# Smart Street lighting Initiative NAMA

## Implementation Plan

# Preface

In response to climate change the Government of Indonesia has established a national GHG mitigation policy framework, which is detailed in the Presidential Regulation No. 61 – the National Action Plan for GHG emission reduction (Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca, RAN-GRK) on 20th of September 2011. RAN-GRK is regarded as the underlying policy for the development and implementation of Nationally Appropriate Mitigation Actions (NAMAs). NAMAs shall support the further implementation of the RAN-GRK with unilateral means (to support the 26% emission reduction target) and with international support (to support emission reductions up to 41%). At the same time they shall support Indonesia's development goals.

Energy efficiency has been one of the main policies of the Government of Indonesia to develop more sustainable and environmentally friendly national energy. Along with renewable energy development, energy efficiency is the tool to move from dependency on fossil-based energy with the target of elasticity less than 1 in 2025 and reducing energy intensity 1% per year. Economic growth, nourished by high rates of fossil fuel use, has shifted the vastly growing energy sector alongside deforestation and land-use changes at the center of climate policy and action. Herein, the Ministry of Energy and Mineral Resources (MEMR) pursues an integrated NAMA approach consisting of measures on the production side (maximize renewable energy utilization) and the consumption side (application of energy efficient technologies) in various sub-sectors. This approach builds upon existing energy policies and aims at gradually lowering GHG emissions in the energy sector's development path.

The Smart Street Lighting Initiative (SSLI) NAMA constitutes one important element in Indonesia's integrated energy NAMA approach. It introduces and promotes efficient street lighting technologies in a large scale of implementation, combined with the necessary capacity building measures related to regulations, performance and safety standards, installation and maintenance, monitoring and awareness raising. Its Impacts can be manifold: The application of more efficient street lighting technologies leads to cost, energy and GHG reduction as well as increased safety in public spaces. The SSLI NAMA implementation plan describes the necessary measures to be taken within this NAMA in order to significantly improve Indonesia's street lighting systems in urban areas up to 2020. The SSLI NAMA implementation plan has been developed in a partnership with the German government. The MEMR gratefully acknowledges the support of the GIZ Policy Advice for Environment and Climate Change (PAKLIM) program in developing this NAMA concept and is looking forward to cooperate within future implementation.

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Jakarta, December 2013

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| ADB | Asian Development Bank |
| AILKI | Association of Lighting and Electrical Industries |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| BAPPENAS | Ministry of National Development Planning |
| BE | Baseline emissions |
| BEE | Indian National Energy Efficiency Agency |
| BIS | Bureau of Indian Standards |
| BL | Baseline |
| BLH | Local Environment Agency (Badan Lingkungan Hidup) |
| BMU | German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety |
| BOCM | Japanese Bilateral Offsetting Credit Mechanism |
| BPK | Supreme Audit Agency |
| BSN | National Standardisation Agency of Indonesia |
| BURs | Biennial update reports |
| CAPEX | Capital Expenditure |
| cd | candela |
| CDM | Clean Development Mechanism |
| CERs | Certified Emission Reductions |
| CFL | Compact fluorescent lamp |
| CIE | Commission internationale de l'éclairage |
| CMH | Ceramic Metal Halide |
| COP | Conference of the Parties |
| CRI | Colour rendering index |
| DAK | Special Allocation Fund |
| DGEEU | Directorate General of Electricity |
| DKP | Agency for Hygiene and Landscape Gardening (Dinas Kebersihan dan Pertamanan) |
| DNA | Designated National Authority |
| DNPI | National Council on Climate Change |
| DO | Delivery Organisation |
| DOE | Designated Operational Entities |
| DPU | Local Public Works Agency (Dinas Pekerjaan Umum) |
| EB | Executive Board |
| EE | Energy efficiency |
| EBTKE | Directorate General of New/Renewable Energy and Energy Conservation |
| ERs | Emissions Reductions |

| | |
|---|---|
| ES | Electrical savings |
| ESCO | Energy Services Company |
| ESDM | Centre for Data and Information on Energy and Mineral Resources |
| EU ETS | European Union Emissions Trading Scheme |
| EUR | Euro |
| FDI | Foreign Direct Investment |
| FTL | Fluorescent Tubular Lamp |
| g1 | $E_{min}/E_{max}$ |
| GDP | Gross Domestic Product |
| GEF | Grid emission factor |
| GHGs | Greenhouse Gases |
| GIZ | German Society for International Cooperation |
| GoI | Government of Indonesia |
| GWh | Gigawatt hours |
| HID | High-intensity discharge |
| HPS | High-Pressure-Sodium |
| HPSV | High Pressure Sodium Vapour |
| ICA | International Consultation and Analysis |
| ICLEI | International Council for Local Environmental Initiatives |
| ICCTF | Indonesia Climate Change Trust Fund |
| IDR | Indonesian Rupiah |
| IEC | International Electrotechnical Commission |
| IES | Illumination Engineering Society |
| INR | Indian Rupee |
| IPP | Independent Power Producer |
| IRR | Internal Rate of Return |
| ISO | International Organization for Standardization |
| JAMALI | Jakarta Madura Bali Grid |
| JIS | Japan Industrial Standard |
| kW | Kilowatt |
| kWh | Kilowatt hours |
| LED | Light-emitting diode |
| lm | lumens |
| MASTAN | Standardisation Society of Indonesia |
| MBF/U | Mercury vapor lamps |
| MoE | Ministry of Environment |
| MoF | Ministry of Finance |
| MEMR | Ministry for Energy and Mineral Resources |
| MER | Monitoring, Evaluation and Reporting |
| MFI | Multilateral Financial Institutions |

| | |
|---|---|
| MH | Metal Halide |
| MoI | Ministry of Industry |
| MoT | Ministry of Transport |
| MPW | Ministry of Public Works |
| MRV | Measurement, Reporting and Verification |
| Mt $CO_2e$ | Million tonnes of Carbon Dioxide Equivalent |
| MW | Megawatt |
| MWh | Megawatt hours |
| NAI | Non-Annex I parties |
| NAMA | Nationally Appropriate Mitigation Action |
| NES | Net electricity savings |
| NGO | Non-governmental organisation |
| NMM | New Market Mechanism |
| NPV | Net Present Value |
| O&M | Operations and maintenance |
| $O_i$ | Annual operating hours |
| ODA | Official Development Assistance |
| OWG | Other Working Groups |
| P | Project |
| PAKLIM | Policy Advice for Environment and Climate Change |
| PAS | Performance and Safety |
| PDD | Project Design Document |
| PE | Programme emissions |
| PIP | Indonesian Investment Agency |
| PJU | Local government units responsible for street lighting |
| PLN | National Electricity Utility |
| PNPS | Planning of National Program for Standard Development |
| PPP | Public-private-partnerships |
| RAD-GRK | Provincial action plans |
| RAN-GRK | National Action Plan on Emission Reduction |
| R&D | Research and Development |
| RSNI | Standard Draft |
| SBSTA | Subsidiary Body for Scientific and Technological Advice |
| SC | Steering Committees |
| SN | Serial number |
| SNI | Standar Nasional Indonesia, Indonesian National Standards |
| SOF | System Outage Factor |
| SON | High pressure sodium lamps |
| SOX | Low pressure sodium lamps |
| SSC | Small scale |

| | |
|---|---|
| SSL | Smart Street lighting |
| SSLI | Smart Street Lighting Initiative |
| TA | technical assistance |
| T&D | Transmission and Distribution |
| TBT | Technical Barriers to Trade |
| $tCO_2$-e | Tonnes of Carbon Dioxide Equivalent |
| TDL | Transmission and distribution losses |
| TJ | Glare Limitation |
| ToT | Training of Trainers programs |
| TSU | Technical Support Unit |
| ULBs | Urban Local Bodies |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| US | United States of America |
| USAID | U.S. Agency for International Development |
| USD | US Dollar |
| UU | National law |
| VA | Effective power |
| VD | $L_{min}/L_{max}$ |
| VI | $L_{min}/L_{average}$ |
| WTO | World Trade Organization |
| WIPP | Waste Isolation Pilot Plant |

## 1. Executive summary

In 2009, the Indonesian President Susilo Bambang Yudhoyono pledged to reduce the country's greenhouse gas (GHG) emissions by 26% compared with business as usual (BAU) by 2020 and up to 41% below BAU with international support. This was translated into a National Action Plan on Emission Reduction, known as the 'RAN-GRK', in 2011, which calls for actions across all major sectors of the economy. Actions undertaken to meet this target are detailed in provincial action plans or 'RAD-GRK'. Indonesia's coal-dominated power supply is a major source of GHG emissions. Emissions from the generation of electricity have increased in line with the country's strong economic performance in recent years and this trend is set to continue with electricity demand growth projected at around 9% per annum, resulting in the need for over 50 GW of new generating capacity by 2025. Energy efficiency measures in the cities and urbanised areas could thus make an important contribution to meeting Indonesia's GHG emissions reduction targets.

Some cities, including Yogyakarta and Makassar, have experience with the introduction of energy-efficient street lighting, including Light Emitting Diode (LED) lamps. LEDs have been improving steadily since the 1960s and although the upfront costs are still 2-4 times that of most conventional lamps, the energy consumed is half of an equivalent conventional lamp or less and LEDs last longer. The limited experience to date in Indonesian cities shows the significant energy savings that can be achieved by LEDs compared with conventional lamps - up to 60% in optimal conditions. Other efficient lighting technologies such as induction lamps and approaches such as dimming and use of movement sensors can also result in significant energy savings and are slowly being tested by Indonesian cities. The uptake of such measures results in associated GHG emissions and cost savings as well as other co-benefits including enhanced public amenity, the creation of job opportunities, and improved safety due to better illumination of roads at night. The perception of improved safety due to better lighting in public spaces could increase the mobility and freedom of women in particular to use public transportation, to extend working hours, and to participate in community life. Thus, a gender-sensitive approach to improved street lighting could maximise the benefits (improving livelihoods) for various groups of society in urban areas.

Due to a range of challenges, however, efficient street lighting has not been a priority for Indonesian cities to date. Common problems experienced by the local government units responsible for street lighting, known as 'PJUs', include:

- A lack of adequate data on the number and type of installed lamps, due principally to the high number of illegal connections and the low level of electricity metering for street lighting.
- The standard practice of being billed by PLN[1] on a lump-sum basis, which tends to over-estimate consumption and reduces the incentive to implement more efficient street lighting.

[1] National Electricity Utility (Perusahaan Listrik Negara – PLN)

- Many PJUs are constrained in their budgets and local governments are typically unable or unwilling to increase the street lighting taxes further to raise additional revenues.

Nationally Appropriate Mitigation Actions (NAMAs) are voluntary emission reduction measures initiated by developing countries under the UNFCCC[2] and are typically aligned with national policy objectives. If conceptualised as a NAMA, a “Smart Street Lighting Initiative” (SSLI) aimed at driving the introduction of energy-efficient street lighting technologies in cities and provinces of Indonesia could contribute to the RAN-GRK objectives. The SSLI NAMA would involve several government institutions at the national level, provincial and municipal governments, as well as the private sector. The NAMA would be open to a wide range of efficient and smart technologies, not just limited to LEDs. However, the majority of the analysis in this report has focused on LEDs for sake of simplicity.

The NAMA will logically be coordinated by the Ministry for Energy and Mineral Resources (MEMR), which is the agency responsible for setting energy efficiency policy. In addition, the following institutions are identified as playing a particularly critical role in the implementation of the SSLI NAMA (see Table 1 below).

**Table 1: Institutions and Actors Involved in Implementing the SSLI NAMA**

| Institution / actor | Role |
|---|---|
| BAPPENAS | Responsible for overall coordination of Indonesia’s NAMAs;<br>Responsible for overseeing the Indonesia Climate Change Trust Fund (ICCTF), a key channel for delivering finance for investment in smart street lighting technologies |
| The Indonesian Investment Agency (PIP) at the Ministry of Finance | Sits within the Ministry of Finance (MoF) and would be responsible for providing concessional loans to the participating cities, which is another key element of the financing package |
| Ministry of Industry (MoI) | Responsible for setting standards of lighting products, and would do so for LED lamps as no national standard for LED street lighting products currently exists |
| Ministry of Environment (MoE) | Responsible for keeping track of measured GHG emission |
| National Standardisation Agency of Indonesia | Responsible for facilitation and/or endorsement of national standard (SNI) for LED street light |
| Municipal level PJUs | Responsible for the management of street lighting infrastructure in Indonesian cities, including installation and maintenance of infrastructure |
| Provincial level governments | Responsible for street lighting on roads outside of cities |
| PLN | The national electricity utility, which is responsible for installation of metering, collection of metered data, collecting the street lighting tax and billing cities for their consumption |
| Private sector | Includes lighting suppliers as well as Energy Services Companies (ESCOs) |

[2] United Nations Framework Convention on Climate Change (UNFCCC)

With such a complex institutional environment, the effective coordination of the multiple actors at the national, provincial and municipal level is a key success factor.

MEMR could access international NAMA support funding with both technical and capital cost components. Firstly, this funding could help set up a Technical Support Unit (TSU) which would be responsible for delivering the Technical Assistance (TA) component to the cities involved in the SSLI NAMA. Secondly, international NAMA support could provide finance to kick-start the required capital investment over the intended time frame of 2014-2020. These international funds should be leveraged with additional sources of domestic finance, both private and public.

Specifically, the finance package outlined in this report envisages international NAMA support via initial grants of USD 19m, including a target capital component in the order of USD 11.5m and a TA component of around USD 7.5m. The capital investment support should be channelled through the existing financing facility of the ICCTF energy window, while the TA could be managed by GIZ. Domestic concessional loans should be made available to cities and provinces via PIP using the existing institutional framework and financing instruments but with streamlined procedures for cities to access funds. Further, the private sector must be enabled to provide finance, including via the ESCO model. Additional forms of finance will also be required for the SSLI NAMA to become truly transformational by 2020. It is thus recommended to seek additional international and domestic support with a second grant of USD 11.5m targeted to complement the initial NAMA grant.

Based on the envisaged financing package, the implementation of the SSLI NAMA has been assessed under two different levels of ambition, or pathways. The results that can be achieved have been estimated and are outlined in Table 2 below.

**Table 2: Summary of SSLI NAMA Implementation Pathways**

| Implementation Phases | Conservative Pathway | | Ambitious Pathway | |
|---|---|---|---|---|
| | *Incremental* | *Cumulative* | *Incremental* | *Cumulative* |
| I: Demonstration phase<br>Jan 2014 - Jun 2015 | 2 cities | 2 cities | 4 cities | 4 cities |
| II: Scaling-up phase<br>Jul 2015 – Dec 2016 | 2 new cities join | 4 cities | 8 new cities join | 12 cities |
| III: Transformation phase<br>Jan 2017 – Dec 2019 | 5 new cities join | 9 cities | 10 new cities join | 22 cities |
| Total capital cost | USD 155m | | USD 420m | |
| NPV to 2024<br>(8% discount rate) | USD 3m | | USD -7m without any additional grants<br>USD 15m with an additional grant of USD 11.5m | |
| Emissions reductions | 210,000 t $CO_2$-e to 2020 | | 640,000 t $CO_2$-e to 2020<br>Approximately 1.5 Mt by 2024 | |

| | | |
|---|---|---|
| Cost of abatement (8% discount rate) | -4 EUR/t $CO_2$-e | 2 EUR/t $CO_2$ or -8 EUR/t $CO_2$ with an additional grant of USD 11.5m |

The analysis highlights that in order achieve significant emissions reductions a rapid scaling up of the SSLI will need to be achieved. Based on the estimates in this report, around 22 small, medium and large cities would have to join by 2020 if GHG emissions are to be reduced by 1.5 Mt by 2024 (cumulatively). To achieve such results, a number of barriers will need to be overcome. In summary, the SSLI NAMA will involve the following activities:

- Help local governments deal with technical issues, provide staff training programmes and support them with implementation of the Monitoring, Reporting and Verification (MRV) plan.
- Help ensure that PLN's billing approach can account for installed efficient lamps more smoothly, so that cities are able to reduce their expenditure accordingly.
- Help local government to overcome the incremental cost of switching to LEDs/other smart lighting technologies through the provision of financial assistance (loans and grants).
- Help local government access different sources of finance involved in the NAMA by smoothing procedures and requirements and providing hands-on support for interested cities.
- Undertake awareness-raising efforts to attract new cities/provinces to join the NAMA over time.
- Develop training programmes to improve the skills of workers involved in installation/maintenance.

More widespread reform of Indonesia's electricity pricing and regulations should also be pursued in the context of its national energy policy. However, it is recognised that it may not be feasible for such reforms to be implemented in the time frame intended to enable a quick start for SSLI NAMA.

The current lack of national performance standards for LED products is a potential risk to the successful implementation of the SSLI NAMA. If sub-standard products are allowed to enter the market this will negatively impact on perceptions of the quality of LEDs and slow down the uptake of the technology. The SSLI should also be open and flexible, allowing potentially for other lighting technologies such as induction lamps to be adopted where cities choose to pursue these. While the development of a national standard for LED products is planned, it could take 1-2 years. Therefore an interim solution may be needed. Consensus is required from the relevant ministries and government agencies involved in standards if Indonesia were to adopt a standard based on the available international standards established by the IEC and IES[3] and/or other Asian countries such as India.

Installation and maintenance practices are not consistent across Indonesian cities due to the lack of awareness of the national street lighting standards and the absence of design-based street lighting

[3] International Electrotechnical Commission (IEC), Illuminating Engineering Society (IES)

systems. This results in the adoption of inappropriate technologies, which do not provide the necessary level of service to citizens and is thus closely linked to the high level of illegal connections.

MRV of the SSLI NAMA outcomes is an important element of the SSLI from both a national policy perspective and an international perspective under the UNFCCC framework. The GHG reductions resulting from the lighting replacement is the key outcome to be monitored, reported and verified, but other co-benefits could also be included in the MRV framework. For monitoring GHG reductions, an approach for the SSLI NAMA can be developed based on the approved CDM methodology AMS.II.L *Demand-side activities for efficient outdoor and street lighting technologies*. The approach in AMS.II.L uses sampling of lamp operating hours and calculated energy savings based on lamp specifications and the number of replaced lamps. This makes it possible for cities that have not yet implemented widespread metering to join the SSLI. Cities that are already advanced in their metering installation programme should utilise metered data for emissions monitoring as this will be more accurate.

Greater coverage of electricity metering is a key success factor that will address the lack of reliable data and free up local government financial resources. Of the cities considered in this report, only Yogyakarta, Makassar and Cimahi have achieved full or near-full metering coverage. Other cities could be supported by the national government to overcome the up-front costs of metering if it is recognised as a national priority. In the meantime, baseline estimation should be done at the city/province level and can be estimated ex-ante and then adjusted ex-post. A certain minimum level of data quality/metering is recommended for cities joining the SSLI NAMA to ensure reliability.

On-going and continuous awareness-raising efforts will be required if the SSLI NAMA is to be effectively implemented, achieve the intended scale foreseen in this report, and to ultimately reduce GHG emissions. The TSU will play a critical role in this respect.

## 2. Introduction

This report outlines the strategy for the implementation of a Nationally Appropriate Mitigation Action (NAMA) in Indonesia involving the installation of efficient lamps in place conventional lamps currently used for street lighting. The activities that are to be undertaken as part of implementing this NAMA, referred to hereafter as the Smart Street lighting Initiative (SSLI) NAMA, will be carried out by various actors at the national and local government level as well as the private sector. The resources required for enabling the NAMA to go ahead are to come from the combination of both domestic Indonesian resources and international climate finance.

The report was commissioned by GIZ and is published by the Ministry for Energy and Mineral Resources (MEMR), which will act as the Government agency with primary responsibility for coordinating the implementation of the SSL NAMA. The report was prepared by a team of consultants from Perspectives GmbH, ICLEI and the GIZ PAKLIM program.

## 3. Context

### 3.1. The Smart Street Lighting NAMA in the context of Indonesia's climate policy

The energy sector is the second largest contributor to Indonesia's greenhouse gas emissions, which are otherwise mainly dominated by emissions from deforestation and land use change; in 2005 energy sector emissions accounted for around 20% of total emissions when land sector emissions are included, or around 56% without including land sector emissions (Second National Communication to the UNFCCC in: Government of Indonesia, 2010). Energy sector emissions totalled around 370 Mt $CO_2$-e in 2005, with emissions from electricity generation being the major contributor. Strong economic performance and an abundance of coal for power generation contributed to a growth of over 30% in energy sector emissions between 2000 and 2005.

Annual electricity demand in Indonesia is growing at around 9% and the national, state-owned, electricity utility PLN forecasts that the total electricity generation capacity needs to be increased from around 30 GW to around 83 GW by 2025 to meet this growth in demand (Differ Group, 2012). The energy sector and the management of demand growth is therefore very relevant in the Indonesian climate and energy policy context.

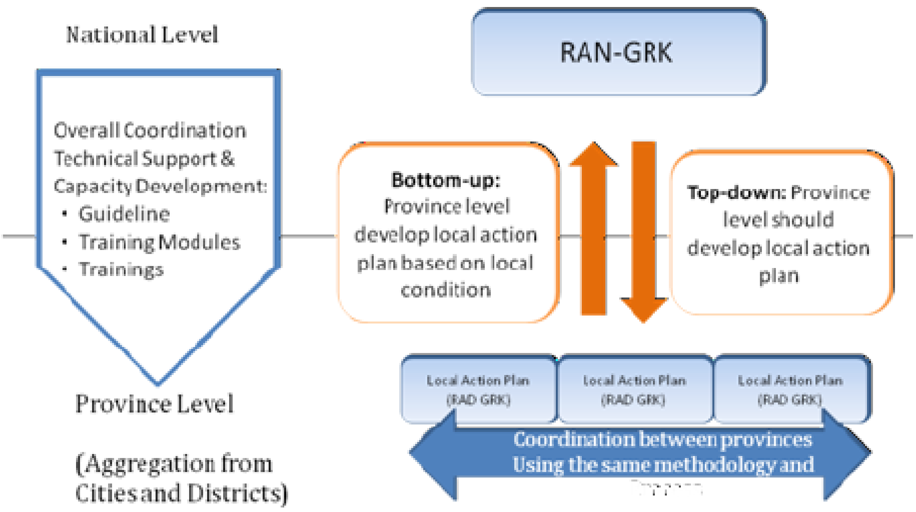
Due to Indonesia's far-reaching decentralization, its climate policy is multi-layered and complex[4]. In 2009, President Susilo Bambang Yudhoyono made a pledge for Indonesia to reduce its emissions by 26%, and up to 41%, with international support, putting Indonesia at the forefront of countries willing to

[4] For a history of the development of Indonesia's climate policy see Purnomo, A.: *Evolution of Indonesia's Climate Change Policy; From Bali to Durban*. Jakarta, 2013

pledge ambitious abatement targets internationally. After the Copenhagen climate change conference, the 26% reduction was translated into a National Action Plan on Emission Reduction ("RAN-GRK") which details Indonesia's submission to the UNFCCC into national and sectoral planning on how, when, and where the reduction will take place (Purnomo, 2013). A number of challenges remain, however, including the definition of a national baseline, allocation of the target to sectors, and implementation of a detailed monitoring, reporting and verification (MRV) framework. NAMAs can help contribute towards the achievement of Indonesia's abatement target, but exactly how this is to be done is still being defined.

The National Action Plan was specified by presidential decree (Perpres) 61/2011, which also defined the role of Provincial Action Plans ("RAD-GRK"). While the National Action Plan, RAN-GRK, is the key policy framework for the achievement of the national GHG emission reduction goals, the actions themselves often need to be taken at the local level, which is specified in the RAD-GRKs, which are to be developed by each province. So far, 32 of the 33 provinces have published their RAD-GRK action plans. In some cases, the actions that need to be implemented also require the direct participation of municipal governments, for example in the area of street lighting energy efficiency. The achievement of Indonesia's greenhouse gas abatement goals thus potentially involves three layers of government - national, provincial and municipal - each of which has a separate government, with its own legislative and budgetary procedures, but must work together effectively to achieve the intended outcomes.

**Figure 1: Coordination of national and provincial climate action**




Source: BAPPENAS (2012)

To date, only three provincial governments have explicitly included actions involving energy efficiency improvements for street lighting in their RAD-GRK climate plans, while an additional 4 have included non-specified lighting replacement activities, with two of these identifying Light Emitting Diode (LED) technologies. In addition, a number of Indonesian cities are starting to develop GHG mitigation action plans; for example, in 2012 Yogyakarta city released a GHG inventory and action plan, prepared by ICLEI with support from USAID (U.S. Agency for International Development).

**Table 3: Overview of street lighting in provincial RAD-GRK climate action plans**

| Province | Explicitly mentions energy efficient lamps for street lighting | Includes energy efficient lamps but not explicitly for street lighting |
|---|---|---|
| **DKI Jakarta** | ✓ | |
| **Jawa Tengah** | ✓ | |
| **Gorontalo** | ✓ | |
| **DI Yogyakarta** | | ✓ (LED) |
| **Sulawesi Utara** | | ✓ (LED) |
| **Kalimantan Barat** | | ✓ |
| **Sulawesi Tenggara** | | ✓ |

Source: Analysis by GIZ in 2013

The primary benefit of implementing SSL for Indonesian provinces and cities is the energy savings that can result from this. The bill charged by PLN for street lighting electricity consumption every month often makes up a significant share of the city budget. Switching to SSL also has co-benefits for local governments, in particular improved public amenity and safety due to better illumination of roads at night. Several cities in Indonesia already have some experience with the introduction of energy efficient street lighting. Municipal public lighting agencies (PJU) in municipalities that are targeted to be involved in the initial phases of the SSL NAMA include Yogyakarta, which started with meter installation from 2001 onwards and has achieved full coverage of all installed street lighting. Other cities with previous experience include Semarang and others previously involved in GIZ-led activities, such as Malang, Mojokerto, Pekalongan, Probolinggo and Surakarta as well as some other cities outside of Java such as Makassar (South Sulawesi), which has achieved full metering and has some experience with installation of LEDs. The SSL NAMA aims to build on this experience and accelerate the uptake of smart street lighting technology across Indonesia between 2014 and 2019.

In relation to climate finance, the Government of Indonesia (GoI) is currently preparing different financing mechanisms to support the implementation of the RAN-GRK. In light of the significant investment needs required for addressing climate change in Indonesia, the Government decided to establish the Indonesia Climate Change Trust Fund (ICCTF) to pool and coordinate funds from various sources including international donors. The ICCTF channels funds towards climate change policies and programs in the priority areas of land-based mitigation, energy and adaptation and resilience. The capacities of specific financing mechanisms such as of the ICCTF are being further strengthened to acquire and administer international financial support for NAMA implementation. In addition, the Ministry of Finance (MoF) offers concessional loans for a range of infrastructure-related activities through the Indonesian Investment Agency (PIP), including in the energy sector (in particular, renewable energy development, but also potentially energy efficiency).

Alongside NAMA development and financing mitigation actions, Indonesia has already taken its first steps toward a national MRV system. Guidelines including reporting templates for the Monitoring, Evaluation and Reporting (MER) of RAN/RAD-GRK actions were published by BAPPENAS in May 2013 with support from GIZ PAKLIM[5]. The Ministry of Environment (MoE) is currently developing the concept for the MRV system that includes the institutional set-up for MRV of unilateral/supported NAMAs. The first Biennial Update Report (BUR) and the Third National Communication are currently being prepared by MoE.

## 3.2. The technology context

When discussing energy efficient street lighting, mainly two technologies are seen as suitable replacements for conventional lamp types: Light Emitting Diodes (LEDs) and Magnetic Induction Lighting. This chapter gives an overview of the technological characteristics as well as main benefits and challenges. The assessment is based on the following criteria:

- Effectiveness and maturity: Assessment what illumination quality the lamps typically provide, how reliable and mature the technology is, what the experiences have been regarding operation, maintenance and lifetime.
- Efficiency: Assessment of the characteristics regarding installation and operation costs.
- Environmental impacts: Assessment of environmental impacts during production and recycling/disposal phases.

### Light Emitting Diodes (LEDs)

Light-emitting diode (LED) technology is a fast-evolving lighting technology with significant energy-saving potential. The technology is based on semiconductor crystals where charge carriers (electrons) are flowing and recombining with holes while originating photons (i.e. light). This process is called electroluminescence effect. Hereby an applied external electric field across the semiconductors' junction will allow electrons in the conduction band, which are more mobile carriers than holes, to gain enough energy to cross the gap and recombine with holes on the other side of the junction emitting a photon as a result of the decrease in energy from the conduction to the valence band (radiative recombination). Theoretically, it is possible that all free electrons recombine to create a photon. This suggests the high energy efficiency potential of LEDs (see Halonen et al., p.111).

**Effectiveness and maturity**

Since the first commercially available LEDs in 1960, the technology has been constantly improving. Today's LEDs cover spectral emissions from the red to yellow region of the visible spectrum. White LEDs can be realised by mixing the emission of different coloured LEDs or by the utilisation of phosphors. Depending on the properties of the phosphor layers utilised, white light of different qualities can be realised.

[5] Policy Advice for Environment and Climate Change (PAKLIM)

Electrically, an LED is characterised by its forward current and forward voltage. Due to their typical characteristic of representing the forward current as a function of the forward voltage, LEDs are called current-controlled devices.

The electrical and optical performance of an LED is interrelated with its thermal characteristics. Due to the inefficiencies resulting from the imperfections in the semiconductor and in the LED package structure, heat losses are generated. These losses have to be removed from the device in order to keep the operation temperature below the maximum allowed and avoid premature failure of the device. The heat losses are firstly conducted to the exterior of the LED package throughout an included heat slug. Next, the heat is realised to the ambient throughout convention and radiation. In some applications the utilisation of an exterior cooling system such as a heat sink is required to facilitate the release of the heat to the ambient (see Halonen et al., p.114).

Figure 2: Examples of LEDs and LED modules

(Zheludev, 2007; Kinzey, B.R., Myer, M.A., 2010,p 4)

Based on an average operation of 10 hours per day, LEDs have a life span of up to 13 years (Masthead LED Lighting, 2009). The lifetime and performance depends on quality of the LED, system design, operating environment, and other factors such as the lumen depreciation factor over a period of time.

**Efficiency**

Although the upfront cost of the LED is 2-4 times more than the cost of most high-intensity discharge (HID) lamps, the energy consumed by the LED is half of the conventional lamp's energy (or less) and LEDs last longer than conventional lamps, resulting in significant savings. The LED fixture does not require ballast or a capacitor; instead it converts the supply voltage to low voltage direct current, using a small electronic power supply. Average annual maintenance costs are two times lower than that of Mercury or HPS lamps (GIZ PAKLIM, 2012).

**Environmental impacts**

The U.S. Department of Energy (DOE) explored the environmental impacts of LEDs in comparison to incandescent and CFL lamp types. Hereby the lighting production process, used raw materials, recycling options and required energy resources have been taken into account. As a total result the currently produced LEDs had a significantly lower environmental impact than the incandescent, and a slight edge over the CFL. Main negative impact of LEDs is the waste landfill due to the lamp's large aluminium heat sink. It is expected that this impact will decrease due to efficiency improvements and recycling efforts in the near future (Kinzey, B.R., Myer, M.A., 2013).

**Summary of key advantages and shortcomings of LEDs**

Advantages of LEDs:

- Small size (heat sink can be large)
- Physically robust
- Long lifetime expectancy (with proper thermal management)
- Switching has no effect on life, very short rise time
- Contains no mercury
- Excellent low ambient temperature operation
- High luminous efficacy (LEDs are developing fast and their range of luminous efficacies is wide)
- New luminaire design possibilities
- Possibility to change colours
- No flickering, strobing, or noise
- No optical heat on radiation

Disadvantages of LEDs:

- High price
- Low luminous flux / package
- CRI can be low
- Risk of glare due to high output with small lamp size
- Need for thermal management
- Lack of standardisation

### Magnetic Induction Lighting

The burning time of discharge lamps is normally limited by abrasion of electrodes. It is possible to avoid this characteristic by feeding electrical power into the discharge inductively or capacitively. Simply stated, induction lighting is essentially a fluorescent light without electrodes or filaments, the items that frequently cause other bulbs to burn out quickly (US Department of Energy 2013). The filling of the discharge vessel consists of mercury (amalgam) and low pressure krypton. Like in fluorescent lamps, the primary emission (in UV-region) is transformed with a phosphor coating into visible radiation

(Halonen et al., p.105). The technology is far from new. Nikola Tesla demonstrated induction lighting in the late 1890s around the same time that his rival, Thomas Edison, was working to improve the incandescent light bulb. In the early 1990s, several major lighting manufacturers introduced induction lighting into the marketplace (US Department of Energy, 2013).

Figure 3: Induction streetlight

US Department of Energy, 2013

**Effectiveness and maturity**

Experience with using induction lighting at the U.S. Department of Energy's Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, has demonstrated the long life in actual usage. WIPP's first induction lighting system was installed in 1998, replacing high-pressure sodium (HPS) lights. More than 10 years later, all but three of the original 36 induction units are still operating after more than 88,000 hours of continuous, 24/7 operation. Additional systems were installed in 2002 and succeeding years, both indoors and outside, with excellent results.

Thus, many induction lighting units have an extremely long lifetime of up to 100,000 hours. To put this in perspective, an induction lighting system lasting 100,000 hours will last more than 11 years in continuous 24/7 operation, and 25 years if operated 10 hours a day. Some manufacturers only rate their ballasts for 60,000 hours, even though the bulb may last longer (US Department of Energy 2013).

**Efficiency**

A long lamp life and good lumen maintenance can be achieved with these lamps because of the absence of electrodes. The operation is virtually free of any maintenance of the electrical components. However investment costs are significantly higher than for HPS or Mercury lamps. A study conducted by the U.S. Department of Energy shows installation and equipment costs of induction lamps in the range of LEDs. Energy consumption for generating similar illumination seems to be higher than for LEDs (see DOE 2012, p. 15)

**Environmental impacts**

As standard fluorescent bulbs, induction bulbs contain a small amount of mercury, although it is in a solid state that makes it less harmful in case of breakage. Nonetheless, disposal of induction bulbs has to be done responsibly at the end of their service life because of the mercury content (US Department of Energy 2013).

**Summary of key advantages and shortcomings of induction lamps**

Advantages of induction lamps:

- Virtually maintenance-free operation
- High efficacy – in many cases, 60+ or 70+ lumens per watt
- Long life
- Excellent colour rendering index (CRI) – 80+ and in some cases 90+
- Choice of warm white to cool white (2,700–6,500 K) colour temperature
- Instant start and restrike operation
- No flickering, strobing, or noise
- Low-temperature operation

Disadvantages of induction lamps:

- High price
- Lower luminaire efficacy than LEDs
- Higher electricity consumption than LEDs
- Contains mercury
- Lack of standardisation

**Comparison of LED vs. induction lamps**

The following Table 4 compares LEDs and Induction lamps as described above with other, typical street lighting technology options.

**Table 4: Fixture technology options for street lighting**

| Technology | Mercury Vapour | High-Pressure Sodium Vapour | Induction | New Ceramic | LED |
|---|---|---|---|---|---|
| **Relative Age** | Oldest | ⟵ | ⟶ | | Newest |
| **Description** | Older, very common white-light HID technology | Most prevalent HID light source for SL | White light Electrode-less light source with long operating life | White light HID technology; new CMH fixtures are >35 more efficient than previous CMH | White-light, directional, solid-state light source |
| **Pros** | • Low initial cost<br>• Longer lamp life (~24k hrs)<br>• White light<br>• Sudden failures are un-common | • Low initial cost<br>• Longer lamp life (~24k hrs)<br>• High lamp efficacy (70-150 lumens/ watt) | • Virtually maintenance-free operation<br>• High efficacy – in many cases, 60+ or 70+ lumens per watt<br>• Long life<br>• Excellent colour rendering index (CRI)—80+ and in some cases 90+<br>• Choice of warm white to cool white (2,700–6,500 K) colour temperature<br>• Instant start and restrike operation<br>• No flickering, strobing, or noise<br>• Low-temperature operation | • White light<br>• Longer lamp life (24-30k hrs)<br>• High lamp efficacy (~115 lumens/ watt)<br>• High fixture efficiency | • Small size (heat sink can be large)<br>• Physically robust<br>• Long lifetime expectancy (with proper thermal management)<br>• Switching has no effect on life, very short rise time<br>• Contains no mercury<br>• Excellent low ambient temperature operation<br>• High luminous efficacy (LEDs are developing fast and their range of luminous efficacies is wide)<br>• New luminaire design possibilities<br>• Possibility to change colours<br>• No flickering, strobing, or noise<br>• No optical heat on radiation |
| **Cons** | • Poor lamp efficacy (34-58 lumens/ watt)<br>• Lower fixture efficiency 8 (~30%)<br>• Contains Mercury | • Low initial cost<br>• Low CRI<br>• Contains Mercury | • High initial cost<br>• Lower lamp efficacy (36-64 lumens/ watt)<br>• Contains mercury | • High price<br>• Lower luminaire efficacy than LEDs<br>• Higher electricity consumption than LEDs<br>• Contains mercury<br>• Lack of standardisation | • High price<br>• Low luminous flux / package<br>• CRI can be low<br>• Risk of glare due to high output with small lamp size<br>• Need for thermal management<br>• Lack of standardisation |

Source: Table based on GIZ PAKLIM 2012, p.8

# 4. Smart street lighting NAMA implementation plan

## 4.1. Institutional framework

### 4.1.1 Existing institutional framework

The overarching institutional set-up for NAMA design and submission is currently under development in Indonesia. The most preferred option being considered at present is to establish a panel that reviews and approves NAMA concepts and proposals. This panel will most likely consist of the National Council on Climate Change (DNPI), the Ministry of National Development Planning (BAPPENAS) as the coordinator of RAN-GRK implementation, as well as representatives from the leading sector-relevant ministries. Where the SSL NAMA is concerned, a number of key national ministries will need to be involved.

Implementation of the SSL NAMA will require national leadership and coordination, as well as joint management of actions at the provincial and municipal (city) government level. This is because it is the municipal government which has responsibility for installation and maintenance of street lighting in the urban/district areas, while the provincial government is responsible outside of the city. The National Government is responsible for lighting on national roads.

The key actors that have been identified as having a relevant role/responsibility with respect to the implementation of the SSL NAMA are summarised in the following Table 5.

**Table 5: Institutional framework for the SSL NAMA**

| Institution | Primary responsibility/interest | Comments |
|---|---|---|
| **Ministry of Energy and Mineral Resources (MEMR)** | Responsible for energy efficiency policies and measures, including energy efficiency standardization for street lighting (includes LEDs). | MEMR will coordinate the efforts of other key agencies involved in implementation, including those responsible for financing, maintenance and installation and performance standard setting. EBTKE is logically the home of the technical support unit |
| **Directorate General of New/Renewable Energy and Energy Conservation (EBTKE)** | Owner and champion of the SSL NAMA with primary coordination responsibility for energy efficiency standardisation. | |
| **Directorate General of Electricity (DGEEU)** | Responsible for metering regulation with regards to PLN | |
| **BAPPENAS** | Overall coordinator of Indonesian NAMAs and agency overseeing the ICCTF | Key stakeholder as ICCTF may be a logical financing channel for international finance to support the SSL NAMA |

| | | |
|---|---|---|
| **Indonesian Climate Change Trust Fund (ICCTF)** | Fund established to help achieve Indonesia's goal of transitioning to a low carbon economy.<br><br>Potential financing mechanism for management and disbursement of international (supported-NAMA) funds. | Replenishment of ICCTF with a combination of sources of finance is required to enable NAMA implementation. |
| **Ministry of Finance (MoF)**<br><br>**Indonesian Investment Agency (PIP)** | Agency responsible for administering the national budget, including financing for a range of climate mitigation actions. MoF is responsible for overseeing the Indonesian Investment Agency (PIP), which manages a key financing mechanism for the SSL NAMA. | Key stakeholder as domestic financing is required for scaling up of the NAMA over time. PIP loans could be used as one financing option; other options also to be considered. |
| **Fiscal Policy Office** | Unit within MoF responsible for giving recommendation on direction for climate change policy expenditure. | Considering establishment of a revolving fund for energy efficiency improvement investments. |
| **Ministry of Public Works (MPW)** | Responsible for standards of initial street lighting investment, luminance on road surfaces, minimum distance of lighting poles and lifetime of lamps on national roads. | Relatively minor stakeholder |
| **Ministry of Industry (MoI)** | Responsible for standards of lighting products. | Key stakeholder for regulating manufacturers in LED industry. Standards for LED lamps for households (not yet for street light) are being drafted |
| **Ministry of Transport (MoT)** | Responsible for standards for the different components of the furnishings that contain street lights (i.e. poles, sockets etc.).<br><br>Costs for installation of lighting for national roads are covered from the MoT budget. | Key stakeholder for ensuring standard on quality of luminaires and intensity range on public street. |
| **Ministry of Environment (MoE)** | Responsible for keeping track of measured GHG emission | One of the key stakeholders to ensure that GHG emission is nationally recognised |

| | | |
|---|---|---|
| **National Standardisation Agency of Indonesia** | Responsible for facilitation and/or endorsement of national standard (SNI) for LED street light | Key stakeholder for ensuring that an SNI is in place. |
| **National electricity utility (PLN)** | Supplies electricity; charges local municipal lighting agencies for street lighting energy consumption; recovers street lighting energy consumption tax from consumers; responsible for installation, calibration and reading of meters, | Key stakeholder because of the role of metering and the current billing practice. PLN requires the municipality to cover full installation cost of metering and has little incentive to provide metering itself, but will process requests for metering from municipalities. PLN currently benefits from the standard lump sum billing which tends to result in bills that are significantly higher than actual consumption. |
| **Municipal public lighting agencies (PJU)**<br><br>**Typically part of either the Local General Works Agency (DPU) or the Agency for Hygiene and Landscape Gardening (DKP)** | Under the Indonesian regulatory framework, lighting for municipal roads is financed out of the city's budget [6]. The municipality is responsible for maintenance of all street lighting, also on provincial and national roads on the territory of the municipality. | Have an incentive to install metering and efficient lighting as a way of reducing their energy bills, but typically cannot afford to do so without obtaining an increase in their budget allocations. |
| **Private sector companies supplying efficient street lighting equipment**<br><br>**e.g. Osram, Fokus and Philips** | Commercial providers of equipment supply contracts to local PJUs.<br><br>Members of the Association of Lighting and Electrical Industries (AILKI) | Philips has already sold over 3000 LED streetlights in Indonesia; Osram has developed a financial benefits calculation tool for municipalities to demonstrate payback periods. |
| **International donors/financiers**<br><br>**German and UK Governments via the NAMA Facility and potentially others** | Interested in efficient and effective use of climate finance to support mitigation activities in Indonesia | The SSL NAMA was submitted to the NAMA Facility in its first round call for submissions in September 2013 |

[6] See Government Regulation No.34 of 2006, Para 1, Articles 8-9; Law no 22 of 2009, Article 25, and Government Regulation No. 32 of 2011 article 33.

### 4.1.2 Challenges for the institutional framework

There are a wide range of challenges facing successful implementation of the SSL NAMA. Based on the research undertaken for the preparation of this report, including interviews with stakeholders at a national and local level between June – November 2013, the most important issues regarding the institutional framework can be grouped under two broad issues:

- Coordination of multiple agencies and actors
- Addressing the incentive structure regarding billing and metering

### Coordination of multiple agencies and actors

One of the key challenges to be overcome in the implementation of the SSL NAMA is the integration of actions by the multiple institutions at the national, provincial and municipal level. The national level agency which has ownership of the SSL NAMA and is responsible for its coordination is MEMR, as the responsible authority for energy efficiency policy and measures. MEMR will need to achieve buy-in and coordinate the efforts of several other agencies and actors to enable successful implementation. The main coordination issues identified include:

**Standard setting by MoI**

While MEMR is responsible for setting energy efficiency levels that are to be considered in technology/product standards, it is MoI which is responsible for performance standard setting for new products in general. There is a need for cooperation between the two Ministries with MEMR taking the lead as the owner of the SSL NAMA. It is likely that up to a 1-2 year time period is needed for the establishment of a new standard for LED lamps by MoI[7]. Thus, alternative options may need to be considered during the demonstration phase, such as using the International Electrotechnical Commission (IEC) standard in the interim.

**Financing by MoF**

MEMR will coordinate with MoF as the primary agency responsible for administration of the national budget. A key option for scaling up the SSL NAMA is by giving municipalities/provincial governments access to concessional loans under the PIP investment scheme or a similar programme aimed at energy efficiency improvement activities. This could also potentially involve Public-Private Partnership (PPP) models for financing street lighting replacement, for example through supporting Energy Services Companies (ESCOs).

**Support from BAPPENAS**

MEMR needs the support of BAPPENAS as the administrator of the ICCTF, which could be one of the primary financing channels for international climate finance used to support the NAMA implementation.

[7] Discussions with MoI in July 2013 indicated that the estimated timeframe for issuance of new standard (assumed that new standard has references published by either IEC, JIS, ASTM) is 9 months where 6 months is for technical meeting and 3 months for final review in BSN. MoI indicated that its preference is to wait for a LED standard until the corresponding IEC standards are agreed.

In addition, it is BAPPENAS which is responsible for overall NAMA coordination, so the roles/responsibilities need to be clearly defined between the two agencies, MEMR and BAPPENAS.

**Coordination with provincial and municipal level governments**

Participating provincial and municipal level governments will need to be triggered to act on a number of levels including financial, technical and legislative. The overall coordination of the SSL NAMA will be the responsibility of the Technical Support Unit (TSU) to be established within MEMR. The provincial governments would be directly responsible for installation and maintenance in non-urban areas covered by the NAMA, while municipal governments will be responsible for urban areas within each province. Specific legislation may need to be passed by the provincial or municipal governments to enable implementation, to allocate budgets for SSL investment activities and for certain financing arrangements (e.g. for PIP loan repayments). From a financing perspective, the flow of funds between federal, provincial government and municipal governments will need to be coordinated by MoF, as the agency responsible for national financial affairs. A mechanism for coordinating grant funding for climate change (including the amount of financial support for local governments) is currently being developed by MoF. Currently, the variety of funding sources and channelling mechanisms available to stakeholders for climate change actions are not yet coordinated according to a national financial mechanism (MoF, 2012a). Integration with provincial level action will be a key consideration, especially where gaining access to finance is concerned.

**Coordination with local municipalities' public lighting agencies (PJU)**

As the SSL NAMA will initially focus on pilot cities, it is critical that the PJU units of the cities chosen to participate in the SSL NAMA have the capacity to implement and receive the necessary support from the TSU. The PJUs will be responsible for replacement of the lighting technology, and, where relevant, negotiating with PLN on metering installation and restructuring of the bill payment system. The local municipalities are also critical at the MRV stage, and are likely to require considerable capacity building support for this.

**Coordination with the private sector**

Private sector participants, in particular lighting manufacturers/suppliers such as Osram, Fokus and Philips and potentially ESCO service providers, should be enabled to able to gain access to the market. MEMR will be responsible for ensuring that barriers which may arise are addressed – for example coordinating with local level governments if negotiations around supply of efficient lighting technology are delayed due to national-level regulatory issues.

### Addressing the incentive structure regarding billing and metering

Electricity metering for street lighting is an important factor for the success of the SSL. Several Indonesian cities including Yogyakarta, Makassar, Malang and others have already embarked on a path of installing metering. While the local municipalities have a strong incentive to install metering, since it helps them reduce costs, they often cannot afford to do so on their own, and progress has been slow to date. PLN, which charges the cities for their street lighting consumption on a monthly basis, has little incentive to help facilitate a more rapid shift to metering because of the likely over-charging that is currently taking place in the absence of metering (this is discussed in detail in Section 4.2). The current practice of lump sum billing generates bills up to 30-50% higher than actual consumption. This situation is likely to be due a range of factors, including the calculation approach used by PLN and the widespread illegal tapping of the distribution grid. From a security of supply point of view PLN arguably has an incentive to prevent this theft, but a widespread shift to metering would almost certainly have an impact on the revenue received from local governments for street lighting.

The local (regional) PLN office generally accepts metering requests from municipalities but requires the municipality to cover full installation costs which are in the order of 20m Rp (around 1780 USD) per 3-phase meter, which serves up to 20 lamps. PLN has to provide the meter which itself only costs around 1m Rp per unit (88 USD). Metering requests need to be sent by the municipality to the local PLN office. PLN will then propose the number of meters to be installed and negotiate the rest of the installation. PLN also calibrates the meters and is responsible for checking meters.

This payment structure and separation of responsibilities creates the potential for disincentives on the side of PLN to actively support the roll-out of metering. In a positive development, PLN is spending 1 million USD topped up with additional funds from the Asian Development Bank (ADB) for a LED street lighting pilot in Surabaya and Denpasar, with implementation from 2014.

To address the identified challenges, there needs to be a high level political commitment to fixing the incentive structure, prioritising metering and clear structuring of the responsibilities in the implementation of the SSL NAMA. The implementation of this will require active coordination by the NAMA owner, MEMR, to ensure that all actors are playing their role.

### 4.1.3 Establishment of technical support unit (TSU)

It is envisaged that a Technical Support Unit (TSU) in the coordinating institution, logically EBTKE, within MEMR, should be established to facilitate the implementation of the SSLI NAMA, and coordinate the activities of all of the involved agencies. Part of the international grant funding component will be for the purposes of technical assistance (TA) to the various actors involved in the implementation of the NAMA. With support from GIZ, the TA funding is proposed to be used to for this. The TSU will be the primary institution responsible for coordination of the various agencies involved, and providing technical assistance/capacity building activities where needed.

The key TA functions of TSU would include:

- Policy advice for reform of street lighting tax policies, pricing regulations and related policies, including the prioritisation of electricity metering.
- Providing technical support to provincial and/or municipal level governments in their applications for financing from national government agencies including PIP.
- Technical advice as an input for the formulation of national energy efficiency standards for street lighting products.

- Awareness raising at the city and provincial level, especially during the scaling-up phase of the SSL NAMA (including on ESCO contracting, design and implementation).
- Technical support on installation, maintenance and MRV of smart street lighting systems in municipalities.

For an overview of the activities of the TSU over the lifetime of the NAMA see the Table 6 below.

**Table 6: Outline of SSL NAMA Technical Support Unit (TSU) within MEMR**

| Overall purpose | • Coordination of actors/agencies involved in the implementation of the SSL NAMA at the national, provincial and municipal level<br>• Provision of technical assistance on policy, financing and technical issues to support the efficient and effective implementation of the NAMA |
|---|---|
| **Functions** | **Phase I: Demonstration phase (2014 – mid 2015)**<br><br>***National level***<br>• Provide technical support and advice to the relevant ministry (MoI or MEMR) for the establishment of energy efficiency performance and safety standards for efficient lighting products at the national level.<br>• Accreditation of auditors and training bodies to enable adequate technical capacities for installation and monitoring of street lighting technologies.<br>• Provide policy advice to MEMR on priority policy issues including electricity metering and a regulatory framework to enable ESCO contracting by cities.<br>• Formulation of policy reform options to enable more efficient scaling-up of smart street lighting, including: reform of taxation policy at the city level and electricity pricing regulations through reduction of subsidy (e.g. phasing in of more cost-reflective pricing).<br>• Interacting with PIP to help reduce bottlenecks/streamline procedures for loan applications. This includes dealing with issues such as the creditworthiness of municipalities and regulatory requirements regarding loan repayments.<br>• Setting up and maintaining a monitoring database required for emissions MRV.<br><br>***Provincial/municipal level***<br>• Provide information via awareness campaigns on the benefits of smart street lighting and metering for city and provincial level governments.<br>• Provide education and training for provincial/municipal governments on correct installation and maintenance procedures and MRV of smart street lighting activities (including measurements required for monitoring emissions reductions). |

- Providing technical support to provincial and/or municipal level governments in their applications for financing for lamp replacement under the SSL. Initially this will focus on two main financing options:

  1. Capacity building to help local governments access *grant finance* channelled through ICCTF when administering international NAMA support.

  2. Supporting local governments in accessing *concessional loans* administered by PIP.

- Support PJUs in conducting audits of the number of lamps installed – such assistance is already provided by MEMR and could be expanded. For example, to support cities in negotiating with PLN or in designing surveys.
- Awareness raising and promotion of the ESCO model, including on the design of contracting arrangements, dealing with national regulations regarding tendering/contracting, and the successful implementation of ESCO-financing.

**Phase II: Scaling-up phase (mid 2015 – 2016)**

***National level***

- Supporting MEMR in the implementation of policy reform options identified in Phase I.
- Exploration of longer term financing options such as a dedicated facility targeting energy efficiency loans managed by the national government (e.g. MoF).
- On-going interaction with agencies responsible for standards (MoI, MEMR).
- On-going and increased interaction with agencies involved in financing, in particular PIP/MoF, as the use of concessional loans is anticipated to play a major role for supporting cities wishing to join the NAMA.
- Enabling the uptake of ESCO contracting by licensing/accrediting ESCOs to give local governments greater confidence in the reliability/quality of their services.
- On-going maintenance and improvement of the monitoring database, including for reporting of NAMA progress at the national/international level.

***Provincial/municipal level***

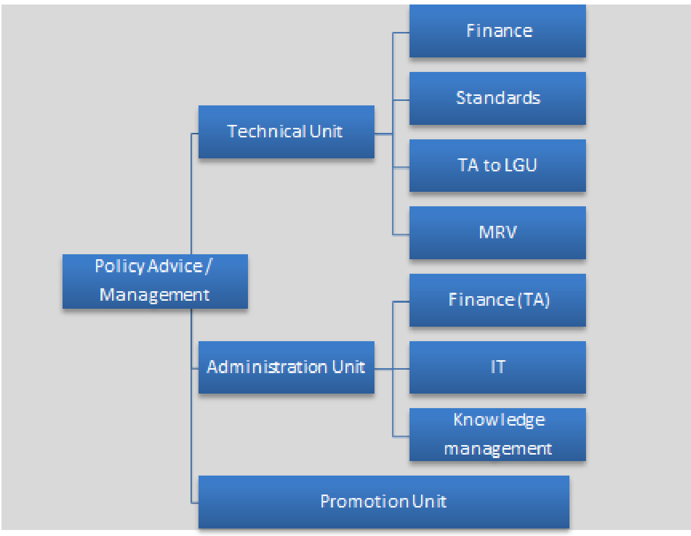
- Expanded awareness-raising of the SSL NAMA benefits at the city and provincial level to promote uptake (in particular, cities outside of Java).
- Technical assistance including training of additional local government PJUs on maintenance and MRV procedures.
- Trouble-shooting support for cities that have already joined the SSL NAMA in the first phase, for example, in dealing with ESCO arrangements or MRV issues.

| | |
|---|---|
| | • Facilitation of ESCO financing in 1-2 cities by supporting local governments in the development of necessary legislation to enable contracting, in preparation of tender documents and so on.<br>• Supporting additional municipal/provincial governments in their PIP loan applications.<br><br>**Phase III: Transformation phase (2017 – 2019)**<br><br>***National level***<br>• Supporting MEMR in the implementation of policy reform options identified in Phase II.<br>• Development of options and budgeting plan for the long term functions of the TSU beyond the SSL NAMA implementation. One option is to adopt a broader Energy Efficiency (EE) focus as an Indonesian Energy Efficiency Agency (similar to India's BEE (Indian National Energy Efficiency Agency)).<br>• Coordinating with national government level agencies involved in financing SSL.<br>• Maintaining the monitoring database including for NAMA reporting at the national and international level.<br><br>***Provincial/municipal level***<br>• On-going support for cities involved in the SSL NAMA as per Phase II, including for new cities joining in Phase III.<br>• Promotion of its benefits to expand coverage nationally.<br>• On-going support for cities in preparation of financing applications and when entering into ESCO arrangements. |
| **Staffing needs** | At a minimum the following staff is foreseen to be required in Phase I-II of the NAMA:<br>• **Manager/general coordinator**: senior level manager, experience coordinating complex projects involving multiple agencies; international experience and ideally energy efficiency expertise.<br>• **Finance coordinator**: finance background, responsible for direct interaction with ICCTF/BAPPENAS, PIP/MoF and municipal/provincial budget officers; supports local governments with related application procedures and guides capacity building efforts.<br>• **Technical coordinator**: engineering background; responsible for interaction with MoI on standardisation, supporting local government PJUs on installation and MRV, including guiding the development of training programmes, and responsible for interaction with PLN on metering issues. |

| | |
|---|---|
| | • **Technical support officers**: up to three support officers who are responsible for carrying out training courses on installation, maintenance and MRV.<br>• **Administrative support staff**: up to two administration and office support staff to maintain databases, organise workshops, meetings, information mail-outs, webinars, local briefings and awareness raising sessions and support the technical/financial/managerial team in its work. |
| **Estimated budget** | Total estimated budget of 5.5m EUR spread over the implementation period 2014-2019, includes salaries, operating costs, and other external costs. |
| **Financing options** | Technical assistance component of NAMA Facility grant channelled and managed through GIZ acting as the implementing agency. By the end of the transformation phase (end of 2019) an alternative funding approach will be defined. |

Figure 4 below provides an illustration of the proposed structure of the TSU. Further detail on each of its functions is provided in the following sections, in particular in relation to its role in MRV and awareness raising/capacity building.

**Figure 4: Organizational set-up of Technical Support Unit (TSU) within MEMR**




## 4.2. Policy and regulations

This section briefly discusses the current regulatory framework relating to the pricing of electricity consumed by street lighting, the mechanism for recovery of the associated costs from the public and the related policy framework. It aims to identify policy reforms which could help incentivize provincial and municipal governments in shifting to more efficient lighting technology.

### 4.2.1 Assessment of existing pricing policies and regulations

At present, there are a number of barriers to street lighting efficiency improvement arising from the way in which electricity pricing and cost recovery is structured. Firstly, as already mentioned, in the absence of metering of street lighting in many Indonesian cities, the level of consumption is estimated and billed by PLN on a lump sum basis. Where there is partial metering of street lighting, the local government receives a bill from PLN which includes a component based on metered data, and a component estimated on a lump-sum basis. This estimation is done using a set of conservative assumptions including 375 hours per month of operating hours and an adjusted power rating based on technical specifications of the lighting technology, which results in the highest possible consumption being calculated for the number of assumed connections. Presidential Decree No. 89 of 2002 governs the formulation to define effective power (VA) of lump sum payment which results in an assumed minimum value twice the installed power rating as shown in the Table 7 below.

**Table 7: Effective Power Rating of street lighting lamps**

**A. Gas Discharge Lamps**

| No | Lamp Power Rate | Effective Power (KVA) |
|---|---|---|
| **1** | 10 - 50 | 100 |
| **2** | 51 - 100 | 200 |
| **3** | 101 – 250 | 500 |
| **4** | 251 - 500 | 1000 |

**B. Incandescent Lamps**

| No | Lamp Power Rate | Effective Power (KVA) |
|---|---|---|
| **1** | 25 - 50 | 50 |
| **2** | 51 - 100 | 100 |
| **3** | 101 – 200 | 200 |
| **4** | 201 - 300 | 300 |
| **5** | 301 - 400 | 400 |
| **6** | 401 - 500 | 500 |
| **7** | 501 - 600 | 600 |
| **8** | 601 - 700 | 700 |
| **9** | 701 - 800 | 800 |
| **10** | 801 - 900 | 900 |
| **11** | 901 - 1000 | 1000 |

The exact number of lamps connected to the PLN distribution network is highly uncertain in many Indonesian cities due to the practice of residents (households and businesses) illegally connecting. For example, in one city in Java, Surakarta, discussions with the PJU revealed that of an estimated 17,360 lamps in total around 40% of these are likely to be illegal connections[8]. Its last full audit of the number of lamps was done in 2007. The PJU expects that further illegal connections have been added since

[8] Two aspects related to illegal connections are: firstly, where people install a lamp without notification to the PJU so the lamp is not accounted for by the PJU; and secondly, the technical connection does not fulfill the standards (cabling type, lamp type)

then but does not know how many. PLN bills the city based on the total number of connections from the 2007 audit (including illegal connections). The city has metering covering around 30% of all street lighting, but this reflects only 16% of its street lighting electricity bill - the remainder (84%) of its bill is based on the lump sum approach. Tax revenues have been increasing due to population growth, but barely keeping up with the growth in the electricity bill; both are expected to reach around 30bn IDR in 2013, with little room for increasing the tax which is already set just under the maximum limit at 9%[9]. That is, the tax covers consumption alone, with new installations, maintenance and any replacement programmes needing to be financed by other means.

Secondly, the disconnect between the tax revenues and the expenditure on street lighting via the PJU does not encourage investment in more advanced and expensive technology. The street lighting tax is defined by the national law (UU) 28/2009 (para 55-56) and the rate can be set by the municipal council through a local decree (Perda). The regulation contains specific provisions restricting the level: up to a maximum of 10% for regular household, business customers, up to a maximum of 3% if the electricity is used by certain industries including mining and the oil and gas sector, or generated from other sources (usually PLN), and up to a maximum of 1.5% if the user is a captive power user. The table below provides a summary of the tax levels charged by a number of different cities/regions. As can be seen, most cities in

**Table 8** are already at or near the maximum possible level of the tax (10%). The actual money is collected from end customers by PLN on behalf of the municipality. PLN then transfers the collected money to the municipal government.

[9] Interview with Surakarta PJU in August 2013.

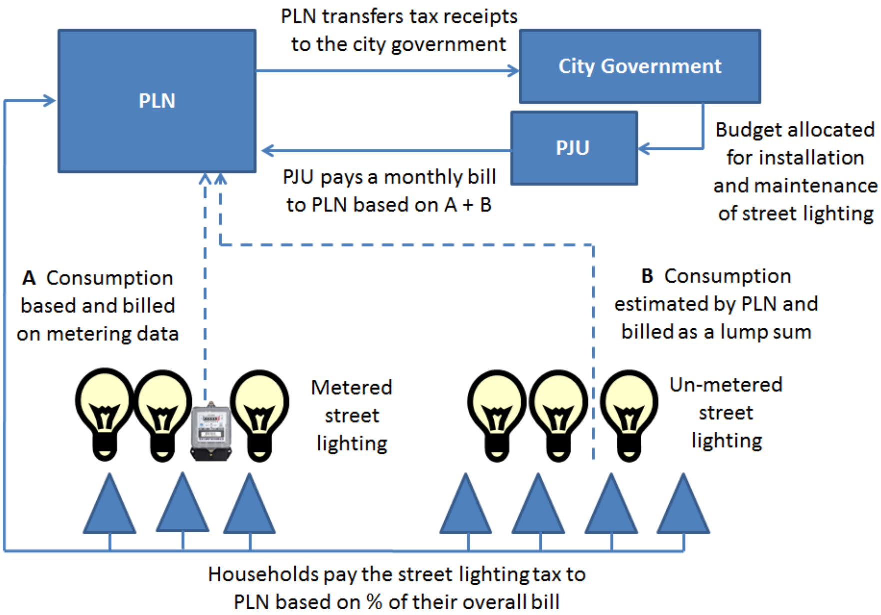
**Table 8: Overview of street lighting taxes for selected cities in Indonesia**

| City | Tax rate on street lighting energy consumption (Note: rate for regular consumers other than restricted industries and users of captive power) | Source |
|---|---|---|
| **Yogjakarta** | 8% | Perda No. 1 of 2011 |
| **Pekalongan** | 9% | Perda No. 5 of 2011 |
| **Surakarta** | 9% | Perda No. 4 of 2011 |
| **Probolinggo** | 10% | Perda No. 2 of 2011 |
| **Blitar** | 10% | Perda No. 7 of 2011 |
| **Malang** | 7% | Perda No. 16 of 2010 |
| **Semarang** | 5-9% (different categories of users) | Perda No. 7 of 2011 |
| **Salatiga** | 9% | Perda No. 11 of 2011 |
| **Medan** | 7.5% households; 10% businesses | Perda No. 16 of 2011 |
| **Makassar** | 10% | Perda No. 3 of 2010 |
| **Mojokerto** | 10% | Perda No. 12 of 2010 |

Because the tax is levied for the purpose of financing street lighting services, the public feels an entitlement to having lamps directly outside their homes and businesses. This is one of the main drivers for the illegal connections. However, since the tax is not linked to the actual consumption of electricity from street lighting, including from such illegal connections, it has no impact on electricity consumption. In addition, since the receipts flow into the municipal government's consolidated (general) budget, the city PJU is not able to directly link tax receipts to the required investment in energy efficiency lighting. Even in the case of cities which have achieved full metering and have adequate tax earnings to cover street lighting energy consumption, such as Yogyakarta, the PJU still relies on the municipal government and legislative for budget allocations to cover its costs. Increasing the tax would therefore not necessarily mean the PJU will receive additional funding which can be used for a LED replacement programme, for example. In addition, since most cities have already reached the 10% tax limit, or are near this limit, it is not an available policy lever for raising finance for energy efficiency improvements. Even where this is theoretically possible it is generally not seen as being a likely option, as is discussed below.

The diagram below (Figure 5) illustrates the cost-recovery and payment mechanism that is currently in place in Indonesian cities.

**Figure 5: Cost recovery and payment mechanism for street lighting electricity**




Thirdly, electricity prices in Indonesia are subsidised more generally, such that PLN is unable to recover the full costs of its supply from its customer bills; this creates a disincentive to move away from the current pricing mechanism for street lighting. Nation-wide, the average cost of power produced by PLN in 2010 was IDR 1089/kWh (1.03 US cents/kWh), while it only recovered on average IDR 693/kWh (6.57 US cents/kWh)[10]. Even in Java-Bali where prices are more reflective of the cost of generation than elsewhere in the country (where average generation costs are higher) there is a need for government subsidisation of PLN's operations (World Bank, 2005). If fully cost-reflective electricity pricing were introduced, there would be less reason for PLN to resist the move to cost-reflective pricing of street lighting consumption, which tends to *over-estimate* consumption, since its operations would be funded by the income received from its customers. At present, essentially many Indonesian cities are being overcharged for their street lighting consumption and this helps to offset PLN's losses elsewhere in the system.

Increasing electricity tariffs would encourage investment in more efficient technology on the side of the provincial/municipal governments and result in greater tax receipts from the public to help finance this. From PLN's point of view, improvement in energy efficiency of street lighting would help ease capacity constraints, especially during peak times.

### 4.2.2 Available options for reforming pricing policies and regulations

To overcome the above barriers, there are a number of regulatory reform/policy options that could be considered further. These are briefly discussed below.

**Reforming the street lighting tax regime**

[10] http://www.pln.co.id/sulselrabar/?p=799

If regulation allowed for higher tax levels, the municipal or provincial governments could be directed (e.g. by presidential decree), to increase their street lighting taxes as a way of financing the LED roll-out themselves. However, there are a number of issues with this approach. Firstly, this would essentially result in the national government shifting the burden of funding the roll-out onto consumers. Local governments would be forced to deal with the political fallout that would result from this and many would be likely to oppose it as an option. In addition, there would be practical challenges in defining a nationally-harmonised approach since cities/regions already charge different tax rates and have different budgetary circumstances (some can self-fund their street lighting activities already, while others are running a deficit due to the number of illegal connections and the lump-sum billing).

If left on a voluntary basis, some city governments may determine that a tax increase is an appropriate option if they have not already reached the maximum limit. For example, discussions in Malang indicated this could be an option: currently a 7% tax is charged from consumers, which could be increased up to 10% to help finance street lighting activities. However, there will be different considerations facing cities when making this determination. Firstly, the roll-out would compete with alternative uses of the tax revenues such as reducing budget deficits and other infrastructure investments. The PJUs would still need to fight for the increased budget allocation due to the non-hypothecation of tax revenues to specific uses. Secondly, the tax increases may be politically unpopular with citizens. Finally, from an equity perspective it is also questionable for consumers to be forced to finance the roll-out when the cost savings associated with it will flow to the local government, unless the benefits are redistributed somehow.

**Reforming the approach which PLN uses to calculate the consumption on a lump sum basis**

Discussions with city PJUs have indicated that there is no transparent process in place for changing the way that consumption is calculated by PLN after energy efficient street lighting is installed. If a city PJU replaces a series of inefficient lamps with more efficient technology, it would expect PLN to consider the resulting electricity savings when calculating the bill for each month. However, the current lump-sum payment system does not distinguish between different types of lamps and their efficiency – the same price is effectively charged for a 400W lamp as for a 1000W lamp (GIZ PAKLIM, 2012). Consumption is also based on a flat rate, which is not effective of peak time consumption, due to the relatively low level of metering in most cities up until now. As it is moving towards full metering, a city expects that the monthly bill will be shifted from the lump sum-billing practice to billing based fully on metered data.

Anecdotal evidence gathered during discussions with city PJUs suggests that a common scenario is that the city PJU must approach PLN and negotiate this transition through a rather non-transparent process which can take time and careful diplomacy. The number and type of installed street lighting needs to be validated by PLN before it will change the way in which consumption is calculated. In some cities, there are on-going disputes between PJU and PLN over the number of connections. Until the negotiations and validation are completed, it is likely that the monthly bill from PLN will remain the same as it was prior to the efficient lamp replacement. Thus, there is a reduced incentive on the PJU to invest in more expensive and efficient technology because it is uncertain if and when the benefits will be reaped.

Discussions with PLN during the preparation of this report indicated that there is indeed a willingness to move to metering, and a commitment to respond to a city's request for installing metering in a timely manner. More open dialogue between officials from the Municipal Government side and the PLN side could help resolve issues on metering and billing. This will require leadership from senior staff at PLN to ensure that officials in regional offices are aligned with overall company policy and directions.

A clear set of national rules setting out the procedural steps, timeframes, and obligations to be followed by both the city PJU and PLN to ensure a speedy transition to cost-reflective billing would reduce transaction costs and create a greater incentive to replace inefficient lamps with more efficient technology. These rules could include both a metered and non-metered scenario, to enable efficiency improvements to proceed on both tracks. A specific issue that needs to be addressed is to determine how to incorporate LED and other smart lighting technologies into the PLN pricing structure. LEDs may not fit easily into a tariff system designed for conventional gas-release lamps.

**Wider reform of Indonesian electricity pricing**

Removing or reducing energy subsidies in Indonesia have long been the subject of discussion, including the debate about moving electricity to a cost-reflective tariff regime. It is important to recognise the scale and hence implications of this issue for the national economy: the total value of electricity subsidies provided by MOF to PLN reached over IDR 90 trillion (9bn USD) in 2011 (IISD, 2012). Street lighting is but one small element of the national electricity consumption profile.

The Indonesian government understands the reasons for removing energy subsidies, which tend to benefit the wealthy more than the poor, and has made efforts to do so in the past. MEMR is planning to take gradual steps towards the removal of electricity subsidies, starting with big industry, based on the decision from Working Committee of the House of Representatives in September 2013. A statement in 2010 by the then energy minister indicated subsidies should be removed by 2014, but this will happen gradually, with protection of low income people remaining in place (Jakarta Post, March 23, 2010)[11].

Expectations for more widespread reform of electricity subsidies in the near term must be considered against the backdrop of the demonstrations seen earlier in 2013, which were held in protest against reduction of petroleum subsidies, and the upcoming presidential elections in 2014. More far-reaching electricity pricing reform is seen as being an unrealistic option in the timeframe for starting the SSL NAMA implementation, which is intended to run over 2014-2019. Electricity pricing reform at a national

[11] http://www.thejakartapost.com/news/2010/03/23/govt-expects-remove-electricity-subsidy-2014.html

level takes considerable time to develop options, achieve political support, draft legislation and obtain approvals from the House of Representatives. Coming into an election year this is particularly challenging. Wider removal of electricity subsidies is hence seen as an unrealistic option for stimulating the SSL NAMA until after the election. At that point in time, it may become clearer whether electricity pricing reform could play a role later on in the NAMA's timeframe.

**Metering**

Perhaps the most important factor for a successful SSLI NAMA implementation is increasing the pace and coverage of electricity metering of street lighting. Currently only a few of the Indonesian cities being considered as priority cities for the SSLI NAMA have reached full metering, as shown in the Table 9 below.

**Table 9: Metering rates in Indonesian cities being targeted for the SSL NAMA**

| City | Metering rate (%) |
|---|---|
| **Yogyakarta** | 100 |
| **Semarang** | NA |
| **Surakarta** | 30 |
| **Malang** | 50 |
| **Probolinggo** | 10 |
| **Pekalongan** | 17 |
| **Makassar** | 95 |
| **Cimahi** | 95 |

Source: Interviews with municipal PJUs in August-September 2013

While full metering is not necessarily recommended as a pre-condition for participation in the SSL NAMA, a more rapid move to this would enable a smoother and more successful implementation, for a number of key reasons.

**Financial**

Metering avoids the need for lump sum-billing by moving to fully cost-reflective pricing of street lighting electricity consumption. This reduces the burden on PJU budgets, freeing up money for energy efficiency improvements and leaving more funding available for the NAMA from national and international sources.

**Monitoring of outcomes**

If metered data can be used to monitor and report on progress of implementing the SSLI NAMA this would be more accurate than estimation based on an assumption of the number of lamps and monitoring the operating hours of those lamps (see MRV section).

**Cost estimation**

Inadequate data on the number and type of lamps, number of illegal connections etc in unmetered cities makes the estimated investment requirements for the SSLI NAMA somewhat uncertain. To deal with this, contingencies need to be built into the analysis (see the Financing section). Increasing metering would significantly reduce this uncertainty, and help make a stronger case for both domestic and international financing to support for the SSL initiative.

Increasing the metering of electricity consumption from street lighting is already being pursued by city governments because of the financial benefits of avoiding the lump sum billing approach. Almost all city PJUs interviewed during the research undertaken for this report indicated a strong desire to reach full metering and were interested in any form of support that might be provided. The role of the national government of Indonesia could be to accelerate this process by making it a policy priority. National government support could be provided in a number of ways, for example by facilitating greater cooperation on the side of PLN, and/or by providing financial support to cities which are unable to self-finance metering easily from within their municipal budgets. The support could be provided by the national government in conjunction with the SSL initiative, via a package of soft loans provided by PIP for example. PIP would be more willing to offer loans for metering if PLN is fast in adjusting the city's billing, since this would enable the cities to pay back the loan amount through the savings generated more quickly. If the modernisation of the street lighting network were defined as a national priority by MEMR this would also open up the possibility for (Special Allocation Fund) DAK grants to be made available to cities which cannot finance a more rapid roll-out of meters themselves. Funding of the metering component with domestic sources could thus be counted as part of the "unilateral NAMA" component of the SSL NAMA.

### 4.2.3 Possible next steps

The following pricing policy and related reform options are considered:

1. MEMR envisages to consult with PLN on a transparent procedure for the calculation of consumption of electricity from efficient street lighting. This would help reduce transaction costs and increase the incentive for PJUs to invest in more efficient lighting. Two tracks are recommended – one with and one without metering.
2. MEMR envisages to facilitate a more rapid move to full metering of street lighting in Indonesian cities by offering facilitation and/or financial support. This would help incentivise cities to switch to more efficient lighting technologies and ensure the SSL NAMA is implemented more successfully.

## 4.3. Baseline data

### 4.3.1 Availability of national data on street lighting energy consumption

The annual energy consumption of street lighting at a national level is stated in the Handbook of Energy and Economic Statistics of Indonesia, published yearly by the Centre for Data and Information on Energy and Mineral Resources within MEMR (ESDM energy statistics, 2012). In 2011, street lighting accounted for 3,068 GWh of electricity sales by PLN. These statistics are made up of a metered and non-metered component. The non-metered component, as was discussed earlier, is likely to overestimate consumption in many cities since PLN has an incentive to charge local governments for the maximum possible consumption and the approach used for estimating street lighting electricity usage is designed to ensure this outcome. Disaggregated data on street lighting energy consumption at the city level is not published by MEMR.

According to GIZ PAKLIM (2012), street lighting accounts for a significant share of GHG emissions from local government operations and contributes significantly to costs, as shown in the Table 10 below.

**Table 10: Contribution of street lighting to local government GHG emissions**

| City | Baseline emissions | Street lighting as a % of total GHG emissions from govt. operations | Electricity bill p.a. IDR billion |
|---|---|---|---|
| **Surakarta** | 17,173 $tCO_2e$ | 77 | 18.9 |
| **Yogyakarta** | 7,775 $tCO_2e$ | 82 | 7.2 |
| **Pekalongan** | 6,910 $tCO_2e$ | 76 | 10.3 |
| **Salatiga** | 2,287 $tCO_2e$ | 20 | 3.2 |

Source: GIZ PAKLIM (2012)

Data on electricity consumption can be obtained from the individual PJU divisions at the provincial/municipal government level, but is of mixed reliability without metering. Reliable metered data is only publicly available in very few municipalities - one positive example is Makassar, which publishes monthly metered data online. Interviews conducted with PJUs during the research involved in this report identified the lack of validated, consistent data on the number and type of street lights installed in Indonesian cities as a key risk factor in the successful implementation of the SSL NAMA. Unless cities have achieved full or near full metering, or have recently conducted a full audit, there is likely to be considerable discrepancies. In the case of the cities in Java interviewed during the research for this report, the estimated number of illegal connections ranged widely, for example:

- Blitar – estimated to account for around 10-20% of all consumption
- Probolinggo – estimated to account for 60-70% of all connections
- Surakarta – estimated to account for 40% of all connections
- Pekalongan – estimated to account for 20% of all connections

Thus, both the national level data published by ESDM and the PJU data should be treated with caution unless there is metering in place.

### 4.3.2 Identification of a suitable baseline determination approach

Widespread metering would provide more reliable data, and could help identify the cause of the losses (depending on the metering design). However, it is not realistic for a full-scale national roll-out of metering to be required for all cities as a precondition for the implementation of the SSL NAMA. Firstly, the costs are likely to be prohibitive (see section on financing needs for the SSL NAMA). Secondly, the timeframe for such a roll-out would prevent utilisation of the financing options identified for the intended timeframe of the SSL NAMA. Thirdly, metering of street lighting may not be essential for monitoring of the energy savings and hence emissions reductions that will result from the SSL NAMA, as is discussed below. This is not to say that metering should not be a matter of national policy priority, but simply that from an emissions point of view there is another approach available – taken from the CDM – for establishing the baseline.

An alternative approach is to calculate baselines for each city/province utilising municipal/provincial level data on street lighting (number of lamps installed, type of lamp, rated wattage, operating hours etc). These calculated baselines can then be confirmed/adjusted ex-post during the monitoring phase. This approach does not avoid the need for reliable data on the number and type of lamps installed, so at the very least a recent (e.g. within the last three years) audit or numbers of lamps validated by PLN should be required from a city as a pre-condition for joining the SSL NAMA. Otherwise, the monitored results could be quite different from expectations based on ex-ante assumptions.

The approved CDM methodology AMS-II.L *Demand-side activities for efficient outdoor and street lighting technologies* defines certain criteria for deriving the baseline situation and can be applied in the context of deriving a baseline for the SSL NAMA. It provides for the following:

- Estimation of electricity consumption in watts multiplied with operating hours.
- Operating hours need to be measured (using sampling) ex-post through e.g. brightness sensors or schedules. Alternatively conservative, regional default values for day light time can be applied.
- Lighting technologies covered by the methodology include all luminaires (LEDs and other technologies) and related equipment such as control systems that decrease electricity consumption.
- The applied technology must be new equipment/not transferred from another city.

In the CDM methodology, monitored data through meters is not required. Rather, lamps that fulfil certain standards are sufficient for deriving the baseline.

### 4.3.3 Key baseline parameters

As the baseline will be different for each city participating in the SSLI NAMA, the discussion in this chapter is on a general level, covering the key baseline parameters that are valid for all assessed options. Average values have been calculated that allow a theoretical up-scaling of lamps under the different scenarios in Section 4.5. We distinguish between technical, financial and emission related baseline elements.

### Technical baseline parameters

Important technical parameters for the baseline can be taken from the CDM methodology outlined above. In particular, this includes the number, type and rated wattage of the lamps installed in the municipal or provincial roads. For many cities researched as part of preparing this report, this data was obtained directly from the PJUs. However, for the purposes of estimating the baseline energy consumption of additional cities that might join the NAMA during its scaling-up, it is simpler and necessary to derive the baseline using assumed average values for a hypothetical "model" city. This can be done based on the average number of lamps per inhabitant in an average Indonesian small/medium/large sized city, the lamps per road km and the typical wattage per installed lamp, using a weighted average approach for the different lamp types, based on the lamps installed in cities where better quality data is available. The most common lamp types that have been installed in the past are Mercury 250W and different kinds of High-Pressure-Sodium (HPS) lamps.

**Table 11: Technical parameters for baseline estimation**

| Parameter | Truncated mean* baseline value |
|---|---|
| **Number of lamps per inhabitants** | 1/47 |
| **Lamps per road km** | 39 |
| **Wattage per lamp** | 205 |
| **Operation hours per day** | 12 |
| **Typical lifetime of average lamp (in hours)** | 24,000 |

*Truncated mean is the average of a number of values discarding the highest and lowest value

Source: Assessment of seven Indonesian cities, based on GIZ PAKLIM (2012)

### Financial baseline parameters

Aside from the technical parameters there is a financial baseline for the business as usual scenario. Key financial elements are listed in the following Table 12. Among these are typical costs per lamp and related civil works and O&M, the electricity tariff and the average tax levels that create current funds for financing street lighting.

**Table 12: Financial parameters for baseline estimation**

| Parameter | Baseline value |
|---|---|
| **Costs per HPS lamp (150W)** | 246 USD |
| **Costs per Mercury lamp (250W)** | 226 USD |
| **Civil work costs per lamp** | 48.6 USD |
| **O&M costs per lamp** | 6.7 USD (8 USD for years 4 and 5) |

| | |
|---|---|
| **Electricity tariff in 2014** | 75 USD/MWh |
| **Average street lighting tax level** | 7% |
| **Average street lighting revenue per inhabitant** | 3.9 USD/year |

Source: Assessment of seven Indonesian cities, based on GIZ PAKLIM (2012)

**Emissions baseline parameters**

A main focus of the NAMA will be on achieving emission reductions. Therefore the setup of a realistic emissions baseline is essential for assessing the mitigation impact of efficient street lighting. In addition to the technical parameters listed in the Table 13 above the other key parameter for estimating the emissions baseline is the respective grid emission factor (GEF) for each of the Indonesian cities which could potentially be covered by the NAMA, as outlined below.

**Table 13: Grid Emission Factors relevant for cities targeted under the SSLI NAMA**

| Grid | Cities targeted under the SSL NAMA connected to this grid | Grid emissions factor (kg $CO_2$-e/kWh) |
|---|---|---|
| **Jakarta Madura Bali Grid (JAMALI)** | Yogyakarta, Pekalongan, Surakarta, Probolinggo, Blitar, Malang, Semarang, Salatiga and Mojokerto | 0.741 |
| **Sumatera Grid** | Medan | 0.748 |
| **Sulawesi-Selatan-Sulawesi-Barat Grid** | Makassar, Sulawesi Selatan | 0.601 |
| **Minahasa-Kotamobagu Grid** | Manado, Minahasa | 0.319 |

Source: MEMR (2012)

Using the above information, an emissions baseline can be established quite easily for each of the cities joining the SSL NAMA. The way this baseline can be used to calculate emissions reductions is explained in detail in Section 4.6.

### 4.3.4 Recommendations

In general, a better understanding of the discrepancies between officially published street lighting consumption statistics and the real situation in Indonesian cities is required. In particular, there is a need to understand the different components of electricity losses in the baseline situation and their relative contribution - i.e. the share of line losses vs. degradation of equipment vs. illegal connections/theft. This is recommended as an area for further exploration following the release of this Implementation Plan. Once these issues are better understood, it may be possible to use official national statistics to calculate the baseline for cities during the further expansion of the SSLI NAMA.

In the meantime, it is recommended to impose a requirement on cities wishing to join the SSLI NAMA that they have at least one of the following:

a) The city has metering in place to cover a minimum percentage of street lighting load (e.g. above 50%); or

b) The city has conducted an audit within a minimum timeframe (e.g. within the last 3 years prior to joining the NAMA).

It is also recommended that the baseline for individual cities/municipalities joining the SSL NAMA in the demonstration phase should be established on a city-by-city basis using the following approaches:

a) For cities where full coverage metering has already been installed or is soon to be installed, it is recommended to use the metered data for baseline establishment.

b) For the non-metered component of the consumption (up to 50%), use the calculated approach as outlined in this section and in Section 4.6.2 (where the emissions reduction equations are included based on approved CDM methodology AMS-II.L).

c) When applying option b), emissions reductions calculated ex-ante should be verified ex-post during the monitoring phase, as is outlined in Section 4.7.

## 4.4. Performance and safety standardisation for LEDs

### 4.4.1 Background

The Indonesian National government is making efforts to improve demand side management through various energy efficiency and conservation programs. LED street lights were implemented on a pilot scale in a few Indonesian cities to study the technical performance and to exhibit energy and cost savings over conventional lighting to the local governments. A few companies have also started manufacturing LED chips in Indonesia, which are the key component in all LED lighting products. To date, Indonesia does not have any standards for LED street lighting. Acceptance of LED based street lighting by local governments is a key factor in determining the large scale implementation of the SSL NAMA. In view of the global mandate to adopt low emission oriented development and Indonesia's RAN-GRK, development of relevant technical performance and safety standards for LED products are imperative. This would restrict the supply of sub-standard LED products in local markets.

### 4.4.2 Existing Standards for street lighting in Indonesia

The Standar Nasional Indonesia (SNI), which are the Indonesian National Standards, specify a range of lighting standards. Most of the standards were developed based on the International Electrotechnical Commission (IEC) standards. These standards are designed for general lighting, performance and safety requirements pertaining to fluorescent lamps (single capped and double capped) and lamp control gear. There is no exclusive standard for LED street lighting in Indonesia. SNI 7397: 2008 LED signal lamps on trains has been adopted from IEC 7397. Ministry of Public Works (MPW) provides standards on procurement and installation of street lights and has set a general standard for street lighting in 2005. SNI 6197:2011 Energy Conservation in Lighting System requires 70 Lumen/W and 40,000 hour lifetime for household LEDs.

The road classification and specification of street lighting for urban areas, including the luminance and illuminance requirements are provided in SNI 7391, 2008. Indonesian standards 04-6959.1-2003 and SNI 04-6959.2.3-2003 have been introduced for producers, importers and sellers of light control equipment and AC electronic ballasts for fluorescent lamps.

All enterprises that produce, import and trade lamps must meet stipulated national standards of SNI 04-6973.1-2005[12], SNI 04-6973.2.1-2005, SNI 04-6973.2.2-2005, SNI 04-6973.2.3-2005, SNI 04-6973.2.5-2005 and have a certificate issued by accreditation institutions or laboratories. Article 91 of Industrial bill criminalizes the non-compliance with mandatory SNI standards (Foreign market access report, 2010). Once an SNI is stipulated as mandatory, the standard becomes a requirement of the market. Mandatory SNIs are put in effect in a non-discriminatory manner which means that they are valid for both foreign imported goods and domestically produced goods.

SNI 04 6973.2.3-2005 (Part 2.3 of Lamps: Special requirements for street lighting) standard specifies the luminaire standard for other lamps but not for LEDs.

Further, a few local governments have come up with their own Technical procurement (technical specification bid) documents for LED street lighting, including the Government of Gorontalo (Spesifikasi Teknis Lampu Penerangan Jalan Umum, February 2010). These documents are not governed by any specific standards approved by the National government and the specifications requirement in the bid documents vary between provinces/cities which in turn could lead to quality, safety and performance issues in the long run.

There is a lack of testing protocols to test LEDs for technical specifications. At present most of the laboratories can test only incandescent lamps and self-ballasted lamps for general lighting. However, *lites.asia*[13] has come up with the "Test and Performance criteria for LEDs operating in tropical countries". The standards include Initial light output, Lumen maintenance, supply over voltage, supply under voltage, accelerated temperature/humidity test, ingress protection, heat sink maintenance.

[12] SNI 04 -6973.2.1-2005 (Part 1 of Lamps: General Requirements and Test)

SNI 04 -6973.2.1-2005 (Part 2.1 of Lamps; Special Requirements: Fixed General Lamps)

SNI 04 -6973.2.2-2005 (Part 2.2 of Lamps: Special Requirements of Embedded Lamps)

SNI 04 -6973.2.3-2005 (Part 2.3 of Lamps: Special Requirements of Street Lightening)

SNI 04 -6973.2.5-2005 (Part 2.5 of Lamps Special Requirements of Floodlight)

[13] *Lites.asia* is a cooperative forum for countries in the Asia-pacific region focusing on lighting

### 4.4.3 Road Classification & Standards for Illumination

Roads in Indonesia are broadly classified into national roads, provincial roads and city/municipal roads. National roads are arterial roads providing highway connection between provincial capitals and national strategic roads and toll roads. Provincial roads are collector roads in the primary road system providing connections between the provincial capital and municipal cities or towns and between district capitals in a province and provincial strategic highways. City roads are public roads in a secondary road network that provide connection between service centres and residential areas in a city (Indonesian commercial newsletter, January 2012).

Classification of roads in Indonesia and specifications for street lighting in urban areas are provided in SNI 7391 of 2008. The specification is as follows:

**Table 14: Road classification and street lighting specifications in Indonesia**

| Type/Road Classification | Illuminance | | Luminance | | |
|---|---|---|---|---|---|
| | **E average (lux)** | **Uniformity g1** | **L** *Average* **(cd/m$^2$)** | **Uniformity VD** | **VI** |
| **Sidewalk / Footpath** | 1 – 4 | 0.10 | 0.10 | 0.40 | 0.50 |
| **Local Roads** | | | | | |
| - **Primer** | 2 – 5 | 0.10 | 0.50 | 0.40 | 0.50 |
| - **Secondary** | 2 – 5 | 0.10 | 0.50 | 0.40 | 0.50 |
| **Collector Roads** | | | | | |
| - **Primer** | 3 – 7 | 0.14 | 1.00 | 0.40 | 0.50 |
| - **Secondary** | 3 – 7 | 0.14 | 1.00 | 0.40 | 0.50 |
| **Arterial Roads** | | | | | |
| - **Primer** | 11 – 20 | 0.14 – 0.20 | 1.50 | 0.40 | 0.50 0.70 |
| - **Secondary** | 11 – 20 | 0.14 – 0.20 | 1.50 | 0.40 | 0.50 0.70 |
| **Arterial Road with controlled access, freeway** | 15 – 20 | 0.14 – 0.20 | 1.50 | 0.40 | 0.50 0.70 |
| **Flyover, interchange road, tunnel** | 20 – 25 | 0.20 | 2.0 | 0.40 | 0.70 |

*Key:*

*cd = Candela*

*g1 = $E_{min}/E_{max}$*

*VD = $L_{min}/L_{max}$*

*VI = $L_{min}/L_{average}$*

*TJ = Glare Limitation*

Since India is a developing country with similarities to Indonesia in various respects, Indian classification of roads and illumination standards are considered for comparison with Indonesian standards. The classification of roads in Indonesia and the prescribed lighting requirements have been compared with standards prescribed by the Bureau of Indian Standards (BIS). Table 15 indicates BIS standards for levels of illumination for different road classifications. A comparison of the two standards indicates the scope for further strengthening the Indonesian standard.

**Table 15: Type of roads and levels of illumination based on Bureau of Indian Standards**

| Classification of lighting installations | Type of road | Average level of illumination of road surface (lux) | Ratio of Minimum/ Average Illumination | Type of luminaire | |
|---|---|---|---|---|---|
| | | | | **Preferred** | **Permitted** |
| **Group A1**[14] | Important traffic routes carrying fast traffic | 30 | 0.4 | Cut-off[15] | Semi cut-off[16] |
| **Group A2**[17] | Other main roads carrying mixed traffic, like main city streets, arterial roads, throughways, etc. | 15 | 0.4 | Cut-off | Semi cut-off |
| **Group B1**[18] | Secondary roads with considerable traffic like | 8 | 0.3 | Cut-off | Semi cut-off |

[14] Group A1: For very important routes with rapid and dense traffic where the only considerations are the safety and speed of the traffic and the comfort of the drivers

[15] Cut-off Luminaire: A luminaire whose light distribution is characterized by rapid reduction of luminous intensity in the region between about 80º and the horizontal. The direction of maximum intensity may vary but should be below 65º. The principal advantage of the cut off system is the reduction of glare.

[16] Semi-cut off luminaire: A luminaire whose light distribution is characterized by a less severe reduction in the intensity in the region of 80º to 90º. The direction of maximum intensity may vary but should be below 75º. The principal advantage of the semi-cut off system is a greater flexibility in siting.

[17] Group A2: For other main roads with considerable mixed traffic like main city streets, arterial roads and thoroughfares

[18] Group B1: Secondary roads with considerable traffic like local traffic routes, shopping streets

| | | | | | |
|---|---|---|---|---|---|
| | local traffic routes, shopping streets | | | | |
| **Group B2[19]** | Secondary roads with light traffic | 4 | 0.3 | Cut-off | Semi cut-off |

The key results of the analysis are as follows:

- The roads are categorized based on the usage and purpose in both the countries
- The prescribed illumination level for specific categories of roads is more or less in the same range in both countries
- The type of luminaire (namely cut-off & semi-cut-off) is not included in the Indonesian standards. Cut-off luminaire allows less than 2.5% of light to leave the light fixture (above 90 degrees) compared to 5% of light emitted by semi-cut off lights. The light emitted into the sky causes glare and light pollution which has a significant effect on mood of human beings, animal life and obstructs astronomical studies. To minimize the light pollution cut-off luminaire are preferred for street lights.

### 4.4.4. International experience in defining LED street lighting standards

India also faced similar challenges due to the lack of LED street lighting standards earlier in 2009-10, when local governments and private companies started adopting LED technology for street lighting. The solution was that Standards prescribed by the American National Standards Institute (ANSI), International Electrotechnical Commission (IEC) and Illumination Engineering Society (IES) were adapted by India as temporary standards. A "Core team" consisting of major ministries and regulatory bodies including Ministry of Power, Bureau of Energy Efficiency, Ministry of New & Renewable Energy and Department of Information Technology was constituted to define this draft standard. A resolution was passed at the national level to promote LED lighting in a phased manner over a fixed time period. Accordingly, Bureau of Indian Standards was directed to come up with Indian version of standards for LEDs based on the available International standards. As a result of the determined effort, BIS defined LED street lighting standards for India in the year 2012. Local governments in India utilise these standards to prepare technical bids for installation of LED street lighting.

The key standards developed by BIS, based on international standards are as follows:

| | |
|---|---|
| ***IS 16101: 2012*** | General Lighting; LEDs and LED modules; Terms and definitions |
| ***IS 16102(Part 1) 2012*** | Self ballasted LED; Lamps for General Lighting Services Part 1 Safety Requirements |
| ***IS 16102(Part 2): 2012*** | Self-Ballasted LED; Lamps for General Lighting Services Part 2 Performance Requirements |
| ***IS 16103(Part 1): 2012*** | LED Modules for General Lighting; Safety Requirements |
| ***IS 16103(Part 2): 2012*** | LED Modules for General Lighting; Performance Requirements |

[19] Group B2: Secondary roads with light traffic

| | |
|---|---|
| ***IS 15885(Part 2/Sec 13): 2012*** | Lamp Control Gear Part 2 Particular Requirements Section 13 d.c. or a.c. Supplied Electronic Controlgear for LEDed Modules |
| ***IS 16104: 2012*** | d.c. or a.c. Supplied Electronic Control Gear for LED Modules; Performance Requirements |
| ***IS 16105: 2012*** | Method of Measurement of Lumen Maintenance of Solid State Light (LED) sources |
| ***IS 16106: 2012*** | Method of Electrical and Photometric Measurements of Solid State Lighting (LED) products |
| ***IS 16107: 2012 (Part 1)*** | Luminaires performance; General requirements |
| ***IS 16107: 2012 (Part 2)*** | Luminaires performance; Particular requirements section 1 LED luminaire |
| ***IS 16108: 2012*** | Photobiological safety of Lamps and Lamp Systems |

A detailed list of IEC published LED lighting standards are provided in Annexure 1.

**Minimum performance standards for LED street lighting in India**

Minimum performance standards in India have evolved over time and are defined and governed by the BIS. BIS standards are referred to by Indian cities for the procurement of LEDs and could be adapted by the Indonesian government at a National level. Typical specifications used by Indian local authorities, based on BIS guidance are listed below (Table 16). These specifications could guide the development of Indonesian standards on LEDs.

**Table 16: Indicative product specification for LED lighting [20]**

| Parameters | Value |
|---|---|
| Luminous efficacy | ≥ 95 lm/W |
| Operative voltage range | 140 – 270 V |
| Operating voltage | 230 V ± 10% |
| LED operating frequency | ≥ 120 Hz |
| Input supply frequency | 50 Hz ± 3 |
| Total harmonic distortion | Current <10%; voltage <3% |
| Correlated Colour Temperature | 6,000 – 6,500 ˚K |
| Rated Colour Rendering Index | 75 (minimum) |
| Power Factor | ≥ 0.90 |
| Operating current | ≤ 700 mA |
| Beam angle (LED) | 120˚ minimum |
| Uniformity ratio ($E_{min}/E_{avg}$) | 40% |

[20] Source: Technical specification requirements adopted by Indian cities based on BIS

Other indicative parameters to be considered in a performance standard for LED lamps:

- LED module/ array shall deliver at least 70% of the initial value of lumen output after 50,000 hours of operation.
- Life span of LED source including its driver shall be minimum of 50,000 hours
- The P/N junction temperature of individual LED must not exceed 70°C
- LED should have thermal resistance junction to solder point is < 5°C/W
- LED junction temperature should be 150°C. ± 5°C

### 4.4.5. Developing standards for LED lighting in Indonesia

**Agencies involved in the development of LED standards**

National Standardisation Agency of Indonesia (BSN) is responsible for the legalisation of Indonesian National Standards (SNI). Technical committees and technical sub-committees to draft standards. must be developed and formalised by BSN.

MPW procures all materials related to national roads and is the lead agency for setting standards on luminance on road surfaces, minimum distance of lighting poles and lifetime of lamps, an approval from MPW is required for installing lighting products on national roads.

Ministry of Transport is responsible for the development of safety standards for street lighting and the replacement of lighting units on national roads.

Ministry of Industry is responsible for setting standards for all goods including lighting products and support the development of technology performance standards for street lights.

There are 27 committees for product standardization, with each lead ministry defining the membership (producers, consumers, test labs, experts). So far, there is only one committee which addresses both electronic household appliances and lighting.

The Ministry of Trade (MoT) monitors products on the market. If deficient products are found, the producer is required to upgrade its facilities within six months. MoT ensures that all enterprises comply with the Indonesian national standards for manufacturing, exporting and trading. Producers are required to undergo an ISO audit and test of a sample before they are certified that they fulfil the SNI standard. Importers are required to furnish proof of a similar check; however, this is rarely verified. Approximately 60 auditors are involved in conducting spot checks of production in the country.

Typically Indonesian standards in the field of electronics are only set after an IEC standard has been defined. There are no Indonesian standards for major street lighting technologies including LED and induction lamps. It is envisaged that the MoI will not propose a product standard for LED lighting, unless such a specification is issued by the IEC. Standards for technical performance and safety for street lighting are developed by Streets and Bridges R&D Agency ("Puslitbang") of MPW. Puslitbang has been asked to review the existing safety and performance standard and also add specific standards for LED street lighting. However, Puslitbang will review the standards only after receiving an official request from Directorate General of Bina Marga (Highway), MPW.

**National standards development process in Indonesia**

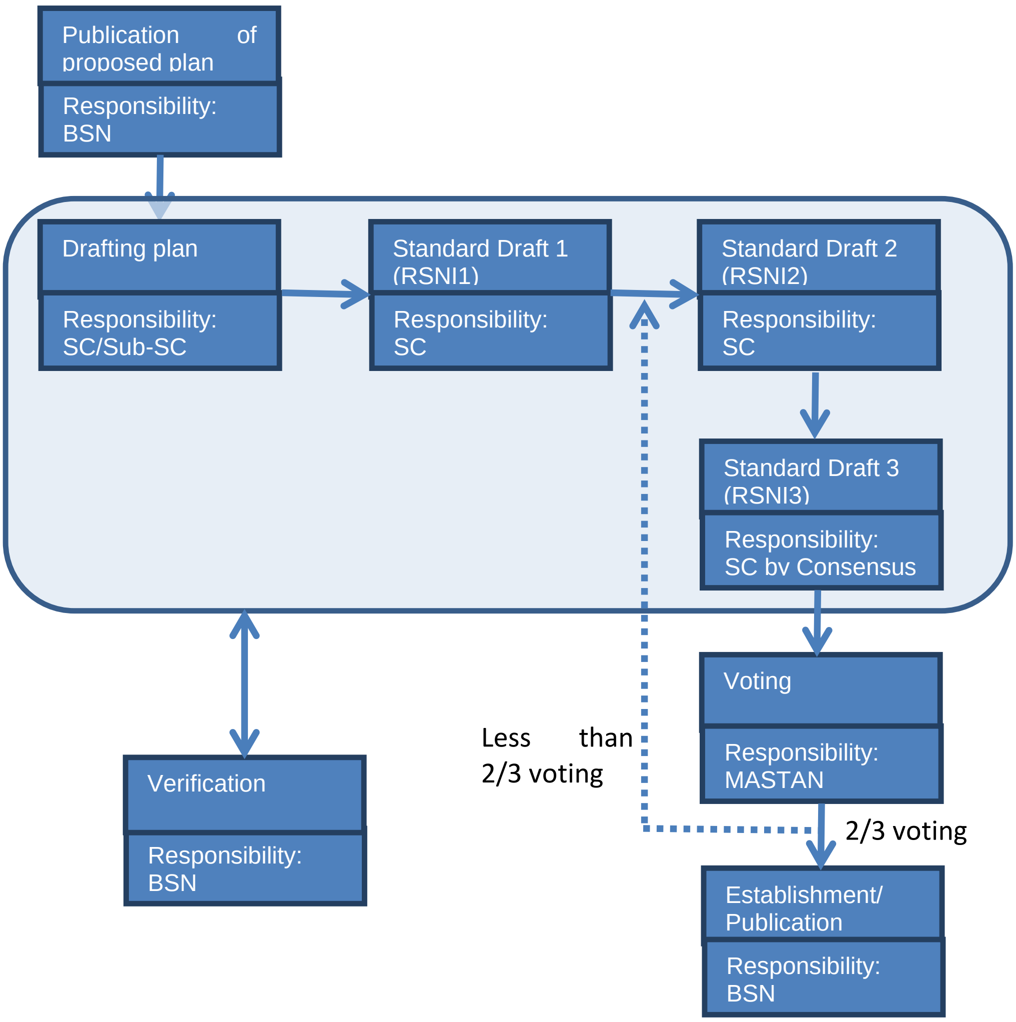
The Agency of National Standard ("BSN") was established under the Regulation of Government No. 102 of 2000 about National Standardization.

