., a higher saving share. In the end, the BPK may raise questions if the appointed ESCO proposes the highest cost to obtain the highest economic benefit. Table 3 illustrates how different evaluations of economic benefit will produce different results. In Table 3, three ESCOs bid on a project by offering different energy-saving targets and saving shares. If the evaluation is based on the lowest ESCO cost, then ESCO 1 will win the bid since ESCO 1 only asks for the lowest saving share, equivalent to 144 MWh, to reduce energy consumption by 1,440 MWh. In contrast, ESCO 3 offers the highest energy savings of 2,880 MWh but, consequently, demands the highest saving share of 1,152 MWh during a three-year contract period. ESCO 2 does not offer either the highest savings or the lowest saving share; however, eventually ESCO 2 provides the lowest cost and benefit ratio (CBR). Cost is defined as the sum of saving payments to the ESCO bills while benefit is defined as the net electricity saving for the municipality.

Table 3: Illustration of ESCO Bidding Evaluation

No	Descriptions	ESCO I	ESCO II	ESCO III
A	Original electricity consumption (MWh/month)	100	100	100
B	Targeted new electricity consumption (MWh/month)	60	40	20
C	Targeted electricity saving (MWh/month) = A-B	40	60	80
D	Contract period (years)	3	3	3
E	Saving during contract period (MWh) = C*12*D	1,440	2,160	2,880
F	Saving share bidding in year 1 (%)	10	15	40
G	Saving share bidding in year 2 (%)	10	5	40
H	Saving share bidding in year 3 (%)	10	5	40
I	Saving for ESCO during contract period (MWh) = (F+G+H)*C*12	144	180	1,152
J	Net saving for municipality (MWh) = E-I	1,296	1,980	1,728
K	Cost and benefit ratio (CBR) = I/J	0.11	0.09	0.67

Selecting the ESCO offering the lowest CBR is more appropriate than only considering the lowest cost or the highest benefit; however, another consideration is the lifespan of used energy efficiency technologies. An ESCO may argue that the benefits of their investment could last longer than three years – the maximum contract period – and, consequently, the benefit will be higher than the costs; however, such an argument seems unreliable, at least in developing countries. For instance, the MEMR deployed pilot projects of smart streetlighting systems in seven cities in 2013 but, at the moment, the smart dimming feature is no longer utilized due to a lack of maintenance ability in the municipalities (Al Irsyad, Halog, and Nepal 2019). The contract period should be extended to more than three years to obtain a lower CBR and ensure the sustainability of energy efficiency measures. The benefits could be defined more broadly to include smart services improving quality of services for urban populations, such as smart traffic signage, improved pedestrian safety, and environmental monitoring and warning systems (Eakambaram 2017; Griffiths 2017; Jin et al. 2016). In this case, the MEMR should provide a standard contract including measuring and verification methods that can become a reference for ESCO projects across all municipalities.

The municipality should also see the streetlights as income-generating units instead of cost units (Al Irsyad, Halong, and Nepal 2019). Currently, the municipality has gained the streetlight tax collected by PLN from electricity customers. In the future, with the help of SSL technology, streetlight poles can be used for digital signage showing public information and advertising content that can be adjusted to the people passing by. The network of streetlights could also be rented as a network for small cells of mobile traffic data (Griffiths 2017). To gain these income-generating activities, the municipality could select a specific ESCO by using the conventional PPP regulation. In addition to the partnership, the ESCO may have an obligation to invest in energy efficiency measures.

5. POLICY RECOMMENDATIONS

5.1 Auction Mechanism Improvements

The auction mechanism for energy efficiency or demand reduction is a relatively new concept that did not exist a decade ago (Rosenow et al. 2017). In the auction mechanism, financing is first received from either an energy-saving fund, a levy on energy bills, capacity charges, or another form of budget allocation. After this stage, the market actors are allowed to put forward bids, either in competitive tenders where the lowest bid wins or within a framework setting the price per unit of energy saving, inviting proposals to deliver savings at that price. In other words, the mechanism aims to achieve energy savings at highly attractive prices whilst avoiding deadweight effects associated with financial support. Our literature counted six auction mechanisms – two in the United States and one each in Switzerland, Portugal, the UK, and Germany (Rosenow et al. 2017). Such auction mechanisms can take on a variety of forms and designs.

Auction mechanisms help to drive energy efficiency in the following ways, as they:

- Deliver cost-efficient energy-saving projects (i.e., minimum requested budget for the highest possible energy savings).

