6. Utilities 2: Lighting and other urban services

Mel Slade, IEA
Pretoria, 15 Oct 2019
Training Overview

6. Utilities: Lighting and other urban services

Scenario: Local residents are complaining about dark and unsafe streets

Question: What can you do to reduce energy use in public lighting and improve service delivery?
Training Overview

1. Energy use in Lighting
   • Energy use and impacts

2. Strategies for energy efficiency
   • Lighting service, technology replacement, management systems

3. Activity: risk mitigation measures in lighting

4. Other Urban Services
   • District energy systems: district energy concept; waste heat integration and sector coupling
   • Waste management: waste generation, impacts, energy recovery opportunity, technologies, and policies
1. Energy use in lighting
1. Energy use in lighting: Energy use and impacts

From a national point of view, costs of public lighting are small. However it is a big strain on local budgets.

1. Energy use in lighting. Need to sustain/improve lighting services

Road safety: 30% reduction in collision, 43% reduction in night time accidents

Lower crime: 7% reduction in New York, 39% reduction in UK

Inability to sustain optimum lighting service affects important social service provided by public lighting. Expanding these are the common goals of a growing municipality.

1. Energy use in lighting. How does your city compare?

Electricity Consumed per km of Lit Roads [kWhe/km]
1. Energy use in lighting. How does your city compare?

Potential electricity savings per sector (MWh/a) across the nine cities of the South African Cities Network (SACN)

Breakdown of energy efficiency projects identified within South African cities Integrated Development Plans

The potential impact for energy savings in street lighting in South African municipalities is significant (~23%). Progress in retrofitting of street lighting has already occurred with more planned as stated in IDPs.
2. Strategies for energy efficiency
2. Strategies for energy efficiency

- **Manage systems better**
  - Proper design and orientation of fixtures
  - Fixing broken wiring, burnt or damaged lamps and posts

- **Replace technology**
  - Replace lamps with more efficient technologies

- **Install smarter systems**
  - Install smarter lighting management systems
2. Strategies for energy efficiency

Manage systems better

- Proper design and orientation of fixtures
- Fixing broken wiring, burnt or damaged lamps and posts

- Saving energy can already be done with same technologies, using only **better design**

Source: http://www.science.smith.edu/~jlowenth/lightpollution/lightpollution.html
2. Strategies for energy efficiency

Manage systems better

• Proper design and orientation of fixtures

• Fixing broken wiring, burnt or damaged lamps and posts

• Proper maintenance reduce excess electricity use caused by faulty fixtures

Source https://wbg.sabacloud.com/Saba/Web_spf/NA1PRD0002/common/ledetail/00003103
2. Strategies for energy efficiency

- Replace lamps with more efficient technologies
  - LED lamps significantly more efficient than other street lighting technology

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Lumens/watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pressure Sodium</td>
<td>80-140</td>
</tr>
<tr>
<td>LED</td>
<td>114-160</td>
</tr>
</tbody>
</table>

Source: [https://www.slideshare.net/ChristineGupta2012/hps-comparison](https://www.slideshare.net/ChristineGupta2012/hps-comparison)
2. Strategies for energy efficiency

- **Case Study:** Ann Arbor, USA pilot project spent 472$ additional cost per fixture but pays back in 4.7 years, resulting to 97% positive response

- Replace lamps with more efficient technologies

- **80%** Energy use reduction

- **2200 tons** Avoided CO2 emissions

- **100$** Saving per fixture

2. Strategies for energy efficiency

• **Case Study:** Before and after illustration of street lighting retrofit in Los Angeles, CA that saw the installation of over 140,000 LEDs

2. Strategies for energy efficiency

- **Case Study:** Potential in India to save on street lighting by 2020 using the current generation LED lamps in replacing the existing lamp technologies.