Standards are typically established via two main approaches:

- Consensus based i.e. all the stakeholders involved agree with the draft of the standard; and
- Scientific evidence based

The standard setting process of the BSN is given in the Figure 6 below.

**Figure 6: Standard setting process of BSN**




Formulation of a standard involves the following sequential steps:

- Planning of National Program for Standard Development **(“PNPS”):** Towards the middle of fiscal year, BSN publishes the proposed plan for PNPS for the next year. Based on the plan, appropriate Steering Committees (SC) or sub-SCs are constituted to draft the plan. The committees will develop and decide the PNPS draft. The draft plan is then submitted to BSN for approval in the month of February in the subsequent year.
- Development of Standard Draft 1 **(“RSNI1”);** Time period - 3 months**:** The SC empanels a drafter(s) to formulate RSNI1
- Development of Standard Draft 2 **(“RSNI2”);** Time period - 3 months: The SC deliberates on the formulated RSNI1; inputs from all members are sourced. Where necessary, relevant stakeholders deemed are invited to provide specific inputs.
- Development of Standard Draft 3 **(“RSNI3”);** Time period - 3 months:
  The SC conducts a consensus meeting between all members and experts for additional inputs to the draft; RSNI3 is finalized based on the collective decision of the SC.
- Enquiry: Draft of RSNI3 is submitted to BSN for approval. The documents are published by BSN and circulated to all SC members and members of the standardization community. If 2/3rd of the voting members agree to the circulated draft, RSNI3 will be used as RSNI (final draft of standard). If not accepted, RSNI2 is further checked and an improved RSNI3 is prepared by the SC.
- Establishment of standard; Time period - 1 month
- Publication of standard; Time period - 1 month

Committees serve for about 3-year period and usually meet three times before a consensus is established on the standard, which is communicated to the Indonesian standards institution BSN, which then issues a standard under SNI.

**Steering Committee of BSN**

BSN is responsible for standards development and it draws on technical committees and technical sub-committees from the relevant ministries to draft a standard. MoI and MoT are responsible for submitting proposals to BSN for the development of safety standards and technology performance standards for street lighting respectively. After submitting the proposals for standards development, a steering committee (SC) and a sub-SC would be formed. Establishment of SC can be initiated by a technical agency (ministries), stakeholders or BSN.

Composition of SC: Typically, the SC constitutes the chairman/vice chairman (if relevant), secretary and members. In case the chairman has no technical capabilities, a vice chairman is nominated, with relevant experience and expertise. Chairman is usually appointed for 3 years and can be extended for 3 years. A minimum of 9 members would constitute the team. The chairman is required to hold at least a bachelor degree with 2 years of experience on relevant scope of work. Members of the SC should be drawn from regulators, producers, consumers and experts. Members should hold at least a diploma degree with minimum 3 years of expertise or 10 years of experience for senior high school degree.

Establishment of sub-SC is in accordance with the scope of work. In cases where the scope of work is too wide, the SC can develop sub-SCs with specific scopes of work.

The Standardisation Society of Indonesia (MASTAN) is an independent non-profit organisation consisting of nearly 3000 members representing regulators, industry, consumers, infrastructure, institutions and experts. MASTAN facilitates the consultation and e-ballot voting processes during the SNA development stages.

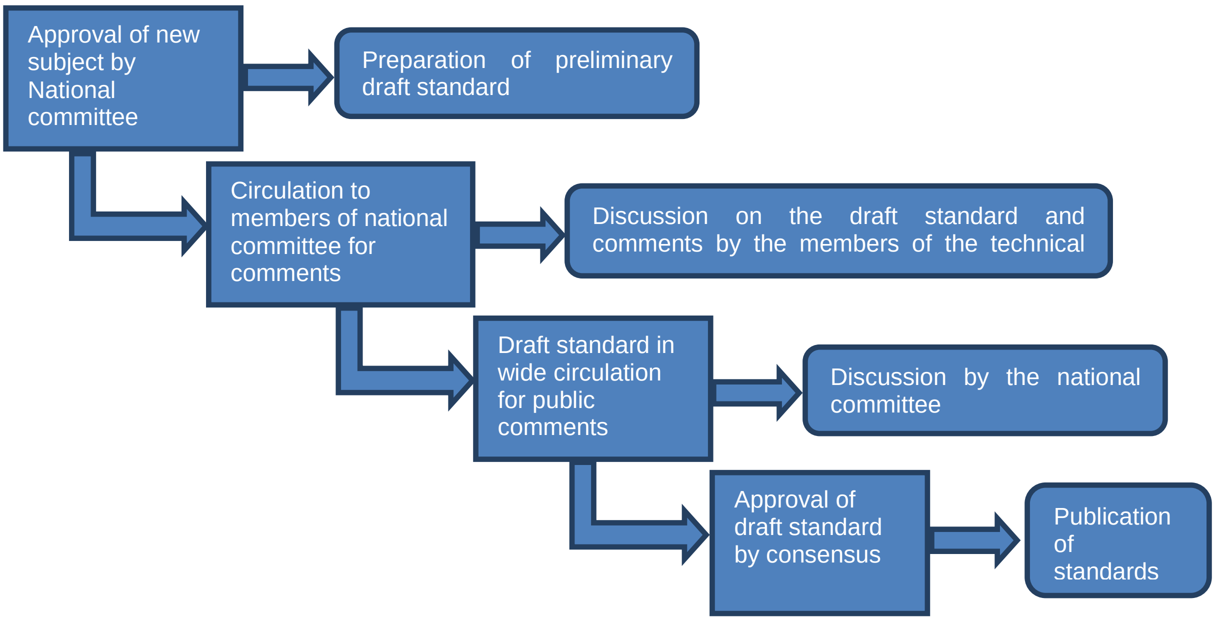
### 4.4.6 Lessons from international standards setting process

The typical process flow for setting standards in India is summarised here for the purpose of comparing it with the process followed in Indonesia. The Indian standardization process entails formation of a balanced technical committee; consultations with concerned stakeholders, seeking comments from public before finalization. The principles of consensus along with World Trade Organization/Technical Barriers to Trade (WTO/TBT) principles are also being followed during preparation of the standards.

The formation of the technical committee is crucial to the standard setting process. The typical composition of the standard committee includes the Chairman (independent body), member secretary (BIS), manufacturers, laboratories/R&D institutions, Government & regulatory bodies, consumer/user organizations, industry associations, public sector units, consulting firms and professional & academic bodies.

The standard setting process of the BIS is given in the Figure 7 below:

**Figure 7: Standard setting process of BIS**



### 4.4.7. Enhancing technical capacity of institutions developing standards on performance and safety

Typically, only selected members from MoI and MoT would be part of the Steering Committees which are set up to define new standards. To further strengthen the technical capacity of the ministries, Other Working Groups (OWGs) could be introduced internally within a Ministry.

- **Formation of Other Working Groups (OWG) under MoI and MoT:**

  **OWG members:** Representatives from the following sectors are probable members who could constitute OWGs: Industrial associations, Ministry of Trade, lighting industries (manufacturers/suppliers), Non-profit organizations, educational institutions, research organizations, sector experts, etc.

  **Role of OWGs:** OWGs make efforts to draft or outline proposals for the development of standards, which are to be submitted to BSN for consideration. OWGs shall follow a definitive procedure (to be defined by the Ministries) and would be involved in data collection, surveys, market assessment, stakeholder consultation (including consumers) and periodic requirement assessment to inform the overall standardization process. The members of OWGs would work as a team and take decisions by participatory approach. OWSs will provide technical support by providing all the necessary information to the respective ministry.

  **Observing members:** OWG members shall be part of the standards preparation process of BSN and could be given an observer status, without voting rights. However, the comments raised by the group should be addressed by the SC. This would provide an opportunity to register the comments of a wider section of the society. BSN shall be requested to provide observer status to OWG of individual ministries.

  **Strengthening the standard setting process adopted by BSN:**

  - The standard setting process should include a wide range of stakeholders including professionals & academic bodies, manufacturers, laboratories, Research & Development institutions, regulatory bodies, industry associations, public sector units, consulting firms, end users and citizen groups.
  - The draft standards prepared by BSN should be widely circulated to the public (also through stakeholder meetings) to seek inputs and suggestions. Draft standards could also be published online to receive comments.
  - The overall educational qualification and experience requirement of the SC members should be raised in consultation with relevant stakeholders.
  - Observer status should be provided to OWG (proposed under MoI and MoT) to enable greater stakeholder participation in and contribution to the standard setting process.

### 4.4.8. Barriers/challenges

- **Use of low standard products -** Due to the price differential between standard and sub standard LEDs of a factor of 2 – which then are still 2.5 times as expensive as conventional street lighting, many Indonesian cities tend to prefer the low standard products. Those however often face problems with heat management; some experience reduction of lumen output up to 50% after 6-12 months. This situation in turn is discouraging the users to choose LED products for street lighting.
- **Lack of IEC standard for LED Street lighting -** lack of an IEC product specification for LED street lighting is hampering the development of Indonesian version of product standards. While IEC has come up with Performance and Safety (PAS) standards for street lighting, the review of these standards for LED is yet to commence. The review is expected to be completed by 2014.
- **MoI confirmed that it wants to wait with a LED standard until corresponding IEC standards have been finalized**[21] **-** Product standard SNI 2008 is purely voluntary. Provincial and municipal roads are not covered by any standard.
- Indonesia lacks training protocol for LEDs, laboratory facilities (including accreditation) and trained operators. There is a need to upgrade laboratory capabilities to test LED standards.

### 4.4.9. Recommendations

- Consensus is required from the relevant ministries including MEMR, MoI, MPW and MoT together with BSN to adopt the existing international standards (including IEC and IES standards) or standards from similar Asian countries, such as India. The TSU to be established with the international NAMA support funding should play the role of a facilitator and provide technical support during the setting of a national standard for LEDs in Indonesia.

- SNI 4 6973.2.3-2005 (Part 2.3 of Lamps: Special requirements of street lighting) specifies the luminaire standard for lamps but not including LED. Solid state lighting (i.e. LED) therefore should be added as addendum to this standard.

- Standards for technical performance and safety for street lighting are developed by Streets and Bridges R&D Agency ("Puslitbang") MPW. Directorate General of Bina Marga (Highway) could request Puslitbang to review the existing safety and performance standards and add specific standards for LED street lighting.

- As an alternate temporary arrangement, a detailed technical specification document on LED street lighting procurement for all kinds of roads could be developed by relevant Ministry. The technical document could be developed considering the existing Indonesian LED street lighting standards and other International standards. This document could then be circulated to all the

[21] Interview with MoI in July 2013.

Indonesian cities through the provincial government and the cities could be directed to use it. Publications and training materials (including on-line versions) together with articles and advertisements could also be released on street lighting (including LED standards, general best lighting practices, etc.) for local governments.

- Testing protocols, infrastructure and accredited laboratories must be set up to ensure testing of LEDs for compliance to the technical standards. As a first step appropriate laboratories should be identified across Indonesia, or national Government should build one, and the laboratories should be equipped with facilities and accredited for testing new requirements arising as a result of adapting international standards. There are some testing laboratories in Indonesia, for example in Surabaya, which can be upgraded with more facilities to test LED performance and safety.

- After adapting suitable standards, all suppliers and manufacturers whose products comply with technical requirements (prescribed by Indonesian standards and other International standards) of LED street lighting, could be listed in the Ministry of Energy & Mineral Resources and other relevant government websites. Local governments shall be directed to procure LED lights only from identified and tested companies. This action would protect users from cheap and non-quality products.

- Given the substantial problems with the lack of National LED standardization, other lighting technologies such as induction lamps could also be considered by the NAMA, especially if their performance is more stable. The technology suitability assessment should be carried out in individual cities to choose the most suitable energy efficient lighting options (may be more than one per city, depending on the baseline situation).

## 4.5. Financing options for efficient street lighting

### 4.5.1 Overview of resource needs for the SSLI NAMA.

In this section an estimated budget for the SSLI NAMA has been developed based on different implementation scenarios. The costs associated with the implementation of the SSLI NAMA include:

- **Capital investment in the LED technology** (or alternative efficient lighting technologies)
- **Capital investment in metering devices**
- **Set-up of institutional infrastructure** (in particular, the set-up of the TSU see Section 4.1.3)
- **Human resources** (in particular, installation and maintenance staffing costs at the city level)
- **Capacity building costs** (technical training related to technology installation and maintenance, awareness raising at municipal level, noting that the TSU will do much of this work).

As capital investment for SSL technology is the main cost driver, an overview of the basic technical and financial parameters is provided below using the same format as outlined for the baseline determination. The emissions related elements such as the GEF are equal to what has already been defined for the baseline.

**Technical project scenario parameters**

The key technical parameters for the project scenarios are the wattage of the installed lamps and the typical lifetime of the lamps. While individual cities will logically be free to determine the appropriate efficient lighting technology/-ies to suit their circumstances, for this analysis it is assumed that the introduced technology is LEDs that are available with different wattages. Similarly, in practice, cities joining the SSLI NAMA will most likely assess the specific lighting requirements as part of an overall “design-based street lighting system”, which is a combination of wattage and type of lamp, pole height and spacing to meet national standards and so on. Cities will logically work with suppliers and ESCOs to design a system which is optimal for their specific circumstances. For simplicity, in our analysis average wattage levels of LEDs replacing equivalent (typically mercury or sodium lights) are applied for an overall assessment at the NAMA concept stage. Hereby we assume that both 150W and 250W HPS lamps as well as 250 W Mercury lamps are both replaced with 140W LEDs.

**Table 17: Technical parameters**

| Parameter | Truncated mean* baseline value |
|---|---|
| **Wattage per lamp** | 140 |
| **Operation hours per day** | 12 |
| **Typical lifetime of average lamp (in hours)** | 50,000 |

*) Truncated mean is the average of a number of values discarding the highest and lowest value

Source: Assessment of seven Indonesian cities, based on GIZ PAKLIM (2012)

**Financial project scenario parameters**

The following Table 18 lists key financial elements relating to the installation of energy efficient lighting. Among these are typical costs per lamp, related civil works and O&M. Again the values are based on the assumption that LED technology is applied.

**Table 18: Financial parameters**

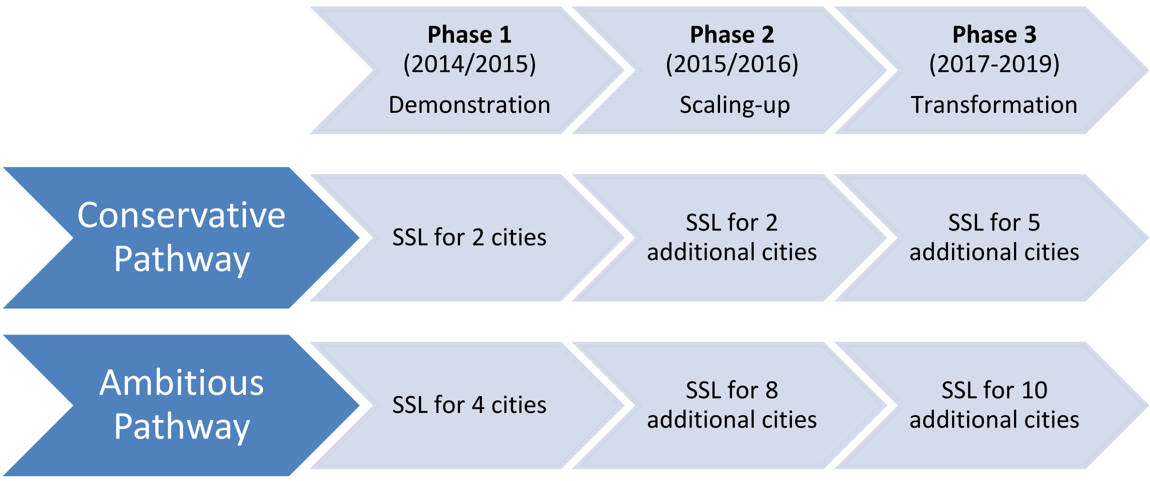
| Parameter | Baseline value |
|---|---|
| **Costs per average LED lamp (110W)** | ~601 USD |
| **Civil work costs per lamp** | 19 USD |
| **Additional contingency assumption per lamp (might cover additional costs for housing and cabling that has to be replaced in some cases as well)** | 30% of LED and civil work costs (~190 USD) |
| | |

| | |
|---|---|
| **O&M costs per lamp and year** | 2 USD (2.4 USD from year 3 onwards) |
| **PIP loan interest rate** | 5% |
| **ESCO model hurdle rate** | 10% |
| **Financial market interest rate** | 12% |

Source: Assessment of seven Indonesian cities, based on GIZ PAKLIM (2012)

The resource needs are estimated below for different scenarios involving different levels of ambition in the number of cities to be covered under the SSL NAMA, and hence different volumes of lamps to be installed. GIZ foresees three phases from 2014 to 2019: A demonstration phase, a scaling-up phase and finally the transformation phase. In the context of these three phases two pathways are assessed, a conservative pathway based on a slower expansion rate for each of the three phases and an ambitious pathway based on a more ambitious expansion rate for each of the three phases. An overview of these is provided in the Figure 8 below.

**Figure 8: Phases and scenarios for efficient street lighting implementation**




Below (Table 19) is an overview of the cities that are considered in the analysis under each of the pathways.

**Table 19: Overview of SSL NAMA Implementation Phases and Scenarios for analysis**

| Phase | Timeframe | Relevant pathway | New cities added | Total no. of cities | Cities covered (sum) |
|---|---|---|---|---|---|
| **Phase I** | Start 2014 to mid 2015 | Scenario I (conservative) | 2 | 2 | Yogyakarta, Makassar |
| | | Scenario II (ambitious) | 4 | 4 | Yogyakarta, Makassar, Probolinggo, Pekalongan |

| | | | | | |
|---|---|---|---|---|---|
| **Phase II** | Mid 2015 to end 2016 | Scenario III (conservative) | 2 | 4 | Yogyakarta, Pekalongan, Makassar, Probolinggo |
| | | Scenario IV (ambitious) | 8 | 12 | Yogyakarta, Pekalongan, Makassar, Probolinggo, Surakarta, Blitar, Malang, Semarang, Salatiga, Medan, Manado, Mojokerto |
| **Phase III** | Start 2017 to end 2019 | Scenario V (conservative) | 5 | 9 | Yogyakarta, Pekalongan, Makassar, Probolinggo + 5 additional cities |
| | | Scenario VI (ambitious) | 10 | 22 | Yogyakarta, Pekalongan, Makassar, Probolinggo, Surakarta, Blitar, Malang, Semarang, Salatiga, Medan, Manado, Mojokerto +10 additional cities |

An estimation of resource needs is directly linked to the number of installed LEDs. The following Table 20 describes the number of required lamps for each phase of the two pathways and estimates the resources needed for installation of LED technology.

**Table 20: Cumulative number of lamps and resource needs for the two pathways**

| | | Phase I | Phase II | Phase III |
|---|---|---|---|---|
| **Conservative pathway** | Number of lamps | 34,000 | 65,690 | 191,232 |
| | Estimated installation costs (1000s USD) | 27,553 | 53,235 | 154,974 |
| **Ambitious pathway** | Number of lamps | 65,690 | 266,557 | 517,640 |

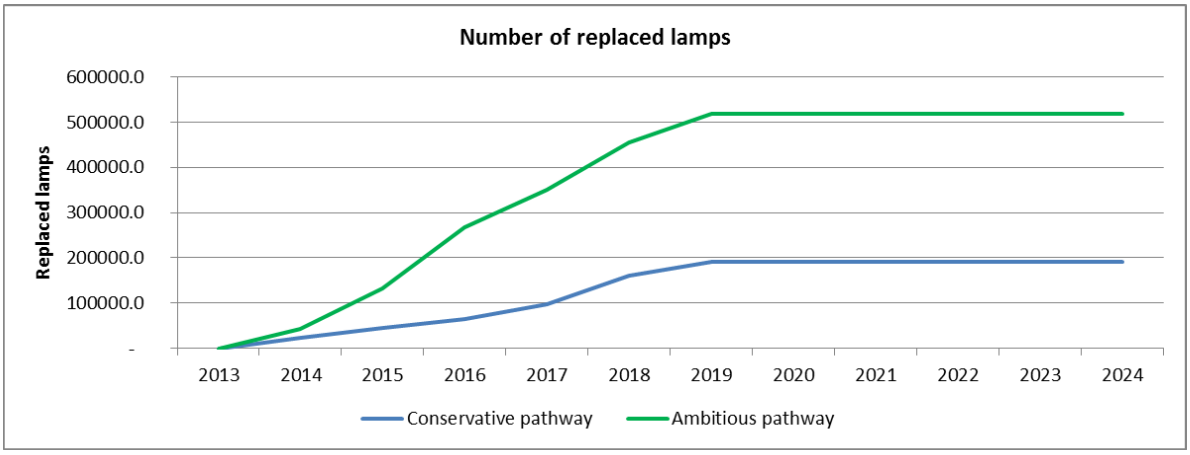
| | | | | |
|---|---|---|---|---|
| | Estimated installation costs (1000s USD) | 53,235 | 216,017 | 419,495 |

Source: Own calculation based on scenarios defined by GIZ

Overall the number of lamps accumulates from about 34,000 to more than 190,000 under the conservative scenario. The costs respectively increase from about 27.5 million USD for phase I to almost 155 million USD in phase III.

**Under the ambitious pathway more than 500,000 efficient lamps are installed in phase III at costs of almost 420 million USD. Both pathways are illustrated in Figure 9.**

**Figure 9: Estimated number of replaced lamps under the two pathways**




Source: Own calculation based on scenarios defined by GIZ

### 4.5.2 Methodological approach for calculation of cash flows for baseline and project scenario

The costs outlined in Section 4.5.1 will be recovered through the reduced costs of electricity consumption, maintenance and retrofits compared with the baseline scenario involving conventional lighting technologies.

Table 21 below summarises the parameters included in the financial analysis of the SSL NAMA, including the baseline values ("Value baseline") and the adjusted parameters for the SSL NAMA implementation scenario ("Value SSL NAMA").

**Table 21: Parameters included in financial analysis of SSL NAMA**

| Lamp Data | Value baseline | Value SSL NAMA | Unit | Source/comment |
|---|---|---|---|---|
| **HPS lamps** | | | | |
| Watts level | 150 | 95 | Watts | Own calculation based on GIZ PAKLIM, p.45 |
| Typical lifetime | 24,000 | 50,000 | hours | GIZ PAKLIM, p.8 |
| Costs per lamp | 246 | 601 | USD | OSRAM |
| **Mercury vapour lamps** | | | | |
| Watts level | 250 | 159 | Watts | GIZ PAKLIM, p.45 |
| Typical lifetime | 24,000 | 50,000 | hours | GIZ PAKLIM, p.8 |
| Costs per lamp | 226 | 601 | USD | GIZ PAKLIM, p.45 |
| **Operational Expenditures (OPEX)** | **Value baseline** | **Value SSL NAMA** | **Unit** | **Source** |
| Operation hours per year | 4,380 | 4,380 | hours / a | Assuming 12 hours of operation a day |
| Electricity tariff | 75 USD[22] | 75 USD | | Average electricity tariff of assessed cities (might deviate according to city) |
| Electricity tariff increase (per year) | 2% | 2% | | Own assumption |
| T & D losses | 10% | 10% | | Default value from CDM meth |
| Overall O&M costs per lamp within year 1-3 | 6.7 | 2.0 | USD / lamp | ICLEI |
| Overall O&M costs per lamp within year 3-> | 8.0 | 2.4 | USD / lamp | Own assumption that O&M costs increase after 3 years by 20% |
| NAMA specific costs (administration, monitoring etc.) | 0 | 25,000 | USD / year | Own assumption |
| **Revenue Specific Data** | **Value baseline** | **Value SSL NAMA** | **Unit** | **Source** |
| Streetlighting tax level | 7.00% | 7.00% | % | Average tax level according to information on 7 cities, plus the 16 cities in long list |
| Decreased energy consumption due to metering | 40% | 40% | %/a | Only valid when power meters are applied |
| **Metering costs** | **Value baseline** | **Value SSL NAMA** | **Unit** | **Source** |
| 3 phase electricity supply | 1,500 | 1,500 | USD / meter | PLN (includes installation costs - civil works) |
| Number of lamps that can be covered by meter | 25 | 25 | lamps /meter | |
| Metering annual cost | 10 | 10 | USD / a | Own assumption |
| Lifetime of metering equipment | 21 | 21 | years | Own assumption |

Source: Spreadsheet “Investment-Analysis – Assumptions” by Perspectives based on sources listed in table

The financial model developed for the SSL NAMA produces the following outputs:

- Cash flow analysis for the SSL NAMA scenario in comparison to the baseline; including the expenses and revenues schedule over the SSL lifetime (approximately 50,000 operation hours). Both for the conservative and ambitious pathway.
- Net Present Value (NPV) for the SSL NAMA scenario. Both for the conservative and ambitious pathway.
- Illustration of financing sources applied for coverage of incremental installation costs. Both for the conservative and ambitious pathway.

[22] The tariff assumed for modeling purposes is lower than the regulated tariff in 2013, which is ca. 90 USD. This was done to avoid over-estimating the cities’ energy bills on the basis of uncertain lamp data, which include a high share of illegal connections. It would be misleading to apply the regulated tariff to all of the installed lamps and calculate payback on this basis.

The results of this analysis are presented below in section 4.5.5.

### 4.5.3 Identification of funding sources

While the replacement of conventional lighting with LEDs or other efficient technologies will logically pay off as a result of energy savings over time, the key barrier to uptake is that municipalities do not have sufficient funds to cover the up-front capital and installation costs. The municipal governments interviewed during the research undertaken for this report generally indicated that their efficient lighting replacement programmes are therefore taking place at a rather slow pace, with small-scale replacement of conventional lighting with efficient lighting happening when replacement is due to take place anyway. As loans are typically available for municipal governments at rather high interest rates of 12-15%, this makes the option of borrowing to fund a more large-scale replacement programme generally unattractive. Hence other funding sources are required to enable the SSL NAMA to reach scale over the timeframe to 2020, and these are considered below.

**Revenues from reduced PLN electricity bill after metering**

Experience to date suggests that if metering is introduced, municipal street lighting electricity bills could fall by 30-40% due to the tendency for overestimating energy consumption; in the case of Yogyakarta the energy bill even fell by 60%. Assuming that the city's street lighting tax is kept constant, the extra revenue could be used to finance the introduction of efficient street lighting, with the electricity bill savings generated by the efficient lights again reinvested in new efficient lights or used to cover the initial costs of the metering roll-out. The drawback is that this financing option is only available to cities that have not yet introduced metering, and that the introduction of the efficient street lights through such a de facto revolving fund approach takes time. For example, savings of 1 MWh/year and lamp through metering as achieved in Yogyakarta and calculating with a tariff of 0.075 USD/kWh would mobilize 75 USD/lamp, which means that financing of the meter itself would be achieved after one year of operation (not including meter installation costs). Financing the entire cost differential between a high performance LED and conventional street lighting would require a decade. This option is therefore only feasible when considered in conjunction with other options.

From the point of view of implementing the SSL NAMA, metering should be seen as a top-order policy priority and could form part of the unilateral NAMA component. It would enable other financing sources to be unlocked (including from the municipal budgets). However, it is not seen as appropriate for funding support be raised from donors to finance the metering roll-out, since the primary purpose of international NAMA support is to support emissions reductions actions. Metering in itself does not save energy or reduce emissions, but rather it helps provincial and municipal governments save money. As a result of this, it can create the incentive for local governments to invest in energy efficiency activities. The finance options considered here can then help stimulate such investment.

**Street lighting tax increase**

In cities which have set the street lighting energy consumption tax still below the 10% threshold (e.g. Malang, where it is currently 7%), a temporary tax increase could create a funding source to cover the investment costs, with the possibility to reduce the tax again once the installation is complete and efficiency gains are being generated (GIZ PAKLIM, 2012a, p. 19). This could be politically difficult, though, as usually the parliament only allows a tax increase when the PJU street lighting bill (lump sum payment to PLN) is larger than the revenues from the tax. This option cannot be applied across the board for political reasons (unpopularity of tax increases). Further, there is no direct hypothecation between the tax revenues and the street lighting budget of the PJU, so it is unclear whether the funds would in fact be allocated for efficient lighting. Therefore this option is also to be considered in conjunction with other financing options.

**ICCTF grant**

The ICCTF is an ideally suited vehicle for the channelling of international sources of finance towards climate mitigation projects in Indonesia, including in the energy sector, which is one of the priority windows of the fund. As the existing funds are fully allocated, however, the ICCTF must be replenished with new sources of finance. This could be achieved utilising NAMA facility funds for example, with the ICCTF acting as the trustee/manager of the grant funding provided by the German/UK Governments, and potentially other donors wishing to join the SSLI NAMA. The ICCTF is thus considered as part of the financing roadmap in conjunction with the NAMA facility funding.

**NAMA facility grant**

In December 2012 the German and UK Governments jointly launched the NAMA facility – a support fund of 70m EUR (95m USD) designed to support developing countries that show strong leadership on tackling climate change and want to implement transformational NAMAs (BMU, DECC, 2012). The first round of the NAMA facility was opened between July and September 2013, and a stage-one NAMA Support Project Outline was submitted by MEMR in application for support funding for the SSL NAMA. The facility will focus primarily on the mobilization of capital investments, but also offer support in the form of technical assistance (TA). Financial instruments will include grant-based support instruments as well as concessional loans. The selection of a specific financial instrument, including the interest rates of subsidized loans, and the amount of funding provided through the Facility will be decided in the context of each individual NAMA support project (German Government, 2013).

Projects selected in stage-one (NAMA Support Project Outline) will enter a second evaluation stage, where full project feasibility studies will be carried out and then considered by the Facility Board. An initial assessment of the suitability of the SSLI NAMA to the NAMA facility is provided in Section 5.1. This financing option is seen as particularly relevant for financing the initial capital investment and TA components of the SSLI NAMA implementation.

**Carbon Markets**

International carbon markets could provide a source of finance if the SSLI were registered under the Clean Development Mechanism (CDM) instead of being financed as a NAMA. However, at current CER prices, which are below 1 USD/tonne on the spot market, the revenues that could be earned from monetizing emissions reductions alone would be highly unlikely to finance the planned lighting replacement. At present, the outlook for the CER market is very weak until at least 2020, and possibly beyond, because of the massive oversupply in the EU ETS, estimated at up to 2 billion allowances, which is the main source of demand for CERs. Prices are essentially reflective of the cost of issuance – at a certain price it becomes uneconomic to pay the transaction costs involved in verification and issuance of credits. Price projections to 2020 are in the order of 2-3 USD/t at best. At current prices of 1 USD/t or less, the total emissions reductions estimated for the SSL NAMA would only raise around 100-400,000 USD if sold on the spot CER market[23]. Thus, CERs are not seen as a relevant source of financing for the SSL initiative.

Other crediting mechanisms including NMM and the Japanese BOCM could theoretically provide longer term monetization options for initiatives such as the SSL initiative. Where NMM is concerned, however, there is still no agreed international framework within the context of the UNFCCC, no modalities for the design and implementation of such a mechanism, and at the time of writing no pilots have been announced or implemented anywhere in the world[24]. Outside of the UNFCCC framework, the EU ETS regulatory framework allows for recognition of bilateral agreements between the EU and countries implementing sector-based approaches, such as NMM. However, there is no certainty whatsoever on the prices that would be paid for credits generated from an initiative implemented under this framework, nor the volumes that would be accepted (if any). The Japanese BOCM is still being operationalised and no projects have yet been implemented, with limited details available on eligibility, likely credit prices, procedures for registration etc. Both of these sources are thus seen as highly uncertain at this stage, and are not considered relevant given the intention to implement the SSL initiative within the next 5-7 years.

**PIP loans**

Concessional loans are offered by the Indonesian Investment Agency (PIP), administered by the MoF. In total, PIP loans include assets under management with a volume of 1.9 billion USD in 2012 (PIP, 2012). According to meetings with PIP in July 2013, approximately 2.8m USD is available in 2013 for energy efficiency activities, and for the following two years the plan is to invest 15-20m USD into public sector energy efficiency activities (including street lighting and waste to energy). The "mandatory" loans offered by PIP, with interest rates typically in the order of 5%, have the potential to be a key domestic source of finance for the implementation of the SSL NAMA. PIP loans can help demonstrate the benefits of the SSL NAMA in the initial pilot cities that would be co-financed with international funding support, and then used to scale-up the NAMA over time.

Some challenges exist. Firstly, there is a lack of experience in the sector since PIP has so far not disbursed significant loans for energy efficiency and renewable energy projects – most of its experience is with major infrastructure such as hospitals, roads etc. Secondly, there is a perceived need from the cities for streamlining the somewhat complicated and bureaucratic approval requirements. Supporting

[23] Prices in the primary CER market (not yet issued CERs) tend to be even lower.

[24] However, it can be noted that the design of a number of pilots is underway at present, funded by the German BMU.

the municipal governments in their PIP loan applications is seen as an appropriate task for the TSU to be set up as part of the NAMA. This option is thus considered in as part of a package in conjunction with NAMA facility funding channelled through the ICCTF.

**Ministry of Finance initiatives on energy efficiency**

The Fiscal Policy Office of MoF is considering the design and introduction of a new scheme to support private sector ESCOs in implementation of energy efficiency. The draft concept at this stage is to establish a revolving fund of 50 million USD to support energy efficiency implementation (maximum 5 million USD per project) with concessional lending rates. The main drawback is that it is very early stage of development, and the earliest the new scheme might be available is the second half of 2014. Depending on how the proposal develops, this option could form part of the package of options for scaling-up the NAMA over time beyond the demonstration phase in 2014-15.