  In general, selected parties (primarily energy service companies, contractors, technology providers, energy agencies, engineering firms, and municipal utility companies) are invited to submit bids for the planning and implementation of energy efficiency projects (Radgen, Bisnag, and Koening 2016). Parties who are interested can submit offers for an energy savings amount and put in a bid for a required budget, which forms 20%–40% of the total costs, including costs for information, planning, conceptual design, investment, measurement, verification, etc. Hence, bidders do not submit the maximal price limit set by the government per se but are closer to the actual value of needed subsidies. Winners are chosen based on the ratio between the requested budget and the energy savings offered to achieve the minimum requested budget for the highest possible energy savings. In other words, by design, the auction mechanism draws out the most cost-effective enhancements from among all the contenders through the use of a specific price in selecting the winner of the auction.

- Engage and encourage a top-down push for energy efficiency projects since they are voluntary measures, so no party will be obliged to establish a business case in which they are not interested.

  Auction mechanisms are very effective in engaging and encouraging a top-down push for energy efficiency projects, which would otherwise not pay for themselves through energy savings made (e.g., infrastructure with a payback period of more than eight years). This is also attributed to the fact that program tenders, in comparison to white certificates, are voluntary measures and might, therefore, be more likely to find political acceptance.

- Allow for the aggregation and bundling of energy-saving projects, facilitating larger savings potential and economies of scale.

  Often, tenders are issued for both projects and programs (IPEEC 2016). Projects are dedicated to individual companies in the industrial and service sector that would like to implement energy-saving measures within their company. On the other hand, programs are bids submitted by associations or other operating agents that bundle multiple similar projects into one program. Both open and closed (i.e., sector-specific) tenders are available for programs. In the case of Switzerland’s ProKilowatt, auctions are held independently for programs and projects to avoid competition between the two types in the same auction. Through program tenders, similar individual projects (across one technological category and one region) can be aggregated and bundled, allowing larger savings potential and achieving economies of scale to be tapped into.

- Provide flexibility for bidders to select their own technologies and programs for implementation in open tenders.

  Some auction mechanisms offer both open and closed tenders (IPEEC 2016); this is demonstrated in the German auction featuring both an “open” auction slot, which is technology- and sector-neutral, and a “closed” auction slot, which is sector-, beneficiary-, or technology-specific. Open tenders ensure flexibility as bidders are allowed to select their own technologies and programs for implementation. On the other hand, closed tenders help to address specific themes with known large potential and constraints, or alternatively, innovation potential.

5.2 Design a Super ESCO to Strengthen the Financial and Technical Capacity of Private ESCOs

Super ESCOs have proven to be a success across the jurisdictions where they are implemented, bringing about large energy savings, fostering the ESCO industry in terms of technical and financial capabilities, and aiding small and medium enterprises (SMEs) in taking up energy efficiency projects. Most importantly, the creditworthy Super ESCOs can back the ESCOs in issuing guaranteed energy-savings contracts under EPCs, helping energy efficiency projects to secure bank loans. To date, at least eight Super ESCOs have been implemented across the world: FEDESCO in Belgium, EC2 in the Philippines, Tarshid in Saudi Arabia, Etihad ESCO in UAE, HEP ESCO in Croatia, the R2E2 Fund in Armenia, EESL in India, and the Fakai Scientific Services Corporation in the PRC.

A Super ESCO will help the public sector to enter an EPC scheme and guarantee specific energy savings, notably for buildings or streetlighting over a set period, either in monetary terms or as a savings percentage. A Super ESCO will facilitate project aggregation to make energy efficiency financing more attractive, procure large volumes of energy-efficient devices and equipment, and, consequently, bring about a rapid reduction in prices, making the energy efficiency measures more cost-efficient. This can have significant advantages for governments, reducing energy bills of public facilities, supporting the fiscal sustainability of governments' energy efficiency efforts, requiring less enforcement than regulation, and according the market the flexibility to select the most cost-efficient technologies.

In addition, a Super ESCO can put in place all required procedures, templates, and documents to enable the maturity of the domestic EPC market. Project development and implementation can be subcontracted to private ESCOs on a competitive tendering basis. Local ESCOs will build their capacity to develop and offer EPCs with low-risk projects while receiving support from the Super ESCO to gain much-needed skills. Later, these ESCOs could extend their services to the commercial and industrial sectors to drive more rapid transformation of energy efficiency.

In Indonesia, we recommend Indonesia's government to consider two institutional options to ensure that the Super ESCO, if desirable, can help tap the public sector's energy efficiency potential and facilitate the domestic energy services and private sector ESCOs. The first option is to leverage existing government agencies with an energy efficiency mandate to set up a Super ESCO. The other option is to leverage the power utility companies to create a utility-based Super ESCO.