![Graph showing energy savings by 2020 for different lamp technologies](https://ies.lbl.gov/sites/all/files/lbnl6576e.pdf)

- Replace technology
- Replace lamps with more efficient technologies

Source: https://ies.lbl.gov/sites/all/files/lbnl6576e.pdf
2. Strategies for energy efficiency

Install smarter systems

- Install smarter lighting management systems

**Case Study:** Ho Chi Minh and Quy Nhon City, Vietnam. Dimming system (bipower ballasts) in 30000 streetlights during low traffic, cutting energy consumption by 40%

2. Strategies for energy efficiency. Steps

1. Assess system and set goals
   (Part 1 – Energy use in lighting)

2. Select strategies
   (Part 2 – Strategies)

3. Deliver

4. Monitor and Evaluate
   (later in Session 9)
2. Strategies for energy efficiency. Delivering change

3. Deliver

<table>
<thead>
<tr>
<th>SITUATION</th>
<th>ACTION</th>
<th>DELIVERY MODEL</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the municipality have sufficient resources to fund the program itself?</td>
<td>Allocate funds by establishing budget line item for project</td>
<td>Municipal Financing Model</td>
<td>• QUEZON CITY, PHILIPPINES • ONTARIO, CANADA (CITIES OPTING FOR THE DESIGN-UPGRADE-TRANSFER MODEL)</td>
</tr>
<tr>
<td>Are there ESCOs active or planning to be active in the local market?</td>
<td>Negotiate an energy service performance contract with ESCOs</td>
<td>Private ESCO Model Public ESCO Model</td>
<td>• AEL, INDIA • EESL IN VIZAG, INDIA • ONTARIO, CANADA (CITIES OPTING FOR SHARED SAVINGS EPC MODEL)</td>
</tr>
<tr>
<td>Are leasing or private financing programs available?</td>
<td>Determine eligibility criteria and negotiate financing agreements</td>
<td>PPP Model Lease to Own Model</td>
<td>• GUADALAJARA, MEXICO • BIRMINGHAM, UK</td>
</tr>
</tbody>
</table>

Source: https://www.esmap.org/node/57252
2. Strategies for energy efficiency. Delivering change
3. Activity
Think about possible options in order to mitigate these common risks associated with public lighting

<table>
<thead>
<tr>
<th>Type of Risk</th>
<th>Risk Manifestation</th>
<th>Risk mitigation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical risk</td>
<td>Failure of luminaries</td>
<td>?</td>
</tr>
<tr>
<td>Performance risk</td>
<td>Failure of installed lighting system</td>
<td>?</td>
</tr>
<tr>
<td>Financial risk</td>
<td>Failure to make payments</td>
<td>?</td>
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</tbody>
</table>
3. Activity

ACTIVITY
Take 15-20 minutes to discuss possible risk mitigation methods in delivering energy efficient public lighting
### 3. Deliver

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<th>Risk Mitigation Measure</th>
<th>Example</th>
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<tr>
<td>Technical Risk</td>
<td>Failure of LED luminaires</td>
<td>• Obtain product warranty from LED luminaire manufacturer</td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensively test luminaires with external technical assistance</td>
<td>Quezon City, Philippines</td>
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<tr>
<td></td>
<td></td>
<td>• Obtain third-party certification of luminaires</td>
<td>Guadalajara, Mexico</td>
</tr>
<tr>
<td>Performance Risk</td>
<td>Failure of installed LED system</td>
<td>• Conduct extensive pilots</td>
<td>Quezon City, Philippines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Outsource risk to private sector by procuring “lighting service” with performance penalties in PPP contract</td>
<td>Birmingham, United Kingdom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Outsource risk to private sector contractors by using EPC contracts</td>
<td>EESL in Vizag, India</td>
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<tr>
<td></td>
<td></td>
<td>• Conduct own maintenance</td>
<td>Guadalajara, Mexico</td>
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<tr>
<td></td>
<td></td>
<td>• Extensively search and procurement of a trusted operator</td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td>Financial Risk</td>
<td>Failure to make payments</td>
<td>• Secure state government guarantees</td>
<td>Guadalajara, Mexico</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Secure commercial bank guarantees</td>
<td>AEL, India</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Work with private sector with substantial resources</td>
<td>Birmingham, United Kingdom</td>
</tr>
</tbody>
</table>

Source: [https://www.esmap.org/node/57252](https://www.esmap.org/node/57252)
Resources
Key Resources: Lighting