**Unlocking unspent budget from line ministries**

There is the theoretical potential for re-allocations within the national budget to unlock unspent revenues. For example, according to MoF (2012, p. 23) MoT only spend 10-30% of its budget in recent years, while MPW spending reached 70-80% of budget. These unspent funds could in theory be used for investing in a range of energy efficiency activities, including street lighting efficiency. The key challenge is that MEMR does not have any power to direct other line ministries in this way and there is no basis for MoF to do so. Due to these difficulties, this option is not considered to be realistic at this stage.

**Special Allocation Fund (DAK) for Emission Reduction grant**

DAK is defined as “a fund that is originated from the national budget that is allocated to specific regions in order to help fund specific activities that are under regional authority and in line with national priorities” (Jakarta Post, 2012). Primarily, the funds are intended to help less advanced regions by financing activities of national priority, for example in education, health and infrastructure. Street lighting is not included in the list of national priorities for 2014. In future years, the national government would need to identify and define street lighting as a priority sector and identify the specific regions which should be targeted for such grants. In order for grants to be allocated under the DAK for emission reductions, the Coordinating Ministry for the Economy would be required to direct MEMR to set targets and objectives for street lighting efficiency improvements. This process would require very high level political engagement and would be likely to take considerable time and effort, with uncertain outcomes and timeframes. The DAK grant is therefore not seen as a likely option for the demonstration phase of the SSL initiative which is intended to start in 2014. It may become a realistic option for certain cities in disadvantaged regions over the longer term.

**Electricity pricing reform**

Indonesia’s subsidised cost of electricity reduces the incentive for municipal governments to invest in efficient street lighting. In theory, regulatory reform could serve to increase electricity prices to cost-reflective levels. However, as discussed in Section 4.2, major electricity pricing reform has been shown to be politically sensitive and is highly unlikely in the lead up to the 2014 presidential election. This option is thus misaligned with the intended timing of the SSL NAMA implementation. It may become relevant as part of the scaling-up phase of the NAMA beyond 2015.

**ESCO models**

While still at an infant stage in Indonesia, an expansion of the ESCO industry could be a way of unlocking cost savings for local municipalities, but would likely need to be supported in combination with sources of public finance and policy reform. Currently, there is a lack of regulatory framework Local Government Regulation in place (Peraturan Daerah) in place to enable ESCO contracting. With the necessary regulatory framework, this option is could support the scaling-up of the street lighting investment when combined with some of the other promising financing options. Exhibit 1 provides more detail on the ESCO model and the experience in Indonesia and India with ESCOs.

**Exhibit 1: ESCOs**

Energy Services Companies, or ESCOs, deliver energy efficiency savings in return for a payment which is financed through the cost reductions associated with those savings. ESCOs can be either state-owned or privately owned. One of the largest Indonesian ESCOs, PT. Energy Management Indonesia is a state-owned corporation with annual turnover of ca. 3m USD (PT Energy Management Indonesia, 2007). In the context of the SSL NAMA, a privately owned ESCO would enter into a performance contracting arrangement with the local government, provided that the regulatory framework allows for this. Payment for the services performed by the ESCO is then made either ex-ante or ex-post, or more likely a mix of both, which is when the ESCO requires a down-payment covering part of the cost.

- *Ex-ante payment*. The local government pays the ESCO up front to undertake the street lighting replacement and then recovers the cost of this through reduced energy bills.
- *Ex-post payment*. The energy savings are guaranteed by the ESCO, which then obtains finance (e.g. by going to a bank to get a loan, or raising finance on the capital markets) and performs the services. The ESCO is paid by the local government through the cost savings that are generated.

**ESCO experiences in Indonesia**

So far the experience with ESCOs in Indonesia has been rather limited – in particular with regards to street lighting. The barriers include the lack of experienced ESCOs (GIZ PAKLIM, 2012a) and the heavy subsidisation of electricity prices, which reduces the incentive on large consumers to seek out and pay for energy efficiency improvement opportunities. Where local government contracting of ESCOs is concerned, perhaps the biggest barrier is the existing anti-corruption regulations, which prevent the sharing of municipal street lighting tax revenues with the private sector.

One example of a successful ESCO arrangement in Indonesia involves the optimisation of street lighting in the city of Pasuruan. In 2003-2008, the company PT Fokus Indo Lighting provided the municipal government with a package of services involving the complete reconfiguration of the street lighting system to meet IEC standards, saving of energy and resulting in a reduction in monthly electricity costs, plus after-sales services (maintenance etc). As a result of the investment, the city achieved a reduction in its electricity bill from around IDR 2bn/month to around IDR 0.6bn/month (75% saving), without reducing energy output.

However, the contractual arrangement was not able to be replicated due to the regulatory barrier identified above. The regulations are designed to prevent corruption at the local government level. Under the arrangement between Pasuruan and Fokus, the city made a down-payment covering part of the total cost of the project, and then paid off the remainder through the generated monthly savings on the city's PLN bill, plus interest. This arrangement was investigated by BPK (the Supreme Audit Agency), mainly because of the interest paid by the city to Fokus on the monthly instalments. The current regulations allow local governments to cooperate with PIP (under the Ministry of Finance) and pay interest on their loans to PIP, but there is no clear regulatory provision allowing entry into a loan-type agreement with third parties.

In addition, National law No.32 of 2004, which includes the protocol to be followed by local governments regarding the receipt and use of different funding sources, prevents the use of tax receipts from local governments to be directly paid to the private sector. Rather, tax receipts are to be kept within the city budget. This creates significant uncertainty for both the ESCO and the PJU about whether the services can effectively be paid for.

**ESCO experiences in India – an example of making the ESCO model work**

Over the last 4-5 years the ESCO model has gained momentum in India. This has been as a result of the rising energy costs on the one hand, and initiatives by the national government to promote large scale implementation of energy efficiency and energy conservation measures in existing facilities using the ESCO model on the other. A national survey of 171 cities in 23 states showed that street lighting accounts for an average of 6.19% of revenue expenditure of Urban Local Bodies (ULBs), yet only 0.88% of the total budget is allocated towards energy efficiency activities by ULBs. There is an estimated saving potential of 60% of electricity consumption in street lighting on average, nationally.

The national government decided to stimulate the ESCO industry as a way of unlocking this untapped potential. To address barriers such as access to finance, absence of an industry association, lack of confidence of prospective clients in the capacity of ESCOs, BEE (the Indian national energy efficiency agency) has now enabled over 120 ESCOs through an accreditation process. This accreditation exercise has helped provide the technical and financial due diligence necessary to create a sense of credibility amongst the prospective clients who are likely to secure the services of an ESCO, as well amongst the financial institutions who are likely to provide the debt and working capital to the ESCOs. Below is an example of an ESCO financing arrangement for street lighting replacement in the Indian city of Rajahmundry.

Name of the city: Rajahmundry State: Andhra Pradesh
Total number of street lights: 10948
Total Investment: INR 7,000 Million
Savings Achieved: 68.57%
ESCO contract Period: 7 Years

| **Existing Load** | **Numbers** | **Watts** | **Load (kW)** | **Proposed** | **Numbers** | **Watts** | **Load (kW)** |
|---|---|---|---|---|---|---|---|
| 250W HPSV | 832 | 285 | 237.12 | 70W LED | 832 | 70 | 58.24 |
| 250W MH | 93 | 285 | 26.505 | 70W | 93 | 70 | 6.51 |
| 150W HPSV | 1973 | 175 | 345.275 | 70W LED | 973 | 70 | 68.11 |
| | | | | 36W LED | 1000 | 36 | 36 |
| 70W HPSV | 295 | 85 | 25.075 | 36W LED | 295 | 36 | 10.62 |
| 40W FTL | 7355 | 50 | 367.75 | 18W LED | 7355 | 18 | 132.39 |
| 400W MH | 488 | 450 | 219.6 | 180W LED | 400 | 180 | 72 |
| **Total** | | | **1221.325** | | | | **383.87** |

### 4.5.4 Assessment of financing options

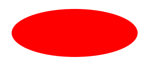
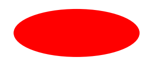
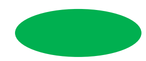
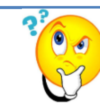
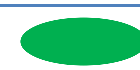
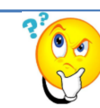
Below, the financing options which were identified in the previous section have been evaluated using a qualitative approach. The options are scored against the following criteria in the table below:

- *Potential volume of funds* – options that can generate/source significant volume of funding are generally scored more highly.
- *Timeframe for implementation* – options that can be utilised more quickly are generally scored more highly.
- *Equity issues* – options which avoid perverse outcomes/unbalanced impacts on certain segment of society are generally scored more highly.
- *Acceptability for policy makers* – options which are likely to be politically acceptable (at both a federal and local level) are generally scored more highly.
- *Transaction costs* – options which avoid high transaction costs are generally scored more highly.

The options are scored against each of the criteria, with a green blob indicating a high score, orange blob indicating a medium score, and red blob indicating a low score. An overall assessment is also provided, in terms of how the option could form part of a NAMA financing package, which is to be described in detail in the following section. Those options which are seen clearly as forming part of the financing package, particularly in the demonstration phase, are given a yellow "smiley face". For the options which have a good potential to form part of the financing package, but where there are some uncertainties which need to be overcome, or where it is necessary to make a case-by-case assessment, these have been assigned with a yellow "pondering face". Those options which are clearly not going to play a role in the foreseeable future are given a red "frowning face".

**Table 22: Qualitative assessment of financing options**

| Assessment criteria | Potential volume of funds generated | Timeframe for implementation | Equity issues | Acceptability for policy makers | Transaction costs | Overall assessment / role in package |
|---|---|---|---|---|---|---|
| **Revenue recycling through metering** | | | | | | |
| | Savings of 40-60% on a city's PLN bill are possible. E.g. in a medium sized city with a bill of 30bn IDR p.a. this would free up 12-18bn IDR (1-1.6m USD). Scale-able across the country. | Will take considerable time. Payback over several years. | Equity would improve since metering reduces overcharging by PLN | Policy makers should be supportive at both federal and local level. PLN may resist. | Up-front cost of meter installation is high. Otherwise low transaction costs. | Metering will play an important role, but need other finance sources to kick-start the SSLI NAMA |
| **Donor or National Grant (through ICCTF)** | | | | | | |
| | Grants of 5-15mEUR (7-20m USD) are possible through the NAMA facility. No restrictions on the size of grants that can be disbursed through ICCTF. | If successful in the first round of NAMA facility grant applications, this could generate a funding stream by mid-2014. | None identified | In line with GoI policy objectives; ICCTF is an established institution | Application procedures for ICCTF require TSU support | Key source of funds for kick-starting the SSLI NAMA in Phase 1 and 2 |
| **Carbon markets (CDM, NMM, BOCM)** | | | | | | |
| | Limited potential. Emissions reductions of 100-400kt $CO_2$-e by 2020 @ 1 USD/CER = 100-400,000USD in total. | CDM is available now, but market is oversupplied to 2020. NMM and BOCM are uncertain at present. | None identified. | Uncertain. CDM is established, but NMM is highly sensitive in terms of international climate negotiations. | Costs (PDD development, validation, verification etc) can be prohibitive. | Unlikely to play a role in the intended timeframe for the SSLI NAMA |

| Assessment criteria | Potential volume of funds generated | Timeframe for implementation | Equity issues | Acceptability for policy makers | Transaction costs | Overall assessment / role in package |
|---|---|---|---|---|---|---|
| **PIP loans** |  |  |  |  |  |  |
| | Loans of up to EUR11-15m (15-20m USD) are available in 2014-15; potentially at a rate of 5% under mandatory loans program. Could help leverage additional funds. | Established procedures in place; loans could be made available in 2014. | None, provided that repayment terms are not too onerous on local governments. | No issues at national government level. Some work needed at local government level to convince cities that accessing PIP loans is a good option. Supported required from TSU. | Application procedure for PIP loans needs to be streamlined to avoid delays/high transaction costs. Support required from TSU. | Key source of funds for expanding the SSL NAMA in Phase 2 and 3. |
| **Street lighting tax increase** |  |  |  |  |  |  |
| | Depends on city circumstances. In some cities, 10% limit has already been reached. Nationally, average is around 7%. | Local governments must pass legislation to increase tax level. Revenue receipts will flow over time, rather than up-front. | Consumers bear the financial burden unless the cost savings are shared with them. | Tax increase is likely to face opposition from citizens. A mandatory national approach is not likely to be popular at local level. | No additional costs aside from legislative amendment. PLN collects tax receipts and transfers to local government | Case by case assessment. Not likely to play a major role overall, but could suit some cities. |
| **ESCO financing** |  |  |  |  |  |  |
| | Potential is very high (up to 75% savings), but contracting needs to be allowed by regulatory framework. | Several ESCOs are ready to start implementing now/early 2014. | None, provided benefits are shared; some risk of private sector capturing benefits. | High level of interest, but regulatory uncertainty is the key barrier to acceptability at the local govt level. | Low if regulatory framework is clarified to allow contracting and with support from TSU. | High potential as a key plank of the finance package if regulatory issue is addressed. |

### 4.5.5 Case studies demonstrating the use of different financing pathways

As outlined in chapter 4.5.1 the implementation plan foresees two pilot street lighting programmes for the demonstration phase (four in the ambitious scenario). This section outlines the financing of the smart street lighting roll out for these two cities in detail. To showcase two cities with quite different situations, Yogyakarta is selected as a more modern, economically developed medium-sized city and Probolinggo is selected as a less modern smaller city more based around the rural sector (agriculture etc). We will outline a suitable mix of financing options and show key investment parameters and results that demonstrate the profitability but also the risks of LED replacements. For both case studies with related baseline and project scenario, limitations of data availability have to be considered. For example the cities do not have a robust and consistent database listing a precise number of street lights. Such constraints are also evident for the exact installation costs thus we have included a contingency rate of 30% for the installation costs of an average 140W LED. This covers, if required, the replacement of the housing and new cabling related the LED.

#### Case study 1: Yogyakarta

Yogyakarta is a middle-size city located at the Southern coastline of the Indonesian island Java. It has approximately 430,000 inhabitants and is known as economic hub of the region with an annual Gross Domestic Product generation of about 675 million USD (bps, 2013). Being a centre of the historic Javanese culture it is also an important touristic destination. Thus the electricity consumption of assumed 860 kWh per inhabitant and year is significant compared to other regions or cities. For example it is about one third higher than in Probolinggo, the other case study described in Figure 10 below.

**Figure 10: Map of Java with Yogyakarta highlighted [25]**


Regarding the street lighting situation, Yogyakarta has reached a comparable advanced stage. The estimated 19,000 street lamps, mostly medium efficiency HPS lamps, have been equipped with meters

[25] http://www.happychap.eu/travel_info/indonesia_2008/java/railway_map_bestanden/image002.jpg

already. This leads to comparably low electricity expenses as the remaining illegal connection are not subsidized by Yogyakarta through the street lighting bill. Due to the high electricity consumption per capita the revenues of the street lighting tax are also comparably high. They exceed the electricity bill by about three times which allows almost sufficient resources for maintenance and replacement of existing lamps. Only few general budget allocations are required for balancing the total street lighting expenses. The municipality has gathered experience with energy efficient LEDs in a pilot programme involving seven 140W LED units used to replace 250W HPS lamps. Based on the positive experience, the PJU would like to invest in the replacement of further HPS lamps. The main challenge is the limited funding available from the municipal budget for a full-scale LED replacement programme, despite the positive balance of the street lighting tax. The PJU is interested in national government financial incentives (grants, soft loans) if made available.

**Table 23: Socio-economic and street lighting specific parameters of Yogyakarta (annually, 2008 data)**

| Parameter | Baseline value |
|---|---|
| **GDP** | 675,400,000 USD |
| **Inhabitants** | 433,000 |
| **Street lighting tax revenues** | 2,200,000 USD |
| **PJU electricity bill** | 720,000 |
| **Street lighting lamps** | ~ 19,000 (HPS dominant type) |
| **Metering coverage** | ~ 100% |

Source: GIZ PAKLIM (2012), 2nd mission report (Perspectives, 2013); bps (2013)

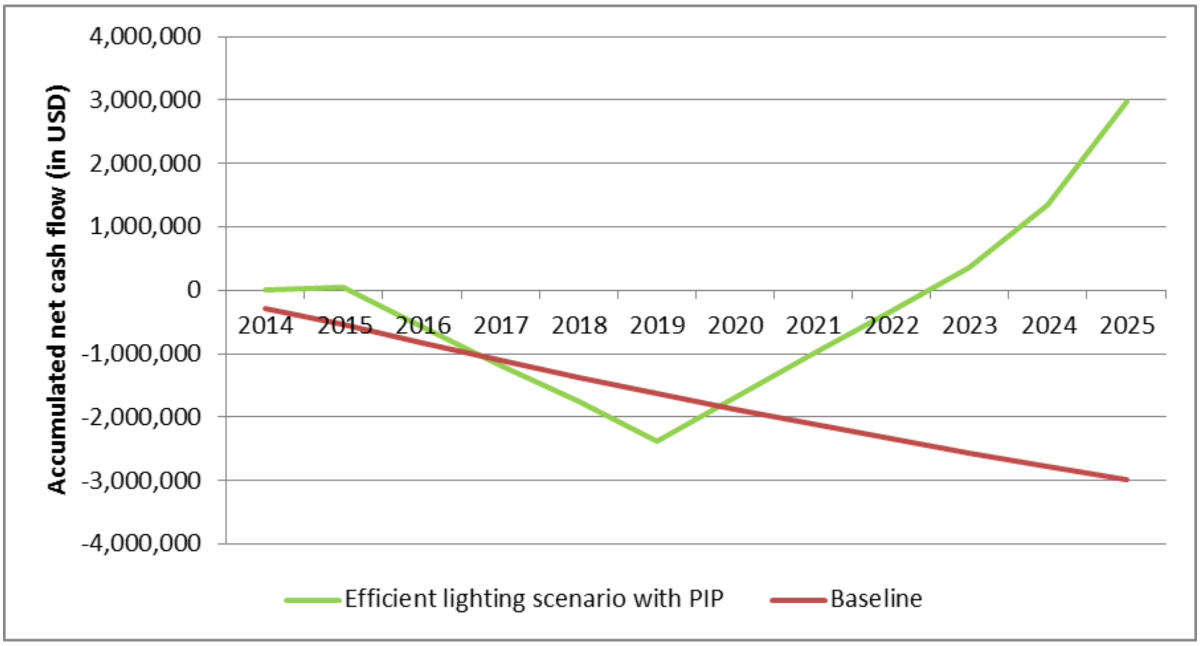
**Baseline scenario:** Our financial assessment shows that the budget for replacement of lamps at the end of their lifetime (in average 5.4 years for HPS), electricity bills, metering and other O&M is almost balanced by the tax revenues. However a shortage of about 10% in 2014, slightly increasing due to rising electricity costs, constantly needs more allocation from the general budget of Yogyakarta.
The NPV derived over the assessment lifetime of 11.4 years (average lifetime of the LEDs) and discounted with 8%/a leads to shortcomings of almost 3 million USD.

**Efficient lighting scenario:** We assume that the HPS lamps are replaced with LEDs as soon as they have reached the end of their lifetime. As there is no detailed information about the current status of the installed lamps available, we assume that about one fifth of the lamps have to be replaced every year. Thus the total implementation time for the LEDs is completed in 2019. Electricity consumption is reduced according to the lower wattage (140W instead of 250W); incremental costs for the replacement are higher due to the LEDs. As financing options we assess an internal option without financial support first. Hereby no NAMA grants and no PIP loans are considered, the municipality would attract funds for the installation of efficient lamps from the financial market. Calculating with an internal discount rate of 8% (represents the cost of capital) the NPV is about 325,000 USD over the lifetime. The IRR of the LED implementation programme has a value of 9%. In this option the NAMA support would be provided through technical advice through the TSU (e.g. assisting the PJU with performance specifications for the LEDs prior to tendering).

The second option involves financial assistance from the Ministry of Finance, via PIP, to help overcome the incremental cost of the LED replacement programme. The modelling simulates a PIP loan of 6.5 million USD provided over 5 years with an interest rate of 5% per annum and repayable from year three onwards. We assume a payback amount of 750,000 to 1,000,000 USD per year until 2024. This approach would increase the NPV to 3.5 million USD over the assessment period.

To illustrate the differences between baseline and efficient lighting scenario we show the annual net cash flow over the lifetime of the LEDs. Whereas the baseline is constantly decreasing, the efficient lighting starts to pay off from year 7 onwards when the electricity savings outnumber the additional burden from higher replacement costs and PIP loan repayments.

**Figure 11: Accumulated cash flows for the baseline and the efficient lighting scenario (including PIP loans)**




### Case study 2: Probolinggo

Probolinggo is a small-medium-sized city located in the Southeast of Surabaya at the Northern coastline of the Indonesian island Java (see red dot in the Figure 12 below). It has approximately 220,000 inhabitants and is a rather rural-oriented city with an annual Gross Domestic Product generation of about 190 million USD (bps, 2013). Its population mainly works in the agriculture and fishing sector. Thus the electricity consumption per inhabitant is comparably low, we assume about 580 kWh per capita and year.

**Figure 12: Map of Java with Probolinggo highlighted** [26]


Regarding its street lighting system, Probolinggo faces a challenging situation. The PJU estimates that around 15,000 street lamps are installed in the city, but only 4,000 connections have been validated by PLN. The PJU estimates that 60-70% of all connections are illegal. The dominant lamp type installed is low efficiency mercury lamps, and only around 10% of all lamps are covered with metering. This leads to comparably high electricity expenses, since PLN charges the PJU for its consumption using the lump sum approach, and assumes a high number of illegal connections, for which no tax income is received. Because of the overall low electricity consumption in Probolinggo, the revenues of the street lighting tax are also comparably low. As the total receipts are about 10% lower than the electricity bill, there are not sufficient resources for maintenance and replacement of existing lamps. A significant amount of general budget allocations are therefore required for balancing the total street lighting expenses. The municipality has elaborated a “green city master plan” which includes replacement of Mercury lamps with energy efficient LEDs in conjunction with metering but the financial challenges prevented its implementation so far. The PJU has been approached by a number of suppliers/ESCOs but cannot afford the up-front capital investment required for a full scale replacement programme. It is not expected that this will change in a business as usual scenario.

[26] http://www.happychap.eu/travel_info/indonesia_2008/java/railway_map_bestanden/image002.jpg

**Table 24: Socio-economic and street lighting specific parameters of Probolinggo (annually, 2008 data)**

| Parameter | Baseline value |
|---|---|
| **GDP** | 187,500,000 USD |
| **Inhabitants** | 220,000 |
| **Street lighting tax revenues** | 750,000 USD |
| **PJU electricity bill** | 950,000 |
| **Street lighting lamps** | ~ 15,000 (Mercury dominant type) |
| **Metering coverage** | ~ 10% |

Source: GIZ PAKLIM (2012), 2nd mission report (Perspectives, 2013); bps (2013)

**Baseline scenario:** Our financial assessment shows that the budget for replacement of lamps at the end of their lifetime (on average 5.4 years for HPS), electricity bills, metering and other O&M is cannot be covered by the tax revenues. About 1.6 million USD from the city budget has to be allocated annually for a proper operation of the system. This amount is slightly increasing due to rising electricity costs.

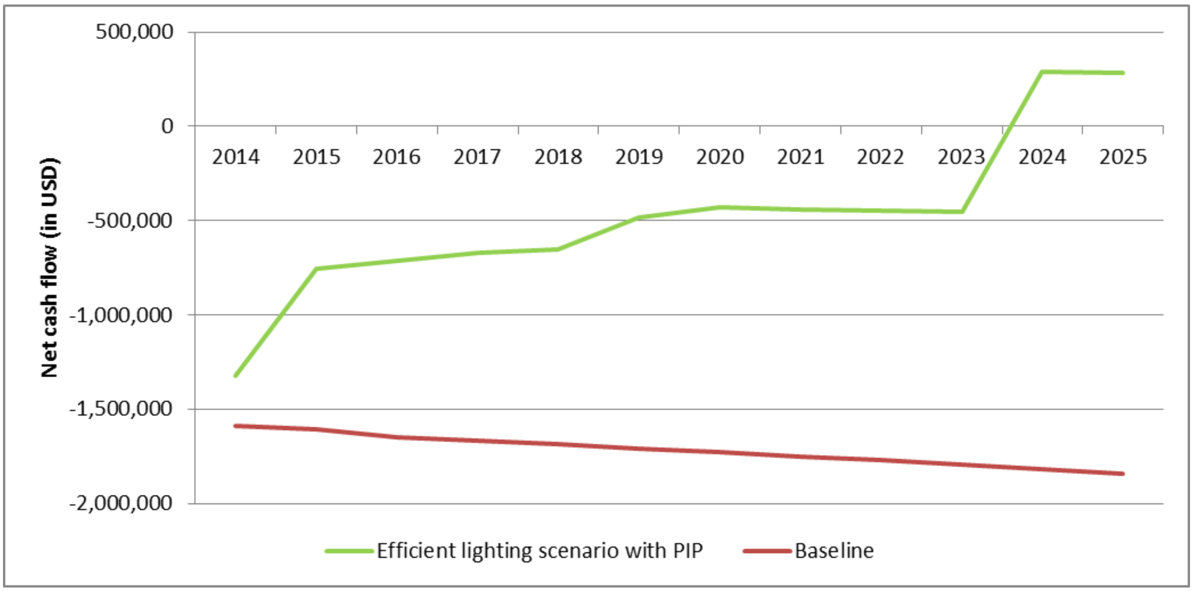
The NPV derived over the assessment lifetime of 11.4 years (average lifetime of the LEDs) and discounted with 8%/a leads to shortcomings of almost 14 million USD. About 1.3 million USD of additional city budget are required for balancing the expenses.

**Efficient lighting scenario:** We assume that the Mercury and HPS lamps are replaced with LEDs as soon as they have reached the end of their lifetime. As there is no detailed information about the current status of the installed lamps available, we assume that one fifth of the lamps have to be replaced every year. Thus the total implementation time for the LEDs is completed in 2019. Electricity consumption is reduced according to the lower wattage (140W instead of 250W), incremental costs for the replacement are higher due to the LEDs. Additionally we assume that a metering system for all lamps is installed. The metering costs would either be covered from the municipal government's consolidated budget, or require national government support. The NAMA TSU would support the local government in sourcing financing to cover metering costs.Investment in metering is not assessed as part of the SSLI NAMA financing package itself, but could form part of the unilateral NAMA component if supported by the national government.

As financing options we assume a combination of three sources: A NAMA facility grant of 5 million USD as well as a PIP loan of 6 million USD with 5% interest rate provided over the first 6 years are representing the external support. We assume a payback amount of 750,000 USD per year until 2023. The NPV of this scenario reflecting the PIP interest rate is about -5.7 million USD over the lifetime. The street lighting system would need net allocation from the city budget up of about 500,000 to 700,000 USD annually until 2023. Afterwards the system will be able to finance itself without any further contributions.

To illustrate the differences between baseline and efficient lighting scenario we show the net cash flow over the lifetime of the LEDs. Whereas the baseline net cash flow is constantly decreasing, the efficient lighting starts to pay off from the beginning compared with the baseline scenario, which aside from the efficiency improvements is also due to the NAMA facility grant and PIP loans. From 2024 onwards electricity savings outnumber the additional burden from higher replacement costs and PIP loan repayments; the system starts to finance itself.

**Figure 13: Development of the net cash flows for the baseline and the efficient lighting scenario (including PIP loans)**




### 4.5.6 Financing roadmap utilising a mix of sources

Below is a recommended roadmap for combining the selected financing options. This roadmap is designed to enable a quick-start demonstration phase for the SSLI NAMA, followed by a scaling-up and transformation phase. The ICCTF is seen as the most appropriate established mechanism to acquire and administer international supported-NAMA funds, in order to:

- Demonstrate NAMA implementation in selected pioneer cities
- Strengthen city's capacities to install, maintain and monitor efficient street lighting
- Overcome barriers through provision of support to municipalities and streamlining of processes, and pave the way for expanded implementation via concessional finance administered through the PIP and enabling use of the ESCO model in the scaling-up phase.

The concessional finance offered through PIP could then be combined with other means of domestic financing (e.g. temporary increases in the street lighting tax or national government grants) to enable scaled-up mitigation action.

In order to assess the financing requirements of the NAMA and its feasibility, the project team developed a financial model that produces results for IRR, NPV and payback periods of the baseline and SSLI

NAMA project scenarios. The results of this analysis are provided below for each of the implementation phases. Key assumptions applied in the modelling are presented in Section 4.5.1.

In the following, the finance roadmaps for the conservative and ambitious pathways are described, distinguished by the three different phases.

### Conservative pathway

**Phase 1: Demonstration phase (January 2014 to June 2015)**

A NAMA grant is sought to be paid into ICCTF, which would then administer the disbursement of funds to two selected pilot cities from the following shortlist: Yogyakarta, Probolinggo, Makassar and Pekalongan.

In total, a targeted grant of 14m EUR (20m USD) is sought, of which 8.5m EUR (11.5m USD) [27] is used to provide funding for capital investment, including purchase of 15,000 suitable LEDs that substitute 10,000 HPS 150W lamps and 5,171 mercury vapour 250W lamps. For illustration, this would cover the installed lamps in Pekalongan. Operation and maintenance is covered through the street lighting tax as in the baseline scenario.

In addition to the capital investment, grant is to provide 5.5m EUR (7.5m USD) for technical assistance. This supports the establishment of the TSU in MEMR, which will provide training for local governments, and technical support for the establishment of energy efficiency performance and safety standards for efficient lighting products at the national level, as well as supporting local governments which need to conduct audits as a pre-condition for joining the SSL NAMA (to validate the number and type of lamps installed).

In preparation for phase 2, the TA funding also enables TSU to support the local governments in preparing proposals to access PIP loans and to help streamline PIP procedures. Together with PIP, the TSU will further support uptake of the ESCO model by providing advice to local governments interested in entering into contracts with ESCOs.

**Phase 2: Scaling-up phase (July-2015 to end 2016)**

In the scaling-up phase, two additional cities obtain access to concessional PIP loans to finance the roll-out of SSL technologies. In conjunction with this, the TSU supports ESCO participation in at least one of these cities by supporting the local government in entering into such an arrangement and by working with PIP to facilitate the ESCO financing. The concept is that a PIP loan is used to pay the ESCO for

[27] The value of 8.5m was chosen for conservativeness, to allow for a 500,000 EUR contingency in the case of higher than anticipated capital costs.

the up-front component of the investment cost and the city then pays back the loan from its cost savings over time. The PIP loan could either flow directly to the ESCO, or via the city.
Technical assistance provided by TSU includes training of additional local governments on maintenance and MRV for the new cities joining the SSL NAMA. The TSU will also provide awareness raising of the benefits of the SSL NAMA to help expand its coverage in the third phase.

In the second phase it will also become necessary to explore longer term financing options including, for example, a new dedicated energy efficiency loans scheme administered by MoF or DAK grants. In conjunction with financial support mechanisms, national electricity pricing reform options such as reduction of electricity subsidies should be explored. The TSU can support the policy agenda by providing advice on the options to be pursued.

**Phase 3: Transformation phase (Jan 2017 to end 2019)**

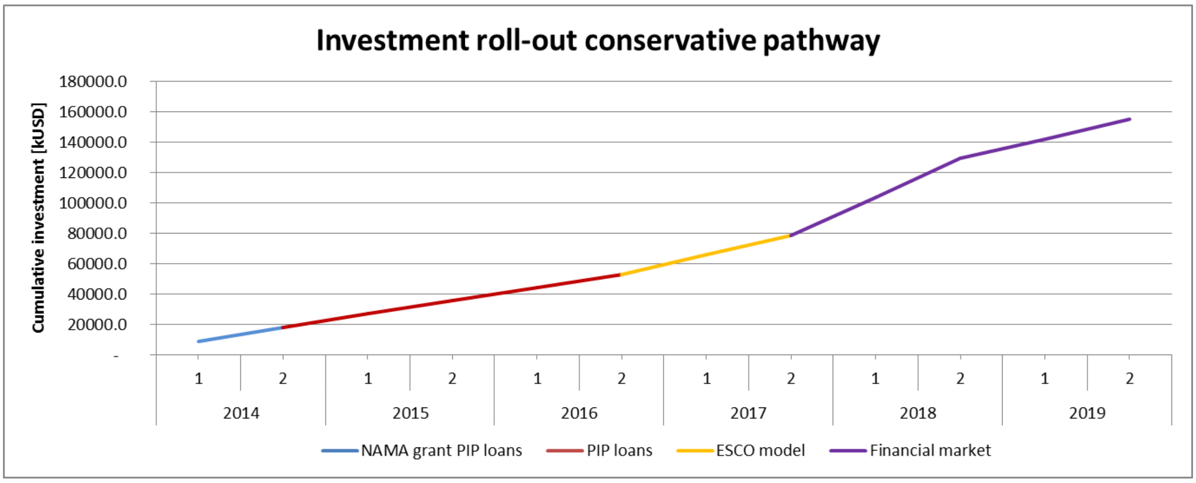
In phase 3, an additional 5 cities implement efficient street lighting under the SSLI NAMA. Implementation of the SSLI NAMA is made possible through the combination of increasing experience with PIP loans, the increasing contracting of ESCOs and potentially other measures (e.g. electricity price reform acting as an incentive for cities to invest in energy efficiency improvements).

In our modelling, local governments continue to use PIP loans until the 40 million USD are fully exploited. As soon as PIP loans are exhausted, ESCOs fill the gap, financing investments for up to 30 million USD. This highlights the fact that ESCOs need to be stimulated/supported in the first two phases, and that cities will need to free up resources for investment in the up-front costs associated with ESCO financing (since PIP soft loans will not be available). They can do this either by allocating additional funds from municipal budgets, going to the financial markets for loans or seeking national government support if available (e.g. DAK grant). The assumed rate of return for ESCOs is 10%. The remaining costs are covered through loans from the financial market where interest rates are assumed at 12%.

Technical assistance provided by the TSU includes training of additional local governments on maintenance and MRV for the additional cities joining the SSLI NAMA. Facilitation of ESCO participation will also be required based on the experience in the earlier phases. In the third phase, there is also the need for the development of a long term budgeting plan for SSLI NAMA TSU, which could adopt a broader energy efficiency focus.

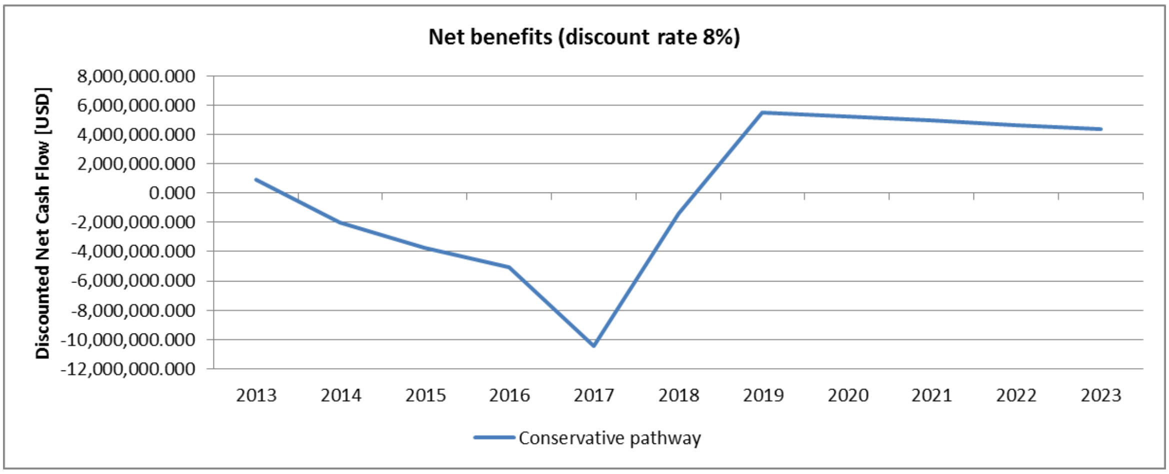
The overall investment roll-out for the conservative pathway is illustrated in Figure 14. We see a comparatively balanced use of different financial sources for covering the incremental installation costs. First the NAMA grant will support funding the SSL technology during demonstration phase (blue line). From 2015 PIP loans finance the additional roll-out during phase II (red line). After roughly 40 million USD of PIP loans are exploited end of 2016, the ESCO model is used for further installations (orange line). A total of 30 million USD is expected to be financed by ESCOs. Finally, the local governments then rely on the financial market for financing the final share of the required 80 million USD investment in 2018 and 2019 (purple line).

**Figure 14: Investment roll-out under the conservative pathway**




The financial benefits of the conservative scenario are illustrated in Figure 15. The blue line shows the net cash flow of installation costs, operating costs and electricity savings compared to the baseline. The discount rate is 8% annually (approximate average of PIP loans, ESCOs demands and financial market loan interest rates). The cash flow stays negative as long as the installation of SSL technology is on-going; from 2018 onwards we have significantly positive cash flows dominated by the electricity savings. From 2019 onwards there are no additional installations of lamps assumed (the curve is still decreasing due to the annual discounting of the cash flow). Considering a NAMA grant of about 12 million USD at the beginning of the project, the overall NPV of the investment until 2024 is 3 million USD.

**Figure 15: Discounted net cash flow under the conservative pathway**



### Ambitious pathway

**Phase 1: Demonstration phase (January 2014 to June 2015)**

A NAMA Facility grant is sought to be paid into ICCTF, which would then administer the disbursement of funds to the four selected pilot cities: Yogyakarta, Probolinggo, Makassar and Pekalongan.

In total, a targeted grant of 14m EUR (20m USD) is sought, of which 8.5m EUR (11.5m USD) [28] is used to provide funding for capital investment, including covering part of the costs of investment in 14,500 suitable LEDs that substitute 14,500 HPS 150W lamps and 20,100 LEDs that replace the same number of mercury vapour 250W lamps. The lamp replacement costs not covered by a NAMA grant will be enabled through PIP loans.

The TSU will facilitate take up of the ESCO model in the ambitious scenario, where at least one of the cities in the demonstration phase finances a street lighting replacement programme by contracting with an ESCO. A PIP loan is used to facilitate this, by covering the up-front payment component.

In addition to capital investment, the NAMA grant is to provide 5.5m EUR for technical assistance. This supports the establishment of the TSU in MEMR, which will provide training for local governments, and technical support for the establishment of energy efficiency performance and safety standards for efficient lighting products at the national level.

**Phase 2: Scaling-up phase (July-2015 to end 2016)**

An additional eight cities implement efficient street lighting programmes under the SSLI NAMA. In our modelling, local governments use PIP loans until the 40 million USD are fully exploited. As soon as PIP loans are used up, ESCOs are contracted for investments totalling up to 30 million USD. This highlights that in the ambitious scenario there is a need for enabling the ESCO model to work even sooner – by the second phase it will play a major role in financing the NAMA. The assumed hurdle rate for ESCO financing is 10%. The remaining costs are covered through loans from the financial market. Interest rates are assumed at 12%.

Technical assistance provided by TSU includes training of additional local governments on maintenance and MRV for the additional cities joining the SSLI NAMA, plus facilitation of ESCO participation. TSU also explores longer term financing options including MoF energy efficiency loans.

[28] The value of 8.5m was chosen for conservativeness, to allow for a 500,000 EUR contingency in the case of higher than anticipated capital costs.

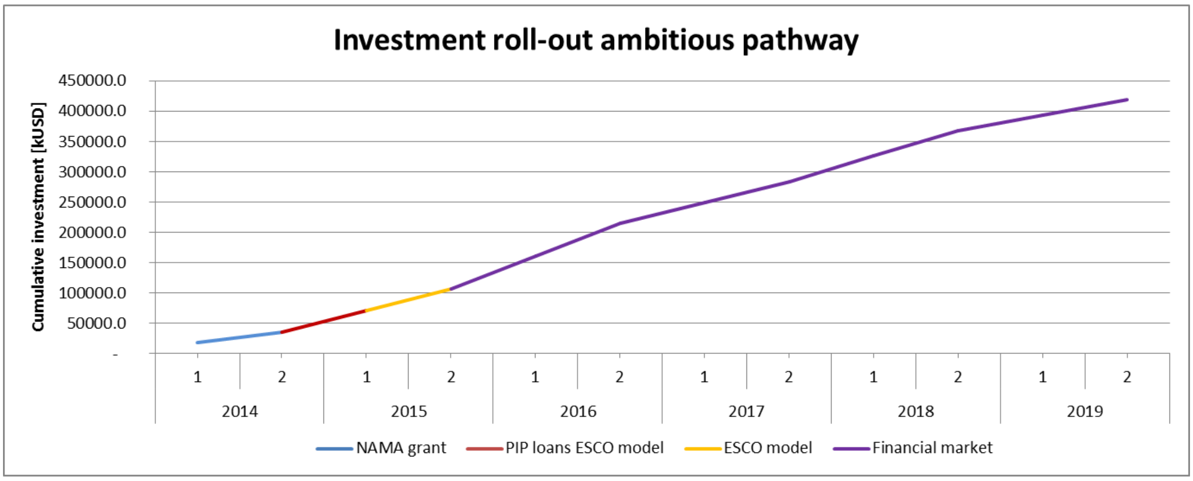
**Phase 3: Transformation phase (January 2017 to December 2019)**

An additional 10 cities implement efficient street lighting under the SSL NAMA. In our modelling, it is assumed that for covering the installation costs they use loans from the financial market. Interest rates are assumed at 12%. Other financing options could make lower cost implementation possible, if for example ESCOs were supported by a dedicated energy efficiency finance mechanism offered by the national government (MoF) or if DAK grants were made available for street lighting replacement. For the purposes of the financial modelling, such hypothetical sources of finance are not included.

As in the conservative scenario, the TSU supports local governments involved in the SSL NAMA on the technical side and with help accessing finance. The TSU is eventually adopts a broader energy efficiency focus as the NAMA comes to an end.

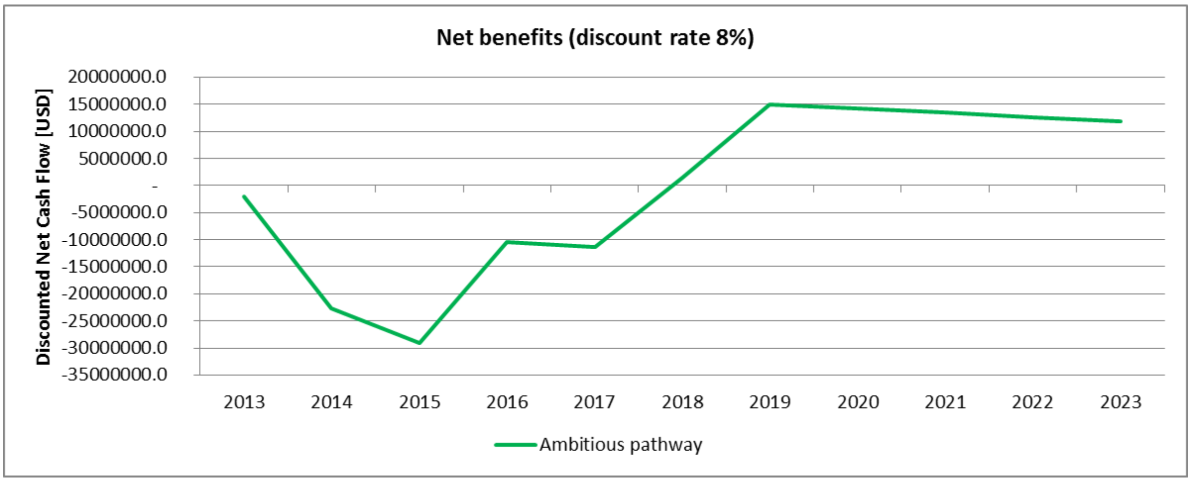
The overall investment roll-out is illustrated in Figure 16. Substantial new sources of finance (e.g. ESCO financing, commercial loans from the financial market or other forms of public financing) will be required to provide loans for the incremental installation costs from 2015 onwards. First the NAMA grant will be sufficient for funding the SSL technology of the first two cities (blue line). However, already during the demonstration phase, PIP loans have to finance the additional roll-out (red line). After the roughly 40 million USD of PIP loans are exploited in the first half of 2015, the ESCO model is used for further installations. In this hypothetical scenario, it is assumed that a significant share of about 310 million USD of financing has to be covered through regular loans at an interest rate of about 12%. In practice, any combination of new sources of finance should be drawn upon to enable the wider expansion of the SSLI NAMA to achieve transformational scale. Such an inclusion of additional new sources is reflected in a second investment scenario below.

**Figure 16: Investment roll-out ambitious pathway**




The financial benefits of the ambitious scenario are illustrated in Figure 17. The green line shows the net cash flow of installation costs, operating costs and electricity savings compared to the baseline. The discount rate is 8% annually (approximate average of PIP loans, ESCO demands and financial market loan interest rates). This scenario considers a 11.5 million USDNAMA grant. The cash flow stays negative as long as the installation of SSL technology is on-going. From 2018 onwards significantly positive cash flows dominated by the electricity savings are generated. From 2019 onwards there are no additional installations of lamps assumed (the curve is still decreasing due to the annual discounting of the cash flow). The overall NPV of about minus 7 million USD is still negative.

**Figure 17: Discounted net cash flow under the ambitious pathway**




This highlights the need for additional sources of finance in order to make the SSLI NAMA commercially attractive for the large number of Indonesian cities being targeted under the ambitious pathway. If another international donor and/or the Indonesian Government were to provide a second grant of 11.5 million USD for the NAMA, equivalent to the intial NAMA grant, the net benefit becomes positive earlier and generates an overall positive NPV of about 15 million USD over time.

**Figure 18: Discounted net cash flow under the ambitious pathway with additional 11.5 million USD grant**

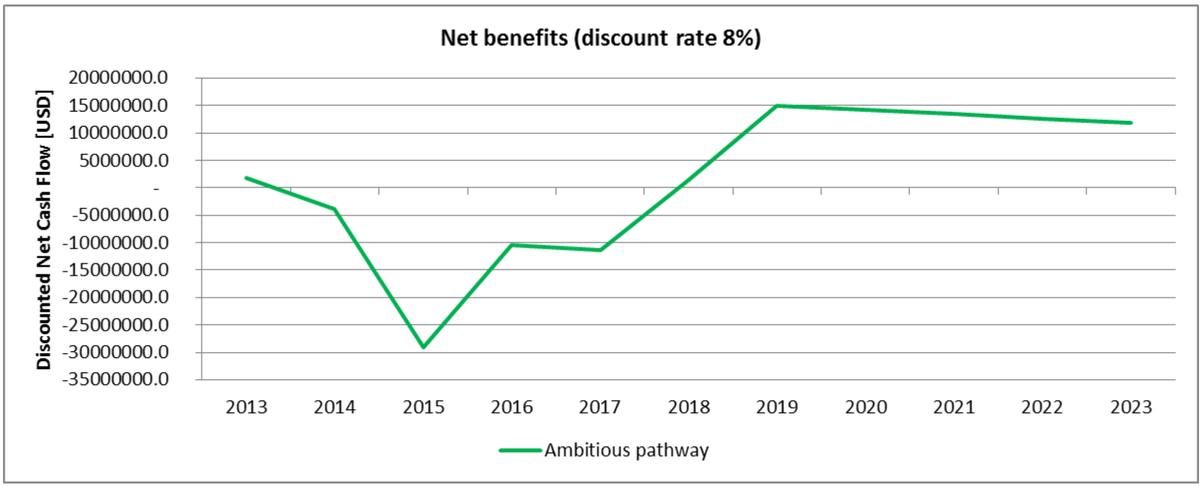



Figure 19 below compares the overall investment needs estimated for the two pathways.

Figure 19 Comparison of investment needs in the two pathways

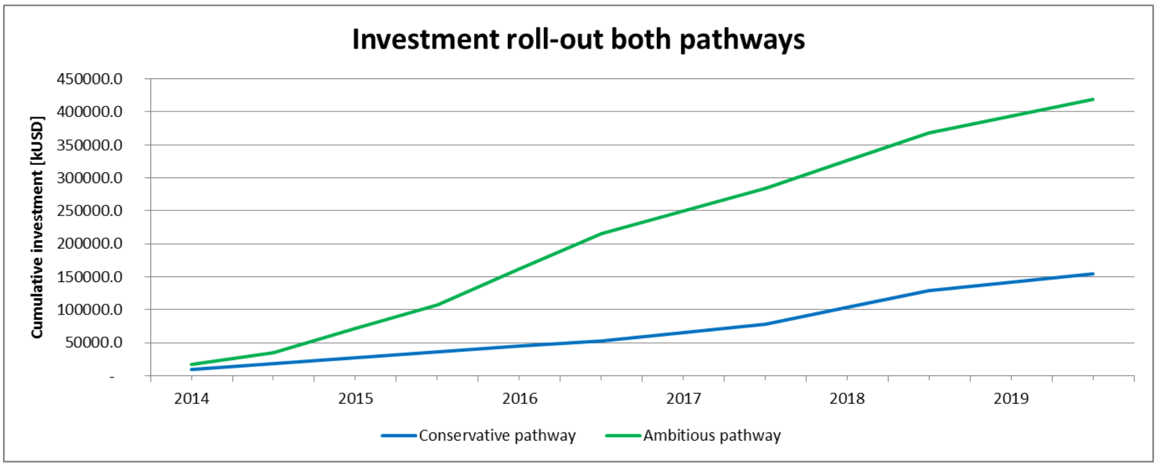



Table 25 summarises the key characteristics of the two financing pathways described above. It highlights the need for additional sources of finance to ensure a positive NPV in the ambitious scenario.

**Table 25: Summary of financing pathway modelling**

| | Conservative pathway | Ambitious pathway |
|---|---|---|
| **Phase I:**<br>**Demonstration phase**<br>**Jan 2014 - Jun 2015** | 2 cities<br>NAMA grant 14m EUR<br>PIP loans (5%) | 4 cities<br>NAMA grant 14m EUR<br>PIP loans (5%) ESCO financing of one city |
| **Phase II:**<br>**Scaling-up phase**<br>**Jul 2015 – Dec 2016** | 2 additional cities join<br>PIP loans (5%)<br>ESCO financing of one city | 8 additional cities join<br>Additional grant 11.5m USD<br>40m USD PIP loans (5%)<br>30m USD ESCO financing (10%) |
| **Phase III:**<br>**Transformation phase**<br>**Jan 2017 – Dec 2019** | 5 additional cities join<br>40m PIP loans (5%)<br>30m ESCO financing (10%)<br>80m USD regular loans (12%) | 10 additional cities join<br>310m USD regular loans (12%) |
| **NPV to 2024**<br>**(8% discount rate)** | 3m USD | -7m USD with commercial loans as per Phase III<br>+15m USD with an additional grant of 11.5m USD) |

### 4.5.7 Challenges to be overcome in the financing roadmap

In order to unlock the potential for the PIP loans as a way of scaling-up finance for the SSLI NAMA, a number of existing hurdles will need to be overcome. At the moment the application for PIP loans involves a lengthy and bureaucratic process, and seems quite discouraging in general for municipal governments. Municipalities are currently unwilling to take loans, mainly because the guarantees required by PIP are substantial. Collateral needs to be provided as a guarantee by the local government and if they default, the value of the loan will be forcibly recouped by the MoF from the municipal budget. Preconditions include the establishment of a local law that shall guarantee that public funds are made available to match with the loan repayment period.

One option is to back the required guarantees through the ICCTF or through another international funding vehicle (there is some history of ADB having done this). MoF would also have to determine that energy efficient street lighting is covered under the "Mandatory" loans component in order to be able to offer loans at 5% interest rates. Initial discussions with PIP have indicated a high level of willingness to engage with municipal governments on financing for street lighting efficiency improvements.

Unlocking the potential of using the ESCO model will also require certain barriers to be overcome - in particular, the lack of clarity in the regulations pertaining to use of local government tax revenues, and payment of interest to third parties which is required for such contracting. This requires amendment of the national regulations to clarify that ESCO contracting arrangements are not corrupt practices under the appropriate circumstances. The TSU will also need to spend considerable time and resources on:

- Raising awareness of the potential for energy efficiency services contracting as a way of financing street lighting replacement;
- Working with local governments to develop regulations to enable such contracting; and
- Working with PIP to enable loans to be utilised by ESCOs (could also be channelled through local governments to pay ESCOs for their services).

For certain municipalities, it may be possible to use the funding raised from the street lighting taxes to finance replacement of inefficient lamps, but this seems only likely to generate a surplus once a high level of metering has been installed. This will require a substantial up-front investment. Each individual city will have to make its own considerations in this respect, and it is recommended that the national government prioritise metering and help encourage cities to make this investment.

### 4.5.8 Recommendations

1. Utilise international NAMA support in combination with domestic finance sources to kick-start the SSL NAMA Implementation. International NAMA support funding provided by a grant could provide 10-12m USD to be administered via the ICCTF. This should be used for SSL lighting replacement investment in 2-4 targeted cities in the demonstration phase from early 2014 – mid 2015.

2. An additional 6-8m USD funding should be sought for technical assistance, specifically for the set-up and operation of the TSU to support local governments in accessing domestic finance via the ICCTF, loans from PIP and potentially other sources.
3. As a priority, the national government should enable local government to enter into contractual arrangements with ESCOs by reforming the regulatory framework.

4. TSU should work with PIP to smooth the process for entering into soft loan arrangements with municipal and provincial governments. Consider using PIP loans to help cities enter into ESCO arrangements.

5. In the scaling-up phase, from mid 2015-end 2016, aim for a further 2-8 cities joining the SSLI NAMA, supported primarily via PIP loans and ESCO financing. In the transformation phase, from early 2017 to end 2019, aim for further 5-10 cities joining the SSLI NAMA, supported by PIP loans, ESCO financing to the extent possible. Once exhausted, either commercial loans or new sources of finance will be required.

6. Under the ambitious scenario without new sources of donor finance or national government financial incentives (e.g. DAK grants or a dedicated loans facility for energy efficiency), the NPV will be negative in 2024. In order to present an economically attractive option for the municipalities, additional sources of NAMA finance would be required. For example, a second grant of 11.5m USD during the transformation phase would generate a positive NPV. International donors but also national, public institutions should be approached for financing.

It should be noted that the results of the analysis of the costs and benefits for the two SSLI roll-out pathways presented here are based on many generalised assumptions, and are for illustrative purposes only. In practice, each individual city that is interested in participating in the SSLI NAMA will need to develop its own financing plan in cooperation with the TSU and MoF, and the individual circumstances can be expected to vary significantly from city to city.

## 4.6. Estimated emissions reductions and abatement costs

### 4.6.1 Estimating emissions reductions against the baseline

A proposed baseline determination approach was outlined in Section 4.3. Once the baseline for each of the cities participating in the SSLI NAMA has been established, it will be possible to estimate the emissions reductions from the SSLI NAMA based on the calculated energy savings. As a rough indication of the overall potential energy savings that could be achieved, we recall that street lighting accounted for 3,068 GWh of electricity sales by PLN in 2011 according to the national statistics. If we were to assume savings somewhere between the modelled results for the two case studies, where a 40% reduction was achieved, and the actual results in the Pasuruan case, where a 75% reduction was achieved, this suggests a 50-60% reduction could be achieved nationally. That is, roughly 1,500-1,850 GWh of electricity saved per annum compared with business as usual. The key uncertainty is that without metering, it is impossible to know the actual level of consumption, since the PLN sales are likely to overestimate consumption significantly, as was discussed earlier.

For conservativeness, it is important to isolate the reductions that are due to the lighting replacement itself versus other factors that could also contribute to energy savings, such as replacement of cabling for example. Following a street lighting replacement (14 LEDs substituted 14 HPS lamps) and metering installation trial in Malang, Osram found significant energy savings were possible compared against the baseline scenario. For the lamp replacement alone, Osram calculated savings of around 44% for an equivalent lighting output based on the rated wattage of the installed LEDs (288W vs 159W). However, based on the metered data Osram found that the total power after 1 month for LED was 805W compared with 2386W resulting in an energy saving of around 66%. It is likely that the replacement of cabling and grounding equipment also contributed significantly to the reduced power consumption of the LED lamps[29]. Another likely factor contributing to savings is the deterioration of electronic ballasts of existing lamps. In one study, Osram conducted laboratory measurement of a sample of lamps and found that the ballasts used 60 W instead of the rated 36 W (i.e. +67% more)[30]. Thus, a conservative expectation is that savings of around 40% are likely on a pure lamp-replacement basis, but under optimal conditions, it is possible that LEDs can reduce energy by as much as 60% against the baseline scenario of HPS lighting (GIZ PAKLIM, 2012).

### 4.6.2 Approach based on CDM methodology AMS-II.L

The approach for calculating the gross electricity savings in AMS-II.L is to multiply the total average power of the installed (programme) luminaires multiplied by the annual hours of operation, compared with the average power rating of the baseline luminaires, multiplied by the baseline annual hours of operation (assumed number of daily operating hours multiplied by 365 or the number of days per year that the lamps are expected to be operated). The approach then produces the net electricity savings (NES) by correcting the gross electricity savings for any leakage and transmission & distribution losses. The key data required for the emissions reduction estimation is outlined in the Table 26 below.

[29] This was suggested by Osram during an interview in July 2013.

[30] Interview with PT Osram in July 2013.

**Table 26: Key data required for emission reduction calculations**

| Data | Potential source |
|---|---|
| Estimated number of conventional lamps and EE lamps | Data provided by cities on the number of lamps replaced under the SSLI NAMA |
| Nameplate/rated power wattage for conventional and EE lamps (use average, if not know for each lamp type) | Manufacturer information and/or measuring of replaced lamps |
| Assumption operating hours (default value for daily hours of operation of luminaires) | Operating hours could be based on of the change in streetlights turning ON time and OFF time depending on the sunrise and sunset times through the year. |
| Emission factor of the electricity grid (GEF) | Use values published/updated by MEMR. |
| Transmission & distribution loss | Data from PLN or MEMR. The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. Or could use 10% default value, if no specific figure is available (as per CDM methodology AMS-II.L) |

Emission reductions hence depend on the energy efficiency savings between the replaced and installed light bulb and applying the approach in AMS-II.L are calculated as follows:

$$ER_y = BE_y - PE_y \qquad (1)$$

Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emission reductions in year *y* ($tCO_2$-e/yr) |
| $BE_y$ | = | Baseline emissions in year *y* ($tCO_2$-e/yr) |
| $PE_y$ | = | Programme emissions in year *y* ($tCO_2$-e/yr) |

Thus, baseline emissions are determined by: the number of conventional lamps, the nameplate/rated power wattage (average, if not know for each lamp type), the assumed operating hours (default value for daily hours of operation of luminaires), TDL losses (10% default for instance, if no specific figure is available) and the GEF for the respective grid in Indonesia. The programme emissions under the SSLI NAMA are determined by the same parameters, but applying the number of efficient lamps and their nameplate/rated power wattage or weighted averages if multiple lamp types are installed. Both, BEy and PEy are used to calculate the emissions reductions (ER) as described below.

Emission emissions from net electricity saved are calculated as follows.

$$ER_y = \sum_{i=1}^{n} \left(ES_{i,y}\right) \times \left(1 \div (1 - TDL)\right) \times EF_{EL} \qquad (2)$$

Where:

$$ES_{i,y} = \left(Q_{i,BL} * P_{i,BL} * O_{i,BL}\right) - \left(Q_{i,P} * P_{i,P,y} * O_{i,y}\right) \qquad \mathbf{(1)}$$

Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emission Reductions in year *y* ($tCO_2$-e) |
| $ES_{j,y}$ | = | Estimated annual electricity savings for equipment of type *i*, for the relevant type of project equipment in year *y* (kWh) |
| $EF_{EL}$ | = | Grid emission factor for electricity generation ($tCO_2$/kWh) |
| $TDL$ | = | Average technical transmission and distribution losses for providing electricity |
| $P_{i,BL}$ | = | Rated power of the baseline luminaires of the group of i lighting devices (kW), or time-integrated average power if equipment operates at various power settings, constant value independent from y |
| $P_{i,P,y}$ | = | Rated power of the project (NAMA) luminaires of the group of i lighting devices (kW), or time-integrated average power if equipment operates at various power settings, normally constant value independent from y unless operating schedule or parameters changes during crediting period |
| $Q_i$ ($Q_{i,BL}$ and $Q_{i,P}$) | | Quantity of baseline (BL) or project (P) luminaires of type i distributed and installed under the project activity (units). Once all of the project luminaires are distributed or installed, Q i,P is normally a constant value independent from y unless size of operating luminaire inventory decreases during crediting period, in which case only operating project luminaires shall be credited. |
| $Y$ | = | Crediting year counter |
| $I$ | = | Counter for luminaire type |
| $N$ | = | Number of luminaires |

For the estimation of the potential total emissions reductions of the SSLI NAMA the above approach has been applied for the actual PJU data available for the cities targeted in the Demonstration Phase and the Scaling-up Phase as described in Section 4.5. For the transformation phase, the approach taken was to extrapolate the emissions reductions using a hypothetical medium sized "model city" baseline as outlined in Section 4.3.

Table 27 below summarises the baseline data used for the emissions reduction estimation for the targeted cities where real data was available.

**Table 27: Summary of city level data used for emissions reduction estimation**

| *Parameter* | *Semarang* | *Probolinggo** | *Malang* | *Mojokerto* | *Yogjakarta** | *Surakarta* | *Pekalongan* |
|---|---|---|---|---|---|---|---|
| | *(pieces)* | *(pieces)* | *(pieces)* | *(pieces)* | *(pieces)* | *(pieces)* | *(pieces)* |
| ***Mercury 125W*** | 0 | 0 | 438 | 0 | 0 | 0 | 0 |
| ***Mercury 250*** | 2,193 | 6,000 | 2,740 | 757 | 4,000 | 12,318 | 5,140 |
| ***HPS 70W*** | 25,681 | 0 | 0 | 155 | 0 | 200 | 150 |
| ***HPS 150W*** | 22,927 | 9,000 | 400 | 235 | 8,000 | 0 | 400 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***HPS 250W*** | 10,561 | 0 | 1,643 | 665 | 7,000 | 1,750 | 1,000 |
| ***TL 35W*** | 39 | 0 | 0 | 39 | 0 | 442 | 0 |
| ***Duluxstar 45W*** | 0 | 0 | 0 | 0 | 0 | 419 | 0 |
| ***HWL 160W*** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Bulb 200W*** | 0 | 0 | 0 | 0 | 0 | 171 | 0 |
| ***Total lamp numbers*** | 61,401 | 15,000 | 5,221 | 1,851 | 19,000 | 15,300 | 6,690 |
| ***Weighted average W/unit*** | 137.2 | 190 | 231.9 | 217.7 | 136.3 | 235.3 | 240.0 |
| ***Inhabitants*** | 2,067,000 | 217,062 | 820,243 | 120,132 | 433,539 | 506,397 | 281,434 |
| ***Road length*** | 727 | 195 | 192 | 112 | 244 | 275 | 128 |
| ***Installed meters*** | 2,738 | ~10% | ~50% | | ~100% | | |
| ***Street lighting tax level (in %)*** | 8 | 8 | 7 | 10 | 8 | 9 | 9 |
| ***Tax revenues (USD/a)*** | 9,450,000 | 750,000 | 2,200,000 | 300,000 | 2,200,000 | 2,880,000 | 1,000,000 |
| ***PJU Bill (USD/a)*** | 3,595,406 | 950,000 | 1,400,000 | ?? | 720,000 | 2,400,000 | 1,030,000 |

Source: Data collected from city PJUs

For the hypothetical model city, an adjusted (truncated) average of the data for the real cities was used to derive a city with the following characteristics:

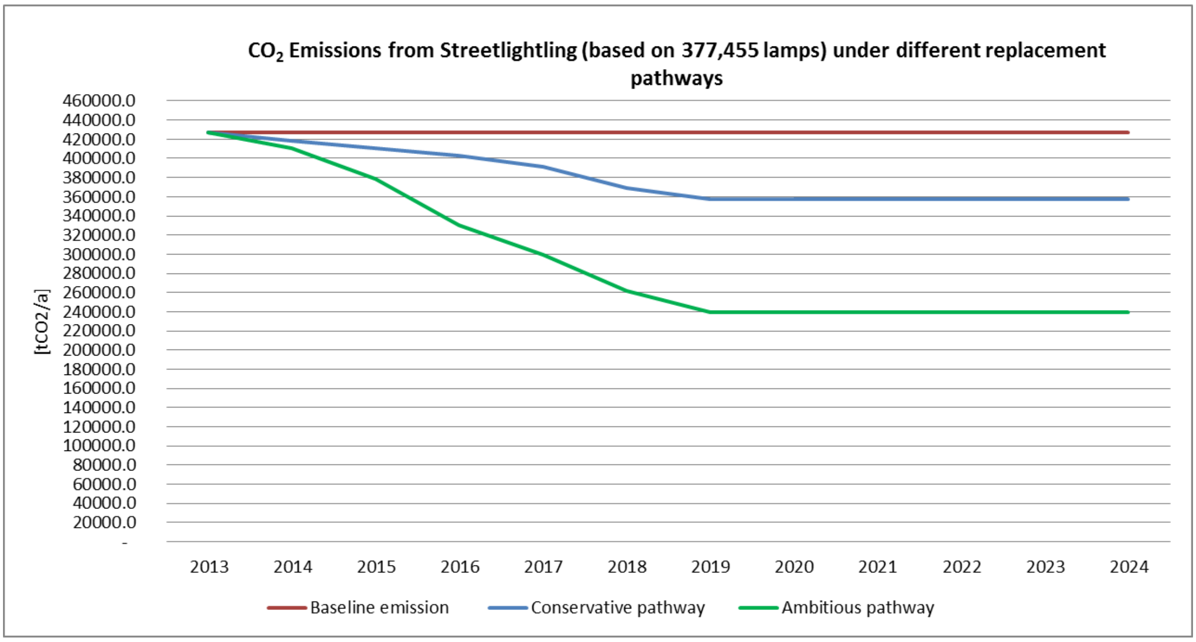
- population of around 890,000 and 502 km of roads
- 25,000 installed street lamps
- average wattage of 202W/lamp

### 4.6.3 Results of emissions reduction estimation

The Figure below summarises the annual emissions reduction estimation results for the two replacement pathways. It shows annual emissions reductions reaching around 60k $tCO_2$-e by 2020 in the conservative pathway, and around 200k $tCO_2$-e in the ambitious pathway.

It should be noted that the baseline (red line) is simply the aggregated level of BAU emissions associated with power consumption from currently installed street lighting in the cities covered by the ambitious pathway – i.e. the total emissions that would occur if the SSLI NAMA were not implemented in any of these cities. In practice, each city participating in the SSLI NAMA will have its own baseline, as per the approach outlined in Section 4.3.

**Figure 20: $CO_2$ reductions under the conservative and ambitious pathway**




The estimated cumulative emissions reductions for the SSL NAMA over the two emissions reduction pathways are summarised in the Table 28 below.

**Table 28: Summary of results from emissions reduction estimation for both pathways**

| Pathway | Phase | Cumulative lamps replaced (units) | Cumulative energy Savings (MWh/a) | Cumulative ER to 2020 | Associated cumulative investment cost (USD) |
|---|---|---|---|---|---|
| **Conservative** | I | 34,000 | 16,381 | 69,899 | 27,553,600 |
| | II | 65,690 | 31,649 | 119,719 | 53,235,176 |
| | III | 191,232 | 92,135 | 210,811 | 154,974,183 |
| **Ambitious** | I | 65,690 | 31,649 | 135,048 | 53,235,176 |
| | II | 266,557 | 128,427 | 450,833 | 216,017,587 |
| | III | 517,640 | 249,399 | 640,608 | 419,495,601 |

Overall, this suggests that by 2020 the SSL NAMA could achieve emissions reductions of around 210k $tCO_2$-e in the conservative pathway, and up to around 640k $tCO_2$-e in the ambitious pathway. When the total energy savings over the lifetime of all lamps installed is accounted for, the emissions reductions would of course increase as the estimation is extended beyond 2020. By 2024, it is estimated that the SSLI NAMA could reduce emissions by as much as 1.5 Mt $tCO_2$-e in the ambitious pathway.