There could be a potential conflict of interest between the state-owned Super ESCO acting as an ESCO for public sector energy efficiency projects and the emerging commercial ESCOs that need public sector projects to support their growth and development (Limaye and Limaye 2011). Within the private sector, a Super ESCO itself has the capacity to develop and implement projects. Nonetheless, this issue can be overcome by having the government dedicate specific responsibilities to the Super ESCO to engage the private sector ESCOs as implementing agents.

In the long run, the super ESCO should aim to build the capacity of local private sector ESCOs and create a competitive private market for ESCO services. Hence, the Super ESCO is best suited to taking up the role of a capacity builder by engaging private ESCOs as contractors for parts of the implementation, such as installation, commissioning, and performance monitoring, etc. The Super ESCO can also help to arrange access to guaranteeing/de-risking financing for small private ESCOs to support them in implementing projects and building their capacity and credentials.

To be precise, a Super ESCO helps to overcome the challenges faced by SMEs in the Indonesian energy efficiency market as it can:

- Facilitate energy efficiency project aggregation to make energy efficiency projects of SMEs more attractive for financing.

  The government could emulate India's Energy Efficiency Services Limited (EESL) in terms of aggregating large demands for energy-efficient equipment and procuring large volumes from a variety of suppliers that meet strong technical standards (Sarkar and Moin 2018). This helps to establish a demand market for participating manufacturers and, as a result, brings about a rapid reduction in prices, making the energy efficiency measures more financially attractive (cost-efficient).

- Provide SMEs with upfront financing.

  The government could also learn from the Energy Saving Association (ESA) of Armenia's R2E2 Fund, under which an SME pays the fund its baseline energy costs over a contract period. The Fund then designs the project, hires subcontractors, oversees construction and commissioning, and monitors the subproject (Sarkar and Moin 2018). In this case, SMEs will incur no debt; the Fund directly pays the energy bills to the utility company on the SMEs' behalf, retaining the balance to cover its investment cost and service fee. In other words, project aggregation, upfront financing, and ESAs are critical to overcoming the lack of financial capacity among SMEs to build up their energy efficiency.

6. CONCLUSIONS

The global electricity demand is growing at a rapid pace, especially in developing countries. One potential for energy efficiency is in the electricity used by streetlights. Energy efficiency measures in streetlights are quite simple and common, so the measures can be immediately implemented with all streetlights without conducting detailed and expensive energy audits. Nevertheless, municipalities usually have budget limitations, so an energy service company (ESCO) is one of the possible solutions to finance energy efficiency in streetlights. However, ESCOs in public sectors are uncommon in developing countries like Indonesia. The Supreme Audit Agency (BPK) had accused the ESCO scheme of being a loan to municipalities that are prohibited from receiving loans from the private sector. The BPK also questioned the method used to determine the saving share given to the ESCO. Based on those problems, the Minister of Domestic Affairs released a circular letter (MDA 2017) to solve those legal issues hampering energy efficiency in the public sector. The main feature of the Circular is its emphasis that paying the ESCO is not an investment loan but rather a payment for an energy efficiency service during the ESCO contract period. Nevertheless, since its release in 2017, the implementation of the circular letter has not been well accepted. No ESCO project has been implemented yet under the circular letter. Some projects are under preparation while others have been turned down by the regional House of Representatives, which views the ESCO contract as an additional expense to current electricity bills for streetlights.

Our study proposes several improvements to the circular letter. Firstly, the circular letter should not limit the ESCO to having intellectual property rights since this may lead to an inefficient or monopoly market. For the same reasons, the Ministry of Domestic Affairs should not prioritize ESCOs with experience in three other cities.

ESCOs are a new business type in Indonesia and as new companies emerge they should be given equal opportunity. The experience requirement is also unnecessary since the nature of the business is that all investment and technical risks will be burdened by the ESCO; therefore, the municipalities should be indifferent to using experienced or inexperienced ESCOs. The third proposal is to use the lowest cost-benefit ratio (CBR) to determine the best economic benefits. The current maximum contract period (i.e., three years) is too short to determine actual benefits and so our fourth proposal is to extend the period by also considering additional features of smart services that can be provided by streetlights managed by an ESCO. We also propose a new business scheme to convert streetlights from cost units into revenue-generating units: for example, as smart digital advertising and mobile traffic data network devices.

Furthermore, we recommend Indonesia's government to consider the energy efficiency auction mechanism to channel the public budget into energy efficiency investments. The mechanism has proved to be a cost-effective method of competitively selecting the market proposals that result in the highest cost savings of public funding. Last, but not least, we recommend Indonesia's government to consider the option of the Super ESCO to tap the public sector's energy efficiency potential and facilitate the use of domestic energy services and private sector ESCOs. It is imperative that the rationale for this Super ESCO is first understood, in the sense that it will develop, finance, and implement energy efficiency projects on a commercial, for-profit basis, using local ESCOs as key delivery partners.

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