Tracking Clean Energy Progress
https://www.iea.org/tcep/buildings/lighting/

IEA’s Technology Collaboration Platforms
https://ssl.iea-4e.org/

SEAD Street lighting tool
https://superefficient.org/tools/street-lighting-tool

United 4 Efficiency
https://united4efficiency.org/products/lighting/

lites.asia (last update 2017)
http://www.lites.asia/
Key Resources: Lighting

- **Guide for energy efficient street lighting installations**

- **Efficient public lighting guide (South Africa)**

- **Proven Delivery Models for LED Public Lighting**
  https://www.esmap.org/node/57252
6. Utilities 2: Other urban services
1. District Energy Systems
## District Energy Systems: The Case for DES

<table>
<thead>
<tr>
<th>1. Reduction of peak electricity</th>
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<tbody>
<tr>
<td>- For heating/cooling systems normally connected to the grid, having alternative sources reduces peak</td>
</tr>
</tbody>
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<table>
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<tr>
<th>2. Fuel diversity</th>
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<tbody>
<tr>
<td>- Low value heat could produce heating or cooling</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>3. Frees up space for buildings</th>
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<tbody>
<tr>
<td>- Space could be used for stormwater retention for water recycling</td>
</tr>
<tr>
<td>- Space could also be used for green roofs to help reduce urban heat island effect</td>
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</tbody>
</table>
**District Energy Systems: Case Studies**

- In Paris, district cooling led to:
  - **35% lower electricity** consumption
  - **50% reduction** in CO2 emissions

- In India, a reduction from 240MW to 135 MW (**44% lower**) in electricity consumption is expected from the GIFT City

Source: https://www.climespace.fr/en/district-cooling/

District Energy Systems: Becoming more efficient and sustainable

Source: http://wedocs.unep.org/bitstream/handle/20.500.11822/9317-
District_energy_in_cities_unlocking_the_potential_of_energy_efficiency_and_renewable_energy.pdf?sequence=2&isAllowed=y
Key Resources

https://www.districtenergy.org

http://www.districtenergyinitiative.org/

https://www.iea-dhc.org

http://wedocs.unep.org/bitstream/handle/20.500.11822/9317/-District_energy_in_cities_unlocking_the_potential_of_energy_efficiency_and_renewable_ene.pdf?sequence=2&isAllowed=y
2. Waste
Solid waste generation is often driven by purchasing power. Their subsequent collection would be crucial in the energy recovery.
Waste Management. Impacts

Unmanaged solid waste can result to multiple knock on effects that increase social problems for the local authority

GHG and other emissions
682.2 ktCO2-eq per year (estimated in Jakarta)
Additional air pollution from uncontrolled incineration

Migration of leachate into groundwater
Water treatment energy intensity increases (Session 5)

Changes in surrounding flora and fauna


Bantar Gebang Landfill, Indonesia
Opportunity for managing waste can also reduce the municipality’s net energy consumption.

Source: https://www.sciencedirect.com/science/article/pii/S0196890415001156#f0015
DIGESTION

- For municipal waste with high organic wastes, it could be **digested to produce biogas**
- Controlled methane generation for gas networks or cogeneration use
- Requires land space
Waste Management: Strategies

INCINERATION

• Recovery of high value energy that can be used for **electricity generation** and **heating** if there is a high amount of combustibles in the municipal waste (less organic waste)

• Reduces stronger GHG emissions (landfill methane converted to CO2 instead)

• High capital costs

Source: https://www.ecomaine.org/our-facility/waste-to-energy-plant/
Installation of small engine generator set can allow the landfill to sell electricity with IRR of 1%
However, aim for reduction. Energy recovery allows reduction of existing waste but will not be a long term solution.
Sustainable waste management was the second most prevalent project type after energy efficiency among IDP plans. Recycling projects made up all of the sustainable waste management projects listed.

Key Resources. Waste Management

Waste to Energy technologies

Solid Waste Management
Poll Time! Cities 4: Barriers

Access the polls here:

**Q:** What are the common barriers that you find in implementing municipal EE projects

- Financing
- Lack of local authority
- Lack of capacity
- Lack of public support