### 4.6.4 Estimated cost of abatement

Initial estimates of the abatement costs associated with the above emissions reductions have been derived applying an NPV approach comparing the total capital and O&M costs against the levelized electricity cost savings over time to 2024, discounted at 8% (all other assumptions are the same as described above, including CAPEX, electricity price assumptions, NAMA facility grant etc). In summary, the estimated cost of abatement for both pathways is negative, reflecting the positive payback of the SSLI NAMA over time resulting from electricity cost savings:

- For the conservative pathway the estimated cost of abatement is around -4 EUR/t $CO_2$-e
- For the ambitious pathway, the estimated cost of abatement is in the order of -8 EUR/t $CO_2$

Increasing the discount rate has a material impact on the results, but the estimated abatement costs are still negative at, for example, 10%, which would increase the cost of abatement to -1 EUR/t and -5 EUR/t respectively for the two pathways.

## 4.7. Installation and maintenance

This chapter deals with the identification of existing installation and maintenance processes in Indonesia, the stakeholders involved in the process, assessing the capacity needs of the sector based on an identification of major gaps, strategizing a capacity building process for installation and maintenance of LED street lighting including the identification of additional support units to be involved in the process.

### 4.7.1 Background

City governments, Local General Works Agency, Local Environment Agency, Agency for Hygiene and Landscape Gardening and Transportation Agency are the organizations responsible for the installation and maintenance of street lighting at the local level. The PJU houses in one of these agencies and carry out the necessary activities for installation and maintenance of street lights. Based on discussions with these organizations, the administrative structure and capacities of these organizations to support energy efficient street lighting implementation in Indonesia have been assessed and training needs is identified. Based on the capacity needs assessment of various departments involved in the activity, a capacity building strategy has been provided.

### 4.7.2 Organizations involved in the installation and maintenance of Street lighting

#### 4.7.2.1 City Government:

The city government has the authority to install and operate street lights at the local level. The installation of street lights is financed from the city budget. After completion of installation, further operation and maintenance responsibilities are delegated to related Dinas. Dinas are local government agencies working in the field of environment, general works, hygiene, landscape gardening etc.

#### 4.7.2.2 Municipal Public Lighting Agencies (PJU)

Within the local government, a specific unit, PJU is assigned to manage street lighting. This unit is usually integrated into one of the following local government agencies:

- Local General Works Agency (DPU – Dinas Pekerjaan Umum)
- Local Environment Agency (BLH – Badan Lingkungan Hidup) and
- Agency for Hygiene and Landscape Gardening (DKP – Dinas Kebersihan dan Pertamanan)
- Transportation Agency

#### 4.7.2.3 National Electricity Utility - PLN

PLN is not directly involved in installation and operation of street lighting; but periodically monitors legal and illegal street light connections in urban areas. PLN is responsible for installing and reading electricity metering for street lighting.

#### 4.7.2.4 The manufacturers and suppliers of street lighting technologies

The manufacturers and suppliers of street lighting equipment are private entities which are also largely responsible for their installation and maintenance. Cities usually select these companies through a competitive bidding process so as to ensure quality services and selection of the best technology.

Fokus Indo Lighting is the leading supplier of street lighting equipment in Indonesia by market share. Philips and Osram are other suppliers which are expanding operations in the country.

### 4.7.3 General guidelines for Installation of LED/Smart Street lighting

Guidance for lighting of public streets, roads, and highways is provided in the Indonesian Standard (SNI, 2008). Since these guidelines are not enforced by any regulatory authority, local governments tend to be unaware of the standards, and many fail to comply. In order to properly design new lighting schemes, it is important to consider the appropriateness and effectiveness of the various energy efficient street lighting technologies and systems for different situations. Street lighting technology and design decisions should be based on meeting local lighting requirements while achieving maximum energy efficiency.

Most importantly, the design of a street lighting system must be appropriate for the site and should provide the level of illumination (lux) and uniformity of light as per the recommended standards. Decisions about lighting systems should also take into account characteristics of lamp efficacy, good colour rendering, and light distribution. Listed below are features to consider for designing and procuring an energy efficient street lighting system:

- ✓ Proper pole height and spacing
- ✓ Proper luminaire aesthetics
- ✓ High lamp efficacy and luminaire efficiency
- ✓ Life of the luminaire and other components
- ✓ Cost effectiveness
- ✓ High lumen maintenance
- ✓ Good colour rendering
- ✓ Short lamp restrike
- ✓ Proper light distribution
- ✓ Proper cut-off
- ✓ Minimizing light pollution and glare
- ✓ Automatic shutoff

#### 4.7.3.1 Types of street lighting poles:

Table 29 provides general standards for street lighting poles. Selection of an optimum quality pole having appropriate diameters at different length segments of the pole is important in installation of new street lighting system. Pole diameters for different height segments of a pole are provided below. Based on requirements, users may select an appropriate design. A, B, C, D is defined as different height segments of a pole starting from its bottom A and reaching to its peak D while H is the complete pole height.

**Table 29: Specifications for street lighting poles**

| Dimension of Street Lighting Poles | | | | |
|---|---|---|---|---|
| **Segments** | **Pole Diameter (mm)** | **Pole Height Alternatives (meters)** | | |
| | | **I** | **II** | **III** |
| **A** | 150 | 3.5 | 5.5 | 5.5 |
| **B** | 125 | 2.1 | 2.1 | 3.1 |
| **C** | 100 | 2.1 | 2.1 | 3.1 |
| **D** | 75 | 3.3 | 3.3 | 3.3 |
| **H** | **Total** | **11.0** | **13.0** | **15.0** |

Source: **SNI 7391:2008**

#### 4.7.3.2 Pole Height for street lighting:

One of the important aspects of design based street lighting systems[31] is to determine the optimum pole to pole distance, as per the width of the road and the mounting height of the pole. The optimum pole distance should be chosen based on the light output of the sources, the light distribution of the luminaires, and the geometry of installation. The mounting height should be greater for powerful lamps, to avoid excessive glare. Table 30 and Table 31 show the pole to pole distance as per the varying pole height and width of the roads.

Table 30: Distance between poles (in meters) based on typical lighting distribution and classification of lights (Lantern A[32])

| Type of Lamps | Height of Poles (meters) | Width of the road (meters) | | | | | | | | Illuminance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| **35W SOX[33]** | 4 | 32 | 32 | 32 | - | - | - | - | - | 3.5 LUX |
| | 5 | 35 | 35 | 35 | 35 | 35 | 34 | 32 | - | |
| | 6 | 42 | 40 | 38 | 36 | 33 | 31 | 30 | 29 | |
| **55W SOX** | 6 | 42 | 40 | 38 | 36 | 33 | 32 | 30 | 28 | 6.0 LUX |
| **90 W SOX** | 8 | 60 | 60 | 58 | 55 | 52 | 50 | 48 | 46 | |
| **90 W SOX** | 8 | 36 | 35 | 35 | 33 | 31 | 30 | 29 | 28 | 10.0 LUX |
| **135 W SOX** | 10 | 46 | 45 | 45 | 44 | 43 | 41 | 40 | 39 | |
| **135 W SOX** | 10 | - | - | 25 | 24 | 23 | 22 | 21 | 20 | 20.0 LUX |
| **180 W SOX** | 10 | - | - | 37 | 36 | 35 | 33 | 32 | 31 | |
| **180 W SOX** | 10 | - | - | - | - | 22 | 21 | 20 | 20 | 30.0 LUX |

**Source: SNI 7391:2008**

[31] A design based street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighbourhood.

[32] Lantern A has a wider spreading of Lighting/spot light

[33] SOX are low pressure sodium lamps

Table 31: Distance between poles (in meters) based on typical lighting distribution and classification of lights (Lantern B[34])

| Type of Lamps | Height of Poles (meters) | Width of the road (meters) | | | | | | | | Illuminance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| 50 W SON[35] or 80 W MBF/U[36] | 4 | 31 | 30 | 29 | 28 | 26 | - | - | - | 3.5 LUX |
| | 5 | 33 | 32 | 32 | 31 | 30 | 29 | 28 | 27 | |
| 70 W SON or 125 W MBF/U | 6 | 48 | 47 | 46 | 44 | 43 | 41 | 39 | 37 | |
| 70 W SON or 125 W MBF/U | 6 | 34 | 33 | 32 | 31 | 30 | 28 | 26 | 24 | 6.0 LUX |
| 100W SON | 6 | 48 | 47 | 45 | 42 | 40 | 38 | 36 | 34 | |
| 150W SON or 250W MBF/U | 8 | - | - | 48 | 47 | 45 | 43 | 41 | 39 | 10 LUX |
| 100W SON | 6 | - | - | 28 | 26 | 23 | - | - | - | |
| 250W SON or 400W MBF/U | 10 | - | - | - | - | 55 | 53 | 50 | 47 | |
| 250W SON or 400W MBF/U | 10 | - | - | 36 | 35 | 33 | 32 | 30 | 28 | 20 LUX |
| 400W SON | 12 | - | - | - | - | 39 | 38 | 37 | 36 | 30 LUX |

**Source: SNI 7391:2008**

## Spacing

Spacing is the distance, measured along the center line of the road, between successive luminaires in an installation. To preserve longitudinal uniformity, the space-height ratio should generally be greater than 3.

## Outreach

Outreach is the horizontal distance between the center of the column and the center of the luminaire and is usually determined for architectural aesthetic considerations

## Overhang

Overhang is the horizontal distance between the center of a luminaire mounted on a bracket and the adjacent edge of a carriage way. In general, overhang should not exceed one-fourth of the mounting height to avoid reduced visibility of curbs, obstacles, and footpaths.

## Recommended Level of illumination:

Table 15 in the standards chapter gives information on recommended level of illumination on different categories of roads. The different types of roads have been classified in to categories based on the

[34] Lantern B has a smaller spreading of Lighting/spot light and directly to the road

[35] SON are high pressure sodium lamps

[36] MBF/U are mercury vapor lamps

Indonesian context, and the recommended level of illuminance, luminance and glare limitation are given for each type of road.

#### 4.7.3.3 Type of lamp technology:

Various types of street light lamps are available in the market and the user has to select the appropriate lamps before installation. Table 32 provides an overview of the different types of lamps covered in the national standard (SNI, 2008) and the expected results from those lamps in terms of efficiency, lifetime, power rate, object colour etc (LEDs are not covered by the standard).

**Table 32: Lamp Technologies**

| Type of Lamp | Average efficiency (lumen/watt) | Average lifetime (hour) | Power rate (watt) | Impact to object colour | Remark |
|---|---|---|---|---|---|
| **Low pressure Fluorescent** | 60 -70 | 8,000 – 10,000 | 18 – 20<br>36-40 | Medium | ▪ Collector and local road<br>▪ Efficiency is quite high but lifetime is short<br>▪ Acceptable for limited application |
| **High Pressure Mercury (MBF/U)** | 50 – 55 | 16,000 – 24,000 | 125; 250;400;700 | Medium | ▪ Collector, local road and intersection<br>▪ Efficiency is low, lifetime is long and size of lamp is small |
| **Low Pressure Sodium (SOX)** | 100 – 200 | 8,000 – 10,000 | 90;180 | Very bad | ▪ Collector, local, intersection, overpass, tunnel, rest area<br>▪ Efficiency is high, lifetime is quite long, size of lamp is big so difficult to control the light and colour of lamps is yellow<br>▪ This type is recommended since the efficiency is high |
| **High Pressure Sodium (HPS)** | 110 | 12,000 – 20,000 | 150;250;400 | Bad | ▪ Highway road, artery, collector, big size intersection, and interchange<br>▪ Efficiency is high, lifetime is long, size of lamp is small and easly to control the light<br>▪ This type is recommended |

**Source: SNI 7391:2008**

### 4.7.4 General guidelines for maintenance of LED / Smart Street lighting

Energy consumption for LED street lighting can be reduced by incorporating good maintenance practices such as:

- ✓ Replacing defective lamps, accessories, and wires
- ✓ Early rectification of cable faults
- ✓ Making sure that cables are joined properly
- ✓ Regular maintenance of service cabinet/fuse box to avoid loose connections
- ✓ Regular cleaning of the luminaire cover to keep it free of dust/dirt and increase light output

A substantial amount of energy savings can also be achieved by installing mechanical/electronic timers and/or daylight sensors for turning street lights on and off.

Besides installation and maintenance, the city governments are also involved in the waste handling of the scrap street lights. Generally, cities store the non-burning lights in the warehouse with no formal waste management practices being followed. In some cities, it is understood that informal scrap-collectors (scavengers) collect broken lamps and salvage the aluminium parts for resale.

### 4.7.5 Identification of gaps

#### Lack of awareness on installation and maintenance practices

Most cities do not have updated and correct information on installation and maintenance practices for street lighting. In the absence of such information, cities rely on inputs from local suppliers to make decisions. This lack of information impacts implementation of effective and efficient street lighting solutions, causing inconvenience to citizens.

#### Noncompliance of installation and maintenance practices

Standards issued by the national government are not complied with. Discussions held with several cities revealed mixed responses to compliance with installation and maintenance practices suggested by Indonesian standards. Cities are also not equipped with necessary facilities to monitor compliance with maintenance procedures, once lighting solutions are installed.

#### Lack of manufactures, suppliers and installers at the local level

Lack of good manufacturers, suppliers and installers at the local level who have a clear understanding of the installation and maintenance guidelines is a major factor contributing to poor delivery of quality street lighting services to citizens.

#### Lack of maintenance staff in cities

Cities do not have enough budget allocated to hire enough trained people as maintenance staff to effectively maintain existing street lighting systems in cities.

### Waste disposal practices of discarded lamps

The cities also do not have access to scientific waste disposal facilities to disposal standards for end of life luminaires. In the absence of such facilities, cities dump all non-functional street lights in warehouse without any segregation.

### 4.7.6 Recommendations:

### Adoption of installation and maintenance practices

Cities should adopt standard installation and maintenance practices which are indicated in this chapter. Design based street lighting, ensuring compliance with all parameters specified in the standards, will greatly improve the quality of street lighting in urban areas.

### Awareness and capacity building activities at the local level for installation and maintenance

Awareness and capacity building programs at the local level will greatly help in improved delivery of services to the people. Lack of awareness on design based street lighting results in adoption of inappropriate technologies, which do not provide the necessary level of service to citizens. Awareness and capacity building programmes for local governments should be undertaken to address these concerns.

### Preparation of Training Modules

Training modules should be developed in consultation with local stakeholders concerned with installation and maintenance of street lighting technologies, while also considering local implementation issues. The training modules should be developed for various categories of staff working at different levels within the PJU and other concerned departments:

- ✓ Senior Administrators and policy makers
- ✓ Senior Engineers / Junior Engineers
- ✓ Technicians involved in the installation and maintenance of street lighting
- ✓ Suppliers of street lighting technologies

### Delivering the training programs

Training programs should be delivered in a phased manner to monitor the outcome of the training programs, to facilitate bridging of all identified gaps. Training programmes will be delivered to educate senior officials, and other stakeholders on the benefits of energy efficiency street lighting and aspects to be considered for installation and maintenance of smart street lighting. Training programs for technicians aim to enhance their installation and maintenance skills.

**Table 33: Overview of training programmes**

| Target Group | Focus Areas | Brief Contents | Duration / City |
|---|---|---|---|
| **Senior officials, policy makers & stakeholders** | Macro issues, importance of installation and maintenance issues | • Global energy scenario, demand and supply, energy security.<br>• Energy scenario of Indonesia, major threats, challenges.<br>• Potential lies in energy efficient lighting system including that of LED streetlights.<br>• Major gaps in installation and maintenance practices and how it can be resolved. | One Day |
| **Senior Engineers / Junior Engineers** | General considerations for design based street lighting and maintenance practices | • Identification of needs and lighting requirements of road<br>• Identification of best available technology and design to meet the lighting requirement<br>• Procurement and tender evaluation<br>• Operation and maintenance practices<br>• Measurement and evaluation | One Day |
| **Technicians involved in the installation and maintenance of street lighting** | Practices to be adopted for installation and maintenance on ground | • General practices to be adopted in installation and maintenance.<br>• Replacement of defective lamps, accessories and wires<br>• Early ratification of cable faults<br>• Regular maintenance of service cabinet/fuse box to avoid loose connections<br>• Regular cleaning of the luminaire cover to keep it free of dust / dirt and increase light output | Two Days |
| **Suppliers of street lighting technologies** | Installation material and supplies complying with applicable standards | • All the installation and maintenance practices are applicable to the suppliers if they are involved in installation and maintenance.<br>• Information on applicable standards so that they can comply with them. | One Day |

### 4.7.6.1 Waste Management practices:

Safe disposal of lamps is also one of the concerns of local governments. The use of various types of street lights including CFLs, metal halide, and mercury vapour, release lead, mercury and other hazardous materials during their disposal phase. In contrast to conventional lamps, LEDs do not contain mercury, lead or other toxic chemicals, and are completely recyclable. This translates into less localized hazardous waste at the end of the product's life cycle.

However, there is a school of thought which believes that LEDs also have toxic materials. A study published in late 2010[37] in Environmental Science and Technology journal found that LEDs contain lead, arsenic and a dozen other potentially dangerous substances. However, the life span of LEDs is

[37]*Environmental Science & Technology (ES&T)* is an authoritative source of information for professionals in a wide range of environmental disciplines. The journal combines magazine and research sections and is published both in print and online.

approximately 50,000 burning hours and thus the safe disposal of LEDs is not an immediate concern like conventional lighting.

There exists an e-waste management concept in Indonesia which indicates involvement of retailers, distributors and local governments for the safe disposal of e-waste. This concept can further be optimised for the disposal of street lights including LED street lights.

#### 4.7.6.2 Role of Technical Support Unit (TSU)

The TSU should also be involved in capacity building for installation and maintenance of LED street lighting. The activities which can be performed by TSU are listed below:

- Preparation of model tender document for procurement of LED street lights for the cities.
- Dissemination of good practices on installation and maintenance to the cities.
- Preparation of training modules for different target groups and delivering the training programs.
- The TSU can undertake Training of Trainers (ToT) programs, to ensure availability of appropriately qualified professionals.

## 4.8. Measurement, Reporting and Verification

### 4.8.1 MRV of emission reductions

In the context of NAMAs, Measurement, Reporting and Verification (MRV) focuses in particular on the mitigation outcomes, namely the tonnes of $CO_2$-e reduced. The Conference of the Parties to the UNFCCC (COP) has defined certain minimum requirements that have to be fulfilled by a NAMA, but there are many details still to be clarified. MRV of NAMAs can also be used to track co-benefits and financial streams, especially if donors are involved in the context of a supported NAMA. The following section describes the main MRV concepts for tracking emission reductions and also outlines potential additional MRV elements in the NAMA context focusing on sustainable development co-benefits and financial flows[38].

The main objective of an MRV system is to provide credibility for the mitigation action undertaken and the emissions reductions claimed. It should guarantee environmental integrity and ensure that no double-counting occurs. Further considerations for a high quality MRV system are transparency, cost-efficiency, a sound institutional framework and transferability.

### 4.8.2 NAMA MRV requirements

UNFCCC NAMA MRV requirements currently contain little detail in terms of the specific level of stringency, data requirements, and degree of external verification. For supported NAMAs at this point in time the MRV stringency will depend primarily on the requirements of donors, financiers and investors.

[38] The development of an actual MRV framework for these parameters is beyond the scope of this report as these are part of a national process relating to reporting and tracking of finance and NAMA outcomes.

If the SSLI NAMA is implemented with both unilateral and supported components, then it is likely that different MRV requirements will have to be taken into account for these different components.

Table 34 below summarises the expected UNFCCC requirements that will be applied to the different types/elements of NAMAs. Some aspects are still subject to a high level of uncertainty (in particular, regarding the comments on credited NAMAs, which are not even part of the agreed text at the COP level).

**Table 34: UNFCCC MRV requirements for NAMAs**

| NAMA type | Expected MRV requirements |
|---|---|
| **Unilateral** | Requirements to be elaborated by Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC<br>Reflection of national circumstances and priorities expected |
| **Supported** | Domestic MRV with international oversight<br>International MRV can be required by donors<br>Tracking of financial (and technical) support |
| **Credited / financed through market mechanisms (unofficial)** | Comprehensive MRV requirements<br>International MRV process<br>Additionality requirements (?) |

The UN rules for biennial reports determine minimum requirements on reporting of NAMAs, which are summarised in Exhibit 2 below.

**Exhibit 2: Information on NAMAs in biennial reports**

The UNFCCC Conference of the Parties in Durban 2011 (COP17) agreed on general MRV requirements without being too specific. The NAMA MRV system may facilitate reporting to complete the report in a similar format to the biennial update reports especially as this will facilitate International Consultation and Analysis (ICA). These reports should be done in a tabular format. Biennial reports should include the following information (UNFCCC, 2011a, Annex III/2):

a) Name and description of the mitigation action, including information on the nature of the action, coverage (i.e. sectors and gases), quantitative goals and progress indicators;

b) Information on methodologies and assumptions;

c) Objectives of the action and steps taken or envisaged to achieve that action;

d) Information on the progress of implementation of the mitigation actions and the underlying steps taken or envisaged, and the results achieved, such as estimated outcomes (metrics depending on type of action) and estimated emissions reductions, to the extent possible;

e) Information on international market mechanisms.

Where supported NAMAs are concerned, the expectations of providers of climate finance are generally likely to be that the MRV framework should if possible be based on sound, reliable and approved standards. Ideally, an approved methodology such as used under the CDM would provide a high level of confidence. However, from the implementing country point of view, simplification is desirable to reduce costs and administrative burden wherever possible. Simplification and standardisation is appropriate since mitigation action for NAMAs is typically to be taken at a sector, or sub-sector level, rather than at a project level, and the emissions reductions claimed will not be used to offset emissions reduction obligations (unless NAMA-crediting is intended, which is not considered explicitly as part of the SSLI NAMA Implementation Plan). The balance appropriate for the MRV of supported NAMAs is therefore somewhere in between that of the CDM on the one hand, and unilateral action taken purely by the implementing country on the other. The expanded Table 35 below compares the likely MRV elements across the three different types of NAMAs, building on concepts that have not yet been defined by the COP.

**Table 35: Comparison of likely MRV elements for different NAMA types**

| Characteristics | Unilateral NAMA | Supported NAMA | Credited NAMA |
|---|---|---|---|
| **Type of finance** | To be financed domestically | To receive international financial, capacity building and/or technology support | To receive payment in return for carbon credits sold on the market |
| **Stringency and scrutiny** | Lower<br><br>Depends on national standards adopted | Higher<br><br>Designed to provide confidence to financiers that emissions reductions claimed are credible | Highest<br><br>Designed to provide confidence to the carbon markets and ensure environmental integrity |
| **Programme oversight** | Government department (e.g. MEMR) | International (bilateral or multilateral) agreement between governments involved, implemented by matching national legislation and using nationally accredited bodies | International body implemented on the basis of an international treaty and using nationally accredited bodies |
| **Standards to be applied** | "National standards" appropriate for Non-Annex I parties (NAI) | Bilateral standards to be defined by donor and recipient | ISO Standard, internationally recognised standard such as approved CDM methodology |
| **Auditing/ Verification** | Defined by implementing government (could be internal audit only) | Third party or approved government body | Third party (similar to DOE under the CDM) |
| **Transparency requirements** | MRV reports are internal only, but archived for possible review | Internal and available to relevant participants (e.g. donors) via registry | Publically available (similar to CDM) |

Source: Perspectives own assessment and UNEP Risoe (2012)

### 4.8.3 Options for the SSLI NAMA MRV framework

The approved CDM methodology AMS-II.L could be used as a starting point for developing the MRV framework for the SSLI NAMA. The parameters in the CDM methodology should be reviewed and adapted where appropriate in order for the MRV system to be feasible and appropriate. For instance, compared with the CDM, monitoring parameters could be adapted to be monitored/reported less frequently, to be monitored using statistical sampling and/or default values for certain monitoring parameters if the CDM methodology does not already allow for this, or with less stringent reliability/accuracy requirements.

Given the overall SSLI NAMA concept and its nature as a supported NAMA, the MRV system for the NAMA should focus on the direct GHG emissions reductions, which are estimated by monitoring and/or estimating the energy savings achieved.

Based on whether cities have full metering in place or not, the following monitoring approaches can be applied. A combination of the two approaches is also possible, and this is likely to be the most common approach since most cities have not yet achieved full metering but have already started.

**Approach A: Based on the approach in CDM methodology AMS-II.L. *Demand-side activities for efficient outdoor and street lighting technologies***

***Approach A does <u>not</u> require actual monitoring of consumption using metering.***

The approved small-scale CDM methodology AMS-II.L, *Demand-side activities for efficient outdoor and street lighting technologies,* defines criteria for MRV that can be used in the NAMA MRV framework. Most importantly, the monitoring concept relies on theoretical calculations and pre-defined values and performance standards only. Physical metering of actual consumed electricity is not required, so this approach can be used even when full metering is not yet installed. The installed lamps have to fulfil either national or local performance standards or an approved international standard such as CIE's Lighting for Roads for Motor and Pedestrian Traffic (CIE 115:2010). The key parameter that is required to be monitored is operating hours.

The methodology could be utilised to build the NAMA MRV framework, with some elements having the potential to be simplified, especially in the case that for the ex-ante emission reduction estimation insufficient data is available. A solution is to have a two-step monitoring approach involving *ex-ante* estimation of the impact in terms of emissions reductions (prior to the lighting replacement) and *ex-post* verification based on sampling groups (following the lighting replacement). In this way, the emission reductions are *calculated/estimated ex-ante* and *adjusted/determined ex-post* following monitoring, which is done via surveys using a statistical sampling approach. The basics of this concept are outlined as follows:

*Ex-ante* estimation of emission reduction would be built up bottom-up, based on the different baselines for individual cities to be included in the NAMA, under the modelled implementation scenarios. The key parameters include the numbers and characteristics of the lamps replaced, the number of cities/municipalities covered and so on. The estimation of emissions reductions for each city can be done using the approach derived from the CDM methodology, as outlined in Section 4.6.

*Ex-post* MRV will allow for adjustment of the emissions reductions estimated ex-ante. The MRV undertaken ex-post should be based on a detailed monitoring plan defined by the SSLI TSU (MEMR), describing all parameters and their use and relevance for the NAMA MRV. The monitoring plan shall facilitate the process of monitoring and recording of information over the lifetime of the NAMA. The plan should include details for:

- Assumptions/default values used and sources of the values
- Sources of monitored parameters
- Frequency of monitoring and reporting of monitored parameters
- Description of the data storage plan
- Responsibilities of different actors involved in monitoring and reporting
- Methodologies to be applied to calculate mitigation benefits (including AMS-II.L)
- Accuracy level to be applied for sampling

If the recommendation is adopted from Section 4.3.4 that as a pre-condition, each city must have either at least 50% metering in place, or have conducted a recent audit, this will help contain the potential for the ex-post results to differ greatly from the ex-ante estimates.

**System boundary**

It is recommended to use the local electricity distribution network to which street lighting is connected to define the system boundary(-ies) of the NAMA and the MRV actions to be undertaken. This means that each city and/or province where the NAMA activities will be implemented represents a sub-system for the NAMA and MRV shall be performed for each of these sub-systems, considering the physical, geographical location of all "project" luminaires (lamps) installed – i.e. the efficient lighting technology replacing conventional lighting as part of the NAMA.

**Ensuring lighting performance quality**

After implementation and replacement, lighting performance quality of project luminaires shall be demonstrated as follows:

- ***Equivalence to existing baseline luminaires***: prove that project luminaires provide equivalent or improved total useful illumination (lx), compared to the baseline luminaires being replaced, at each representative location. Either by: (i) Measurements and calculations; or (ii) Computer modelling of average illuminance from baseline and project luminaires at representative locations that shall be determined in accordance with CIE standard 140:2000;4

- ***Compliance with applicable street lighting standard***: each city participating in the SSLI NAMA shall prove that the selected efficient lighting technology/-ies (LED or otherwise) meet an appropriate standard that is pre-approved by the NAMA TSU within MEMR (see detailed discussion in Section 4.4).

**Parameters to be monitored**

The monitoring activities include:

(a) recording of luminaire distribution data, including the numbers and types of lamps per municipality, with this data provided by the PJU or potentially by an ESCO if contracted by PJU; and

(b) ex-post monitoring surveys/sampling results. This shall be carried out after installation of all project luminaires providing a value for the following parameters, with the specific approach taken from AMS-II.L, and possible to be adjusted for the SSL as appropriate:

- ***Quantity of baseline (BL) or project (P) luminaires*** of different types distributed and installed under the NAMA (units). Once all of the project luminaires are distributed or installed, the quantity is normally a constant value independent from the years, unless the size of operating luminaire inventory decreases during the monitoring period, in which case only the operating project luminaires shall be included in the emissions reduction calculation.

- ***Rated power/wattage of the baseline luminaires*** of the types of lighting devices (kW), or time-integrated average power if equipment operates at various power settings.

- ***Rated power/Wattage of the luminaires installed as part of the SSLI NAMA*** for the types of different lighting devices (kW), or time-integrated average power if equipment operates at various power settings, normally constant value independent from the year unless operating schedule or parameters change during crediting period.

- ***Annual operating hours for the baseline and project luminaires*** in year y. May differ from baseline scenario to the post-implementation scenario. This value is based on continuous measurement of daily average usage hours of luminaires for a minimum of 90 days at monitoring survey sample locations, corrected for seasonal variation of lighting hours and multiplied by 365 days. The method used to extrapolate the 90 days of data to annual values must be documented. Alternatively, sensors could also be used.

- ***System Outage Factor (SOF)*** for equipment type. SOF is calculated as the product of the equipment Outage Factor and the ***equipment Annual Failure Rate***. The value for the baseline is assumed to be the same as monitored post-implementation and may vary from year to year.

The grid emission factor (GEF) is calculated by MEMR for the various electricity grids in Indonesia and regularly updated (see Section 4.3.3).

From the above, it is clear that the key parameter from a measurement point of view is the average annual operating hours. For this, a simple recorder of on/off time or direct monitoring over time of power, or even light intensity, may be used. It is the only parameter that needs to be physically measured, and this can be done using sampling.

For each ex-post monitoring survey, the CDM methodology AMS-II.L requires that the monitoring shall include continuous monitoring of equipment run-time for at least 90 continuous days to determine average daily operating hours for extrapolation to annual operating hours ($O_i$). It is suggested that this requirement could be made more flexible in the context of the SSLI NAMA.

**Frequency**

Subsequent ex-post monitoring surveys should be carried out at least every second year after the first year of the period in which emissions reductions are monitored (i.e. years 3, 5, 7, 9).

**Sampling**

Due to the high number of lamps that would be replaced in each city under the SSLI NAMA it is not possible to directly monitor the energy consumption of each lamp, unless meters which allow this are installed. From discussions with city PJUs it is understood that the preferred technology options typically cover up to 25 lamps per metering unit. This would provide a relatively high level of accuracy for the energy consumption of installed lamps, provided that other factors such as losses due to deterioration of ballasts, sub-optimal cabling and theft are accounted for in the metered data. If the PJU also invests in optimisation of these factors at the same time as installing the LEDs or other efficient lamps then the metering data from each metering point can be used and split between the different lamps installed.

While installation of metering is a high priority from a municipal budget point of view, it is not recommended to require that all cities participating in the NAMA have reached full metering as a pre-condition. Some cities may wish to join while they are still implementing their metering roll-out. Requiring full metering prior to joining would significantly increase the up-front capital costs of the NAMA implementation and delay achievement of emissions reductions.

Therefore, a sampling approach should be an available option for determining the achieved emission reductions. CDM methodology AMS-II.L suggests calculating the sample size for each sampling group to achieve a minimum 90% confidence interval and 10% maximum error margin. The sampling size then depends on the expected mean value and the standard deviation of a specific parameter (e.g. operating hours). The CDM "Standard for sampling and surveys for CDM project activities and programme of activities" defines also minimum requirements for sampling, which can be used as a guide for defining the SSLI NAMA sampling plan. For small scale (SSC) activities a level of confidence/precision of 90%/10% respectively is required, while for large scale activities a level of confidence/precision of 95%/10% is required[39]. As an illustrative example, the likely scale for the Demonstration Phase of the SSLI NAMA is between 4.75 and 15.2 GWh of energy savings per annum, depending on whether it includes 2 or 4 cities. This suggests, on average, energy savings of less than 4 GWh pa per city, which is well below the CDM small scale threshold of 60 GWh pa. It is suggested, therefore, that the more

[39] According the CDM Project Standard (EB 65, Annex 5) the small scale threshold for Type II project activities is defined as: Energy efficiency improvement project activities that reduce energy consumption, on the supply and/or demand side, with a maximum output of 60 GWh per year (or an appropriate equivalent) in any year of the crediting period.

relaxed confidence/precision levels from the sampling rules for SSC CDM activities are appropriate to be applied for cities involved in the SSLI NAMA.

Even if we were to assume the more stringent confidence/precision requirements, as can be seen in Table 36 below, the minimum sample size would be just 24 lamps by city/province (sub-system to reach a 10% precision and keep a 95% confidence interval. As a general principle (rule of thumb), however, it is recommended to have a sample size of at least 30 lamps per sub-system to ensure reliability of the sampling result[40].

This initial analysis thus suggests a very manageable sampling requirement under the SSLI NAMA in terms of costs and human resources for each city.

**Table 36: Minimum sample size in dependency of the confidence interval**

| Sample assumptions | | | | |
|---|---|---|---|---|
| Precision | 0.1 | | | |
| Total no. of lamps | 10,000 | | | |
| Range of parameter | 0.5 | | | |
| Estimation of sample size | | | | |
| Operating hours (h/d) | Standard Deviation | V | Sample size (0.95; 1.96) | Sample size (0.9; 1.645) |
| 10 | 2.5 | 0.06 | 24 | 17 |

**Approach B: Use individual meters and eventually smart control systems.**

This approach is ultimately required from the point of view of optimising the street lighting systems across Indonesian cities and provinces. Without installation of metering, cities are unable to shift away from the lump-sum billing system and will find it difficult to clarify the reasons for non-technical losses that are estimated to be up to 40% based on the experience in Yogyakarta for example.

