Proven Delivery Models for LED Public Lighting:

Municipal Financing Delivery Model

Quezon City, Philippines, Case Study

Pedzi Makumbe, