Energy-efficient street lighting– *Experiences from Melaka, Malaysia*

Parallel Session C3: Tools & Resources -

Renewable Energy/EE Implementation

December 6, 2017, Ho Chi Minh

Asia LEDS Partnership Forum 2017

Nikhil Kolsepatil

ICLEI South Asia

ICLEI - Who we are

ICLEI Local Governments for Sustainability

Pioneers of urban sustainability

ICLEI was founded in 1990, with the idea that a single municipality has a significant impact and that cumulative local actions can achieve tangible improvements in global sustainability.

Today, **ICLEI** is a world-leading association of over 1,500 cities, towns, metropolises in around 100 countries, committed to building a sustainable future.

In
100+
countries

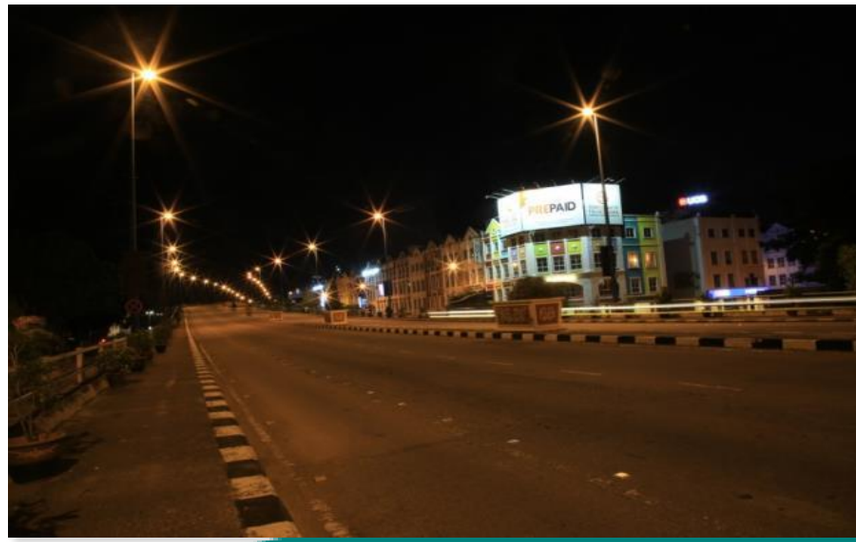
850+
million people

> 25% of the global urban population

71
Members in SA in 2017

Melaka Street Lighting Project

- Objective to upgrade street lighting system of Melaka state using energy efficient LED lamps
  - lower cost of street lighting
  - Improve safety and security
  - reduce GHG emissions
- Replacement of ~100,000 high-pressure sodium (HPS) street lamps with LEDs at estimated cost of USD 40-70 million
- Expected energy savings: 45-60%
- GHG emission reduction: ~22,000-28,000 tonnes CO_2e
- Asian Development Bank (ADB) assisting State of Melaka –
  - high-level scoping study
  - detailed investment grade audit, financial modelling, legal due diligence, tendering, award



Source: Ablaza (2017) : Mobilizing Private Capital for Energy Efficiency through PPP Structures, Asia Clean Energy Forum 2017; Analysis from ICLEI South Asia's consultant team undertaking Investment Grade Audit for the LED Street Lighting Project in the State of Melaka

Entities involved in Provision of Street Lighting Service in Melaka State

- Power distribution company TNB operates 90% of the street lights– mounted on its power distribution poles
- Local authorities operate remaining 10% street lights
- Tariffs: Street lights (including maintenance) - 0.305 MYR per kWh
  Street lights (excluding maintenance) - 0.192 MYR per kWh

Responsibility	Melaka City Council	Hang Tuah Jaya Council	Alor Gajah Council	Jasin Council	Tenaga National Berhad
Purchase of Material/spares (HPS lamps, MCBs, wiring etc.)	Contractor	Contractor	Alor Gajah	Contractor	TNB
O&M related services	Contractor	Contractor	Alor Gajah	Contractor	Contractor
Logistics for maintenance (storage, transportation, sky-lifts)	Contractor + Melaka City (storage)	Contractor + Hang Tuah Jaya (storage)	Alor Gajah	Contractor + Jasin (storage)	Contractor + TNB (storage)

Efficient Street Lighting- Design Aspects

- Effective energy efficient street lighting design integrates the following factors:
  - Efficient lamp technologies
    - Utilizing lower energy consuming technology
  - Optimum pole height and placement
  - Efficient light distribution and aesthetics
    - Maintaining visibility and appropriate light level (uniform, continuous, no glare)
- Components of street lighting system

Electrical	Structural	Optical
• Lamps • Ballast • Service cabinets/ feeder panels	• Poles • Pole bases (foundations)	• Luminaires