Metering technology would have to be installed such that it is possible to meter the actual consumption of lamps, not just sections of a street with multiple poles, since theft could still be an issue in the case of the latter. If metering data cannot be attributed directly to the connected lamps for each metering unit then the volume lost due to theft could still appear in the metered data. One advantage of the CDM approach is that it avoids this issue. If the configuration of metering technology does not take this issue

[40] According to the *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*, if the sample size calculation returns a value of less than 30 samples, a minimum sample size of 30 shall be chosen when the parameter of interest is a proportion. If the parameter of interest is a numeric mean value the Student's t-distribution shall be used. Thus in the case of lamp operating hours, this would apply, since it is not a proportion or percentage, but rather a mean value.

into consideration, then some other solution is required – e.g. at the time of meter installation all illegal connections need to be either removed or brought into the "legal" system (metered and billed accordingly). Regular audits/surveys can also be applied after metering has been installed, to check whether new illegal connections have been installed.

The actual reading and calibration will be done by PLN. Hence, for the measurement of energy consumption for the NAMA MRV, the metering data needs to be provided by PLN to the corresponding PJU and then verified and fed into the NAMA MRV system which will be maintained by the TSU in MEMR.

### 4.8.4 MRV of co-benefits

Apart from emission reduction, the SSLI NAMA results in co-benefits such as sustainable development benefits to the economy, environment and population. In particular, there is likely to be an improvement in safety standards in urban areas, and possibly a reduction in traffic accidents. It is recommended to also track these indicators as part of the MRV framework. Where possible, this should be referenced against existing data that might exist in individual municipalities and provinces or even on a national level. When developing the evaluation framework for co-benefits, particularly for sustainable development benefits, it may be useful to refer to the CDM sustainable development checklist of the Designated National Authority (DNA), if available, and taking into account national circumstances. Potential criteria and measurable indicators for co-benefits for the SSLI NAMA are included in the Table 37 below.

**Table 37: Criteria and measurable indicators for co-benefits**

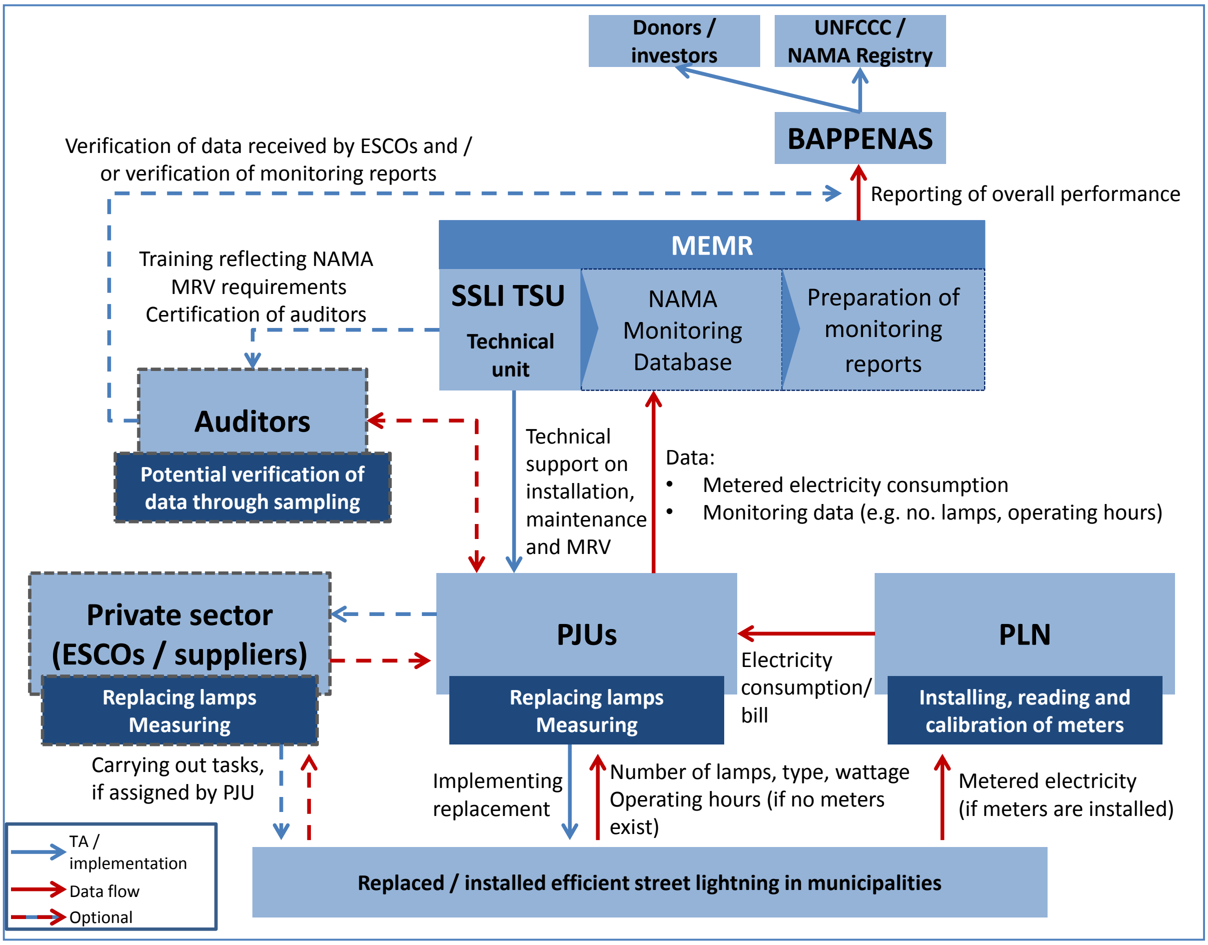
| Criteria | Indicator |
|---|---|
| **Economic** | |
| **Job creation** | - Created employment<br>- Availability of qualified, highly efficient productive national labour |
| **Energy security** | - More efficient use of fossil fuels<br>- Reduced import rates of fossil fuels<br>- Reduced costs |
| **Reduced road accidents** | - Cost savings<br>- Saved lives |
| **Social** | |
| **Enhancement of quality of life** | - Health improvements (safety, fewer accidents, violent crimes)<br>- Distribution of costs and benefits<br>- Income distribution<br>- Local participation in civic life<br>- Enhancement of health conditions and safety standards |
| **Environmental** | |
| **Reduction of local/regional environmental impacts** | - Reduction in other pollutants (e.g. from Mercury lamps) |

### 4.8.5 Institutional responsibilities for MRV

The overall responsibility for the development, implementation and running of the MRV system, including data collection, calculation and storage is recommended to be with the SSLI TSU within MEMR. The TSU would be responsible for the development and running of an electronic database to record and manage all relevant baseline and monitoring information. This database will include, *inter alia*, identification data and numbers of lamps covered under the NAMA (Identification Records), which will allow, in case no meters are installed, calculating the corresponding adjustment of the emission reduction calculation ex-post based on Monitoring Records (operating hours, wattage) as outlined above. The database will also help avoid potential double counting of emission reductions (e.g. between provincial level streets and municipal level streets). PJUs will be responsible for both the implementation of the lamp replacement, provision of metered data to the TSU and conducting the field measurements (based on sampling for determining the operating hours). If the electricity bills received from PLN do not provide PJUs with metered data broken down to a sufficient level of detail – that is, meter by meter – then it will be necessary to obtain actual metering data. The TSU may need to facilitate between PLN and the PJUs if this data is not readily provided by PLN.

Figure 21 shows the proposed institutional responsibilities for the MRV framework and the data flows that are needed to track the overall performance of the SSLI NAMA.

**Figure 21: Institutional set-up for MRV**




The SSLI TSU's technical unit will provide technical support on the installation, maintenance and MRV to PJUs that will in turn supply data that are required for the emission reduction calculation and reporting of the overall NAMA performance. The

Table **38** below identifies the data to be obtained for estimating parameter values and the responsibilities for obtaining these, as well as the method.

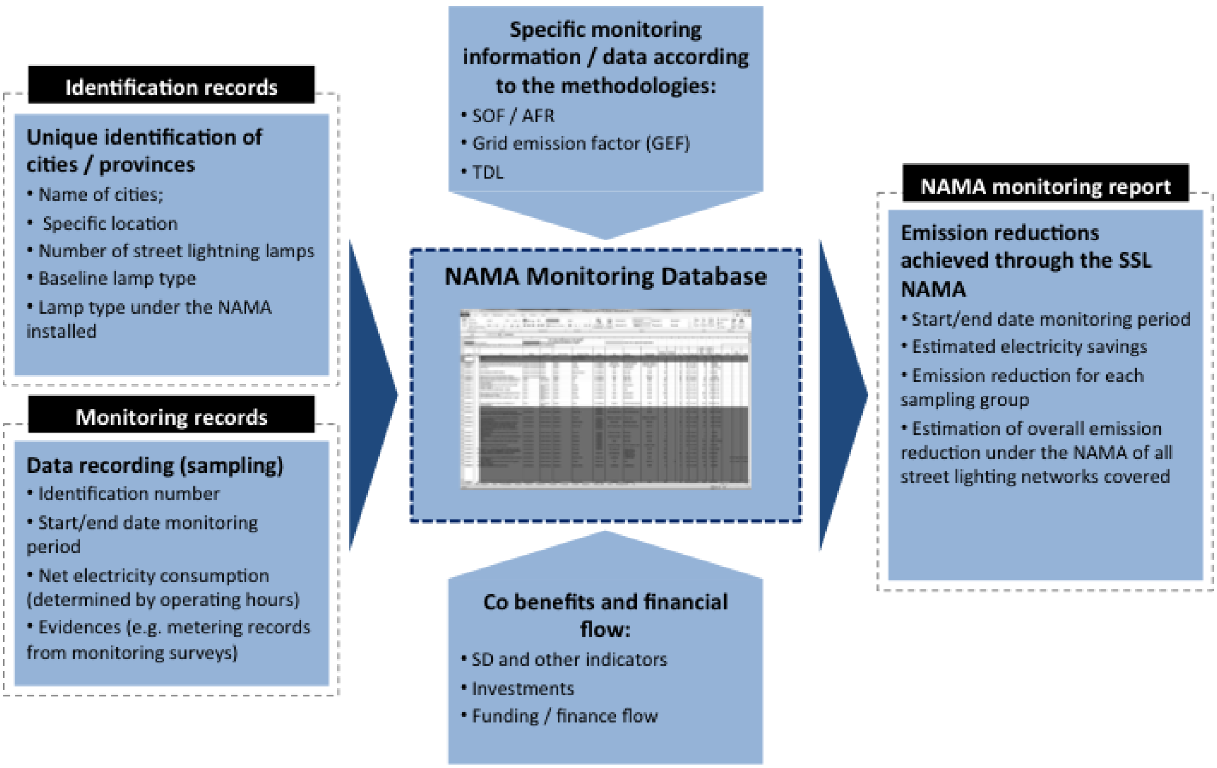
**Table 38: Method for obtaining parameter values under MRV framework**

| Parameter | Responsibility | Method |
|---|---|---|
| **Number of lamps** | PJU | Maintain records |
| **Type of lamps** | PJU | Supplier specifications |
| **Wattage of lamp** | PJU | Supplier specifications |
| **Operating hours of lamps (for the case of lamps which are not yet metered)** | PJU | Via sampling |
| **Electricity consumption data (for the case of lamps which are metered)** | PJU | Obtained from PLN |

The implementation of the replacement and the monitoring could also optionally be outsourced on a commercial basis – i.e. be conducted by private companies such as an ESCO or energy auditor, depending on the individual situation of the municipalities and the PJU. In the Figure above it is indicated as an option, with dotted lines. The same is true for a potential verification of data by a third party auditor. The auditors could provide their assessment at basically two steps of the data flow. First, PJUs may have the interest to obtain a verification of the performance and data received by contracted ESCOs for commercial reasons. Secondly, the monitoring report that will be prepared by the TSU would be externally verified, before it is submitted as part of the national MRV process, i.e. submitted to BAPPENAS. In general, it is suggested to align the SSLI NAMA reporting to the national reporting (RAD-DAK) system (see approach in EU MRV CB/GIZ PAKLIM, 2012). Some form of international audit/oversight may also be required as part of the supported NAMA component where international finance is provided.

To produce monitoring / performance reports of the NAMA the TSU will run a NAMA database (e.g. Excel based). The database will capture both Identification records (once when the replacement of lamps takes place) and the Monitoring records (annually / biennially depending on data availability / methodology of data sourcing, e.g. with or without meters). Additionally, specific monitoring information, e.g. the GEF, and information of financial flow as well as potentially co-benefits should be included. Figure 22 below summarises the data included and the general process for the preparation of the NAMA reports based on the data base.

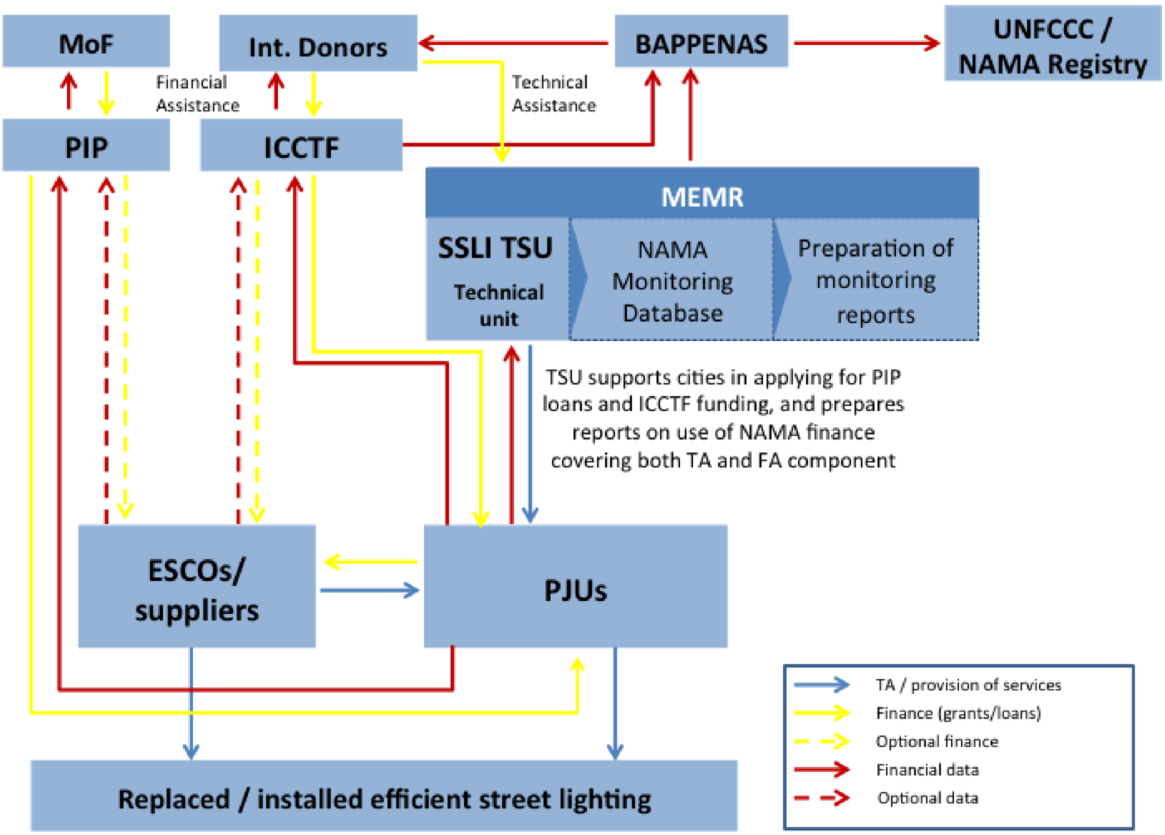
**Figure 22: NAMA database for MRV**



### 4.8.6 MRV of financial flows

Tracking the financial flow could be aligned to the institutional set-up for the MRV as outlined above. As the main two receivers of financial funds will be PJUs and/or private actors (ESCOs) they will need to report back to the providers of those funds - either the ICCTF (BAPPENAS) or the PIP. The TSU should also receive the information and provide an overall financial report that can be submitted to donors/investors, , as well as used for domestically purposes, as outlined in the Figure 23 below.

**Figure 23: Tracking of financial flows under the NAMA**




### 4.8.7 Recommendations

The MRV framework for the SSLI NAMA can be based on a combination of the two options outlined above – using metered data wherever available and using the approach outlined in the approved CDM methodology AMS-II.L where metered data is not available for installed lamps. We see some scope for simplification and adaptation to suit the particular circumstances of each city involved in the NAMA. The CDM approach does not require actual measurement of electricity consumption, but instead uses sampling of operating hours and calculated energy savings. Cities that are already advanced with their metering installation programme and can accurately measure electricity consumption should, however, utilise metered data for emissions monitoring under the NAMA.

## 4.9. Raising awareness amongst stakeholders

This chapter identifies the current level of awareness amongst all stakeholders on the usage of energy-efficient street lighting technologies. An assessment of the uptake of these technologies in cities (target group), prevalent mechanisms facilitating such an uptake and an identification of the capacities of agencies supporting this process is presented here. Based on this assessment, specific needs for capacity building and raising awareness are identified.

### 4.9.1 Background

Implementation of energy efficient street lighting technologies in cities has been identified as a high impact energy efficiency measure which can contribute to Indonesia's stated target of reducing emissions. However, the applicability of these technologies, required policy frameworks for facilitating their adoption, knowledge of appropriate design specifications and on-ground implementation requirements are not widely known amongst all stakeholders, including agencies responsible for the implementation of Indonesia's targets under the NAMA framework, local authorities and citizens. Select advanced cities are aware of related technological options and their cost – benefit implications. Adoption of these technologies is also hindered by certain financial and economic barriers, technological barriers (related to inappropriate design and sub-standard material), institutional and organizational barriers and identified behavioural barriers. Table 39 below summarises these barriers usually associated with uptake of energy efficiency measures and policies:

**Table 39: Barriers associated with uptake of energy efficiency measures and policies**

| Barrier type | Specific issues |
|---|---|
| **Financial and economic barriers** | • Energy prices, inefficient energy subsidies and price volatility<br>• Market structure and functioning<br>• Financial incentives<br>• Lack of funding (private and public funds)<br>• Costs (e.g. high upfront costs) |
| **Technological barriers** | • Non-availability of requisite standard of material<br>• Lack of technical standards |
| **Behavioural barriers** | • Social, cultural, and behavioural norms and aspirations<br>• Decision-making problems (e.g. split incentives) |
| **Institutional, information and organizational barriers** | • Lack of awareness, information, education and training<br>• Policies detrimental to energy-efficiency<br>• Lack of legal and regulatory frameworks<br>• Limited institutional capacity<br>• Lack of coordination and slackness |

Stakeholders comprising government agencies, NGOs, street lighting equipment manufacturers, and others with an interest in promoting effective, energy-efficient lighting throughout the country can help in executing a broad roadmap to implement energy efficient lighting technologies in Indonesia.

### 4.9.2 Awareness & Capacity Building Need Assessment

Many cities in Indonesia are not aware of the various LED street lighting technologies and the benefits associated with it. In addition, absence of national standards on LED street lighting, lack of testing facilities, manufacturers, suppliers and installers, all result in preventing an active and quick uptake of EE street lighting technology in cities. In light of the above mentioned issues, awareness raising activities for promoting LED street lighting technologies should be planned and executed in a holistic manner, addressing all relevant stakeholders, including policy and decision makers, market actors and influencers, consumers and end users of the technology. An assessment of the current capacities of all involved institutions to support and promote uptake of LED technologies was carried out and measures are identified to further strengthen their roles.

#### 4.9.2.1 Standards on LED street lighting

The absence of national standards on LED Street lighting is a major impediment for active technology roll out in the country. Discussions with relevant ministries involved in setting standards indicate that they are facing several challenges to come up with a national standard on LED street lighting. Such a standard will guide consumers in selecting the best available technology, based on scientific design guidelines, and will also curtail sub-standard products in the market. Cities will be empowered to take appropriate, beneficial decisions, considering long term financial sustainability and emission mitigation potentials.

#### 4.9.2.2 Manufacturers, suppliers, installers of technology

There is a need for promoting local manufacturers producing high quality equipment. The supply chain and servicing industry for these products has to be strengthened. In the absence of good in house production capability, substandard products are sold in the market; poor performance of these products impacts the assessment of this technology.

#### 4.9.2.3 Financial Models

Cities need to be supported by appropriate financial mechanisms to be able to absorb the upfront costs of adopting this technology, which are relatively higher than implementing conventional street lighting technologies. As discussed in the Financing section, a range of domestic and international financing mechanisms can be used to support cities to adopt these technologies. Awareness raising efforts will be needed to encourage cities to take advantage of the available financing mechanisms.

#### 4.9.2.4 Enabling Policies

Framework conditions should be established to facilitate adoption of private sector approaches like greater use of the ESCO model. This has been elaborated in Section 4.5 (Financing options for efficient street lighting) of this report. Currently, policies are not in place, which enable ESCOs to participate in energy efficiency contracts with cities.

### 4.9.3 Designing of Awareness & Capacity building Strategies

Cities are the ultimate decision makers in terms of selection of a particular technology for street lighting operations. Several external and internal factors impact these decisions. A range of awareness raising activities addressing different groups of stakeholders can be undertaken across the country to address these issues:

- Awareness raising seminars, trainings and campaigns for all stakeholder groups including policy makers, manufacturers, suppliers, installers, end users and the community at large. By educating the community on the benefits of LED based street lighting (energy savings, environmental safe end of life disposal, low impact on urban sky glow); a positive demand for this technology is created, despite apprehensions of high upfront capital costs.
- Short term, medium term and long term education courses at the university level to create practicing professionals who can support the adoption and implementation of this technology;
- Showcasing of selected cities chosen in the demonstration phase to demonstrate the LED technology and monitor performance;
- Development of national guidelines on recommended practices, and model efficiency programs related to LED street lighting; and
- The continual dissemination of new information to stakeholders throughout the country through a focused and concerted programme implemented through an identified department/ministry. Such a programme should be backed by appropriate financial, regulatory and monitoring frameworks to facilitate LED street lighting.

#### 4.9.3.1 Training programs, seminars and campaigns:

There is a need to create a series of training programs, seminars and campaigns for different target groups in Indonesia to tap various benefits associated with LED street lighting technology. Based on discussions with all concerned stakeholders, these programs should clearly outline solutions for mitigating identified barriers for LED technology uptake; the TSU should take a lead in developing these programs and should coordinate with other concerned ministries to implement these programs, seminars and campaigns. These programs should be targeted at the below mentioned stakeholder groups:

- Policy makers and government officials
- Manufacturers at the national level
- Suppliers and installers
- Investors and financiers
- Academic and research institutions
- NGOs
- Cities and local authorities
- Local community groups and citizens

**Table 40: Target groups for training and focus areas**

| Target Group | Focus Areas |
|---|---|
| **Policy makers and government officials** | • Information on benefits of energy efficient lighting systems<br>• Model programs and policies that have helped in energy savings in other countries.<br>• National forums, seminars and workshops could be the best medium of information dissemination for this group. |
| **Manufacturers at the national level** | • Information to generate awareness on opportunities that lie in energy efficient lighting systems<br>• Developing requisite expertise so as to enable local manufacturers to develop facilities and supply related material and equipment<br>• Seminars, training programs etc. could be targeted to engineers and technicians in these companies, focusing on relevant standards for equipment. |
| **Suppliers and installers** | • Training on benefits of using energy efficient lighting system from the user's perspective.<br>• Information on requisite specifications and standards of these products in order to ensure supply of material/equipment of desired quality.<br>• Short term training programs, interaction with manufacturers etc. could be of benefit. |
| **Investors and financiers** | • Information on investment opportunities in this area.<br>• Successful financial models can be discussed with them.<br>• Short webinars with the target group can help in achieving the desired results. |
| **Academic and research Institutions** | • Information on new research and development in this sector in other parts of the world.<br>• In depth training to all stakeholders with regard to the latest technology with the help of identified experts can be of use. |
| **NGOs** | • Short term training programs to spread awareness on benefits of using energy efficient lighting. |
| **Cities and Local Authorities** | • Information on available energy efficient technologies and benefits associated with it.<br>• Information on manufacturers and suppliers of related material/equipment meeting international/stipulated national standards in local markets |

| | |
|---|---|
| | • Information on a complete model, including appropriate technology, policy framework, financing and operation & maintenance of such systems, enabling decision making in local authorities on related aspects. |
| **Local Community Groups and citizens** | • General information on energy efficiency technologies and linking it with the larger picture of energy security.<br>• Their role in creating a demand for energy efficient lighting can be discussed during such training programs<br>• Addressing barriers to acceptance of new energy efficient lighting technologies and apprehensions associated with their uptake |

#### 4.9.3.2 Graduate and University level courses:

Colleges and universities can help play a big role in creating awareness on efficient technologies including LED street lighting in Indonesia. Certain education programs, short / medium / long term courses on energy efficiency technologies can be introduced so as to prepare future professionals to implement efficient lighting technologies. Professors at the university with expertise in related fields can be part of training programs to educate all the stakeholders. Further universities and colleges in urban areas can be utilised to demonstrate pilot projects of LED street lighting. These institutions may be identified as preferential locations for conducting training programmes for the community. MEMR and technical support unit (TSU) can work with ministry of education and human resources to carry forward these activities.

#### 4.9.3.3 Implementation of pilot and demonstration projects:

The LED street lighting technology is still at a nascent stage in Indonesia and particularly the cities are not ready to adopt the technology on wider scale. The apprehensions related with experimenting with a new technology increases when there are high upfront cost associated with it. In such scenarios, the implementation of pilot projects at strategic locations in selected cities can help in a great way to resolve the problem. The city of Malang with support from GIZ and OSRAM has implemented one such pilot project on one of the prime roads in the city.

The proposed approach is that the cities chosen for the demonstration phase of the SSLI NAMA can be used to showcase the benefits of LED technology to other cities. Subsequently, more cities will join the NAMA during the scaling up phase, and the results of this will be used to spread further uptake during the transformation phase.

#### 4.9.3.4 Continuous dissemination of information amongst stakeholders:

All identified stakeholders should be continually informed of newly emerging and available LED technologies, relevant to the local Indonesian context. The advantages of adopting these technologies in cities should be constantly emphasised. Information dissemination should use multi-media channels effectively to address all sections of stakeholders – creating effective info graphics for use in public media, messages disseminated through appropriate online social network channels, targeted school programs, community level dissemination through public broadcasting using information leaflets and other dissemination material. One of the tasks of the TSU could be the design and implementation of a planned information dissemination programme in all cities, using various media solutions.

#### 4.9.3.5 Role of the Technical Support Unit (TSU):

The TSU could coordinate all awareness building activities to support implementation of LED street lighting in Indonesia. The activities proposed for TSU under awareness and capacity building is:

- Planning and roll out of the awareness building initiatives under SSLI NAMA.
- Coordination, monitoring and evaluation of the on-going awareness building activities related to LED streetlight implementation in other divisions of the Ministry.
- Develop and maintain a database of local governments - human resources – staff & elected representatives and training infrastructure facilities in the area of energy efficiency at local and provincial level.
- Develop and maintain an inventory of training/research institutes working in energy efficiency sector in Indonesia.
- Establish and operate an E-library.
- Advise MEMR on new themes requiring awareness building activities.
- Undertake research studies on LED street lighting and publication of reports.
- Any other activities related to capacity building as directed by MEMR.

## 5. Summary of recommendations

**Institutional set-up**

1. A Technical Support Unit (TSU) within MEMR should be established to facilitate the implementation of the NAMA, and coordinate the activities of all of the involved agencies. Part of the international grant funding component should be used for these activities.

**Policy and regulations**

2. MEMR envisages to consult with PLN on a transparent procedure for the calculation of consumption of electricity from efficient street lighting. This would help reduce transaction costs and increase the incentive for PJUs to invest in more efficient lighting. Two tracks are recommended – one with and one without metering.

3. MEMR envisages to facilitate a more rapid move to full metering of street lighting in Indonesian cities by offering facilitation and/or financial support. This would help incentivise cities to switch to more efficient lighting technologies and ensure the SSL NAMA is implemented more successfully.

**Baseline data**

4. It is recommended to further explore the reasons for discrepancies between reported energy sales/national street lighting consumption statistics and actual electricity consumption, so that an accurate emissions baseline can be established.

5. In the meantime, it is recommended to impose a requirement on cities wishing to join the SSLI NAMA that they have at least one of the following:
   a) The city has metering in place to cover a minimum percentage of street lighting load (e.g. above 50%); or
   b) The city has conducted an audit within a minimum timeframe (e.g. within the last 3 years prior to joining the NAMA).

6. It is also recommended that the baseline for individual cities/municipalities joining the SSLI NAMA in the demonstration phase should be established on a city-by-city basis using the following approaches:
   a) For cities where full coverage metering has already been installed or is soon to be installed, it is recommended to use the metered data for baseline establishment.
   b) For the non-metered component of the consumption (up to 50%), use the calculated approach as outlined in this section and in Section 4.6.2 (where the emissions reduction equations are included based on approved CDM methodology AMS-II.L).
   c) When applying option b), emissions reductions calculated ex-ante should be verified ex-post during the monitoring phase, as is outlined in Section 4.7.

**Performance and safety standards**

7. Consensus is required from the relevant ministries including MEMR, MoI, MPW and MoT together with BSN to adopt the existing international standards (including IEC and IES standards) or standards from similar Asian countries, such as India. TSU is recommended to provide technical support to relevant ministries for setting LED standards.

8. SNI 4 6973.2.3-2005 (Part 2.3 of Lamps: Special requirements of street lighting). This standard specifies the luminaire standard for other lamps. LED could be added as addendum to this standard.

9. Directorate General of Bina Marga (Highway) could request Puslitbang to review the existing safety and performance standards and add specific standards for LED street lighting.

10. A detailed technical specification document (bid document) on LED street lighting procurement for all kinds of roads could be developed by BSN.

11. Testing protocols, infrastructure and accredited laboratories must be set up to ensure testing of LEDs for compliance to the technical standards.

12. Name of suppliers/manufacturers complying with national standards are to be listed in government websites for the reference of users

13. Due to non-availability of national LED standards other smart street lights such as induction lamps could also be considered under NAMA

**Financing options**

14. Utilise international NAMA support in combination with domestic finance sources to kick-start the SSLI NAMA Implementation. International NAMA support funding provided by a grant from the NAMA Facility or similar could provide a grant in the order of 11.5m USD to be administered via the ICCTF. This should be used for SSLI lighting replacement investment in 2-4 targeted cities in the demonstration phase from early 2014 – mid 2015.
15. An additional 6-8m USD funding should be sought for technical assistance, specifically for the set-up and operation of the TSU to support local governments in accessing domestic finance via the ICCTF, loans from PIP and potentially other sources.
16. As a priority, the national government should enable local government to enter into contractual arrangements with ESCOs by reforming the regulatory framework.
17. TSU should work with PIP to smooth the process for entering into soft loan arrangements with municipal and provincial governments. Consider using PIP loans to help cities enter into ESCO arrangements.
18. In the scaling-up phase, from mid 2015-end 2016, aim for a further 2-8 cities joining the SSLI NAMA, supported primarily via PIP loans and ESCO financing. In the transformation phase, from early 2017 to end 2019, aim for further 5-10 cities joining the SSLI NAMA, supported by PIP loans, ESCO financing to the extent possible. Once exhausted, either commercial loans or new sources of finance will be required.
19. Under the ambitious scenario without new sources of donor finance or national government financial incentives (e.g. DAK grants or a dedicated loans facility for energy efficiency), the NPV will be negative in 2024. In order to present an economically attractive option for the municipalities, additional sources of NAMA finance would be required. For example, a second grant of 11.5m USD during the transformation phase would generate a positive NPV. International donors but also national, public institutions should be approached for financing.

**Installation and Maintenance**

20. The national standards and guidelines on installation and maintenance need to be enforced upon at the local level by national government. Besides this, the existing standards are to be supplemented with additional standards on LED streetlights.

21. There is a great need for developing training and capacity building programs for the target groups so as to enable them to better execute installation and maintenance within the city area.

**MRV**

22. The MRV framework for the SSLI NAMA can be based on a combination of two options: 1) using metered data wherever available covering the installed lamps; and 2) using the approach outlined in the approved CDM methodology AMS-II.L where metered data is not available for installed lamps. Cities should utilise metered data for emissions monitoring under the NAMA to the extent possible given the level of metering.

**Raising awareness**

23. The awareness raising activities for a larger uptake of LED streetlights by city governments will need holistic efforts from different level of stakeholders starting from the national, provincial and also at the local government level. The activities listed out in the above mentioned section can be implemented in a phased wise manner after prioritising the activities which need to immediately take off. Seminars, training programs and campaigns have a wider role to play in engaging the different level of stakeholders in identifying the barriers and coming up with logical solutions for the technology to widespread in the country.

## Annexure 1 - IEC Published LED standards

A) Lamps

1) IEC 62031 LED Modules for General Lighting – Safety Specifications
2) IEC / TS 62504 General Lighting – LED's and LED Modules, Terms & Definitions
3) IEC 62560 Self-ballasted LED Lamps for GLS > 50V, Safety Specifications
4) IEC 62612 Self-ballasted LED Lamps for GLS >50V, Performance Requirements
5) IEC / PAS 62707-1 LED Binning – Part 1 General Requirements and White Grid
6) IEC / PAS 62717 LED Modules for General Lighting – Performance Specifications

B) Caps & holders

1) IEC 60838-2-2 Miscellaneous Lampholders - Part 2-2 Particular Requirements-connectors for LED Modules

C) Auxiliaries for Lamps

1) IEC 61347-2-13, Lamps Control Gear Part 2-13: Particular Requirements for dc or ac supplied Control Gear for LED Modules
2) IEC 62384 DC or AC Supplied Electronic Gear for LED Modules- Performance Requirements
3) IEC 62386-207 Digital Addressable Lighting Interface Part 207: Particular Requirements for Control Gear - LED Modules (device type 6)

D) Luminaires

1) IEC /PAS 62722-2-1 Luminaire Performance Part 2-1: Particular Requirements for LED Luminaire.

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