Efficient Street Lighting Technologies

- Considerations for energy efficient lighting technologies
  - Quality of light output
  - Energy consumption of fixtures
  - Life of fixtures
  - Maintenance requirements

- Total Ownership Cost (TOC) has to be considered

  TOC = Investment cost + Energy Cost + Maintenance cost

Efficient Street Lighting Technologies

- Key parameters considered for selection of lamps
  - Color Temperature
  - Color Rendering Index
  - Lumen Output
  - Lamp efficacy
  - Lumen depreciation
  - Lamp life

Lamp	Luminous Efficacy (lumen per watt)	Color rendering properties	Lamp Life in hours
High Pressure Sodium	~40- 80	Fair	~15,000-24,000
LED	~90-130	Good	~40,000-100,000

- LED lamps offer lowest total ownership cost over life cycle
- Energy savings of 25 – 60 % can be achieved by replacing conventional lamps with LED lamps

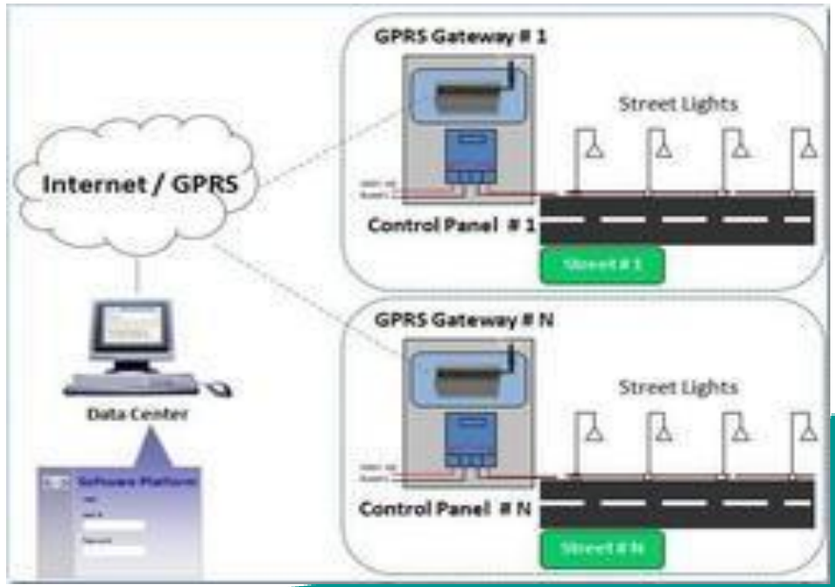
LED advantages

- Low energy consumption
- Higher light output and better visibility
- Long life
- Fast turn-on time
- Reduced light scattering
- Less ageing of optics
- Dimmable and controllable

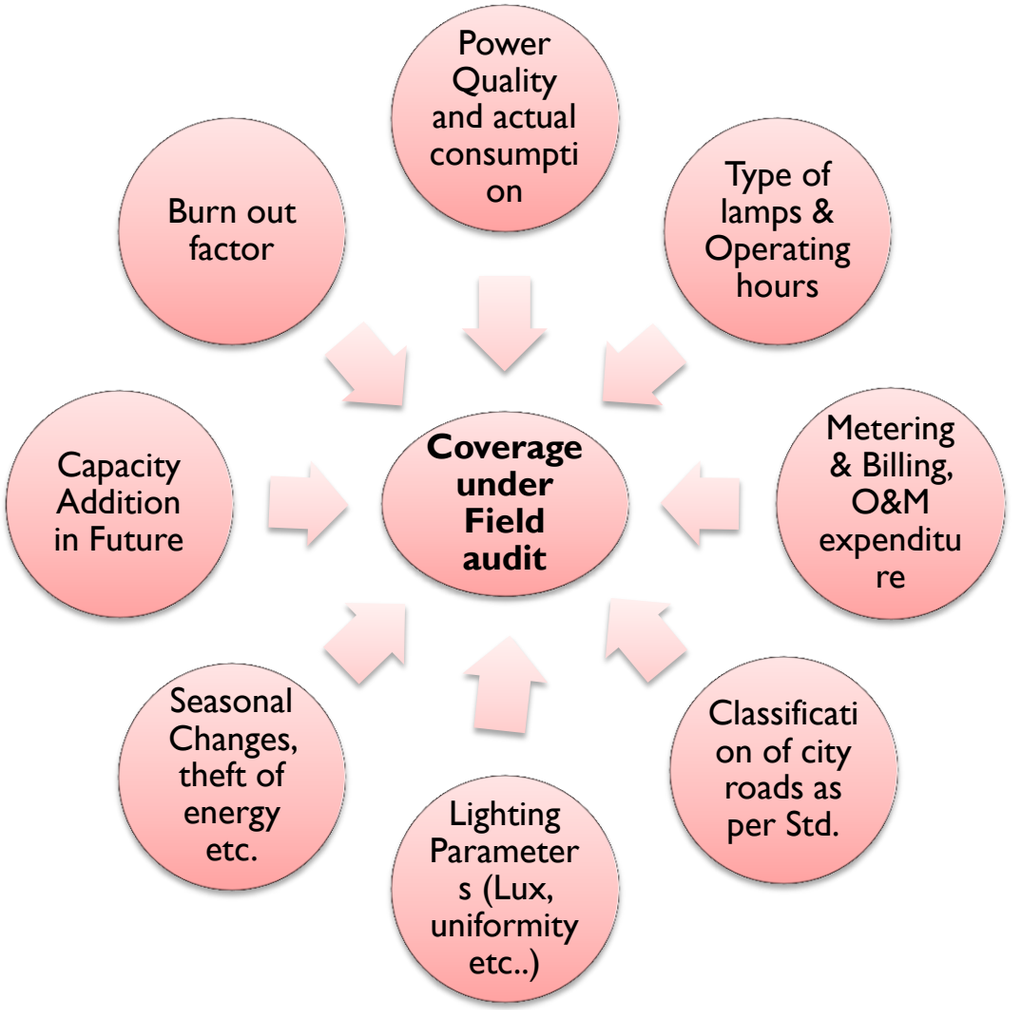
Source: Based on information collected for Melaka and USAID India and Government of India, Bureau of Energy Efficiency (BEE). 2010. Energy Efficient Street Lighting Guidelines. Delhi

Street Lighting Controls

- **Control Switch:** Switching on/off for a group of lights
- **Dimming:** To save energy by reducing lighting levels (for eg. when traffic is low or in early morning hours)
- **Voltage Optimization:** LEDs are susceptible to voltage fluctuations
- **Tele-Management/Smart Control Systems:** Software based systems and controls to gather and communicate information
  - Outdoor luminaire controllers built into the luminaire to
    > switch, dim the lamp, regulate voltage, power factor..
    > detect failure and count burning hours
  - Can be either group control or point-to-point control for each individual light point



Robust Baseline Assessment is Essential



Preparation of road and asset inventory

- Ascertain **total connected load** (by type and wattages) of street lights and **energy consumption**
- Recording of **pole infrastructure** - lamp mounting heights, pole to pole spacing, road widths, road classification
- **Distribution network mapping with location of switching points,** length, size and condition of cables
- Ascertain **actual O&M cost per pole**
- Mapping the **electrical safety requirements**

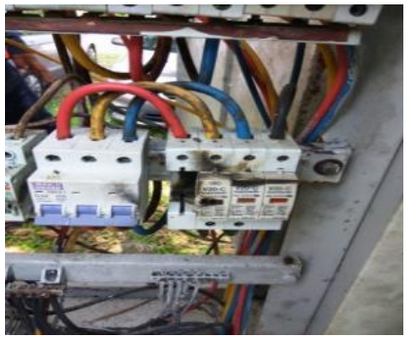
Metering and performance of all street lighting system

- Number of **metered and unmetered street lights**
- Establishing actual energy consumption and performance - **measurement of electrical and lighting parameters**
- Analysis of **electricity bills, energy prices**
- Ascertain **theft and loses in energy**

Recommendation for **CAPEX and Energy Efficiency measures**

Infrastructure Issues and Challenges

- **Baseline**: Inadequate data availability and lack of reliable metering systems
- **Billing**: Wide variation in billed load & actual load - 30-50%; Meter readings vs billing – lump-sum billing
- **Manual operation**: Variation in operating hours results in additional usage of 10-15%
- **Non-conformance to standards**: Light outputs of lamps do not conform to standards
- **Payments linked to bill reduction**: Absence of proper baseline – more technical and financial risk to private parties
- **Payment Security**: Increases cost of capital and impacts viability
- Sub-national governments may lack technical, managerial and financial capacity to implement projects



Electrical faults

Manual metering

Inadequate pole spacing and illumination

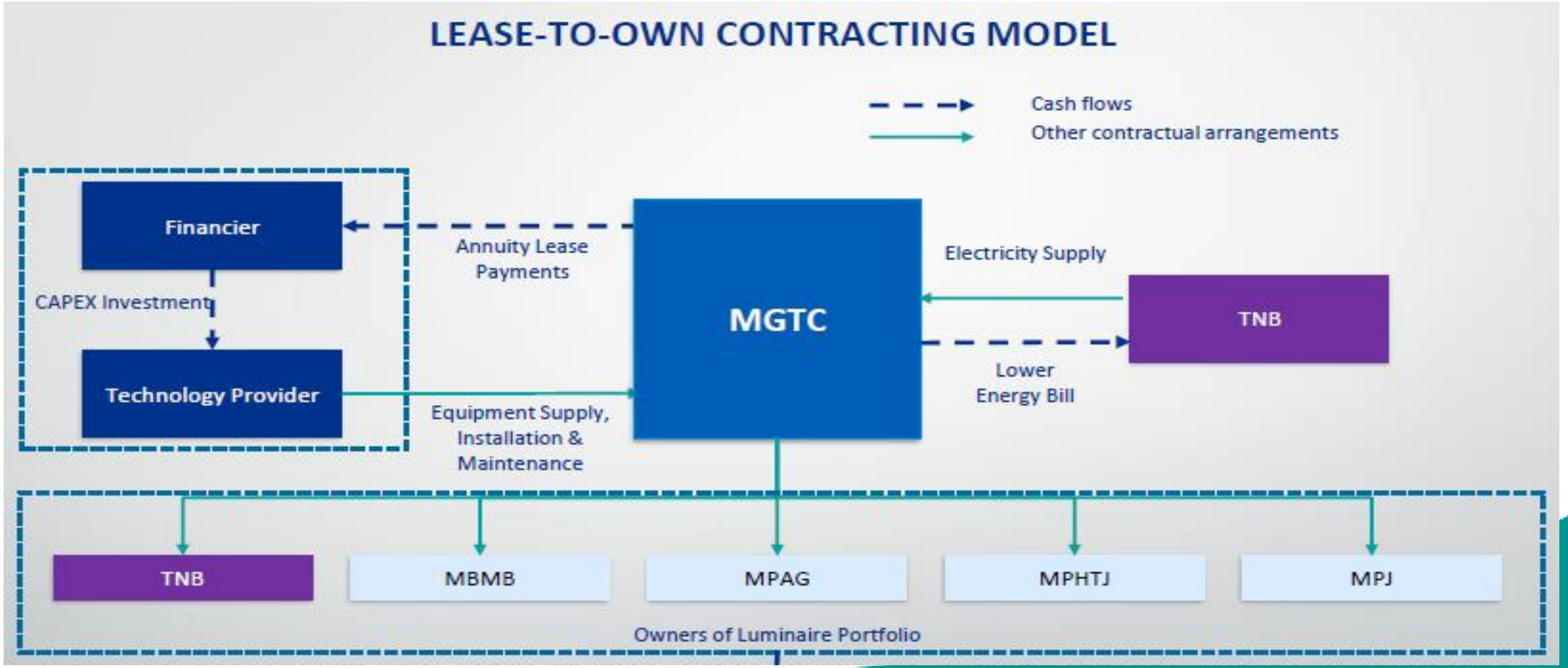
Financing Options for Efficient Street Lighting

Factors	Self Financing		ESCO Models		
	Debt Financing	Equity Financing	Shared Savings	Guaranteed Savings	Annuity payments
Risk on Investment to the host	High	Moderate	Low	Low	Low
Use of Best Available technology	Low	Low	High	High	High
Operating & Performance Risks to the host	High	High	Low	Low	Moderate-High
Monetary Savings to the host	High	Moderate	Moderate	Moderate	Low (fixed)
Investment Required by the host customer	High	Moderate	Zero	High - returns guaranteed	Zero

Potential Model for Melaka

- Shared savings ESCO model not suitable for Melaka case
  – prevalent low power tariffs, perceived risks by private sector

- Annuity payment based (Lease-to-own) model
  - Requires no capital investment from Govt.
  - May attract competitive bids due to lower revenue risks



Source: Ablaza (2017) : Mobilizing Private Capital for Energy Efficiency through PPP Structures, Asia Clean Energy Forum 2017

Technological Options considered for Melaka by PPP Advisory team

- **Option 1: Stand-alone LED – *least cost***
  - Only LED replacement and no digital connectivity
  - Meters installed at the feeder panel are used for energy monitoring
- **Option 2: LED replacement with full point-to-point digital connectivity – highest cost**
  - Dimmable LED fixtures - individual point to point digital connectivity for addressability and control of each light point through GSM technology
- **Option 3: LED replacement with Group connectivity**
  - LED replacement and group connectivity for addressability, control and voltage dimming for a group of lights at feeder panel level
- **Option 4: LED replacement with Partial connectivity**
  - Stand-alone LED replacement for 70 W, 100 W and 150 W HPS lamps and point-to-point digital connectivity for 250 W and 400 W lamps

Provision for easy add-on of communication/control nodes at a later stage can be included in LED performance specifications

Thank You !

Nikhil Kolsepatil
Manager- Energy & Climate
ICLEI South Asia Secreteriat

E-Mail: nikhil.kolsepatil@iclei.org, iclei-southasia@iclei.org
Websites: www.iclei.org, www.southasia.iclei.org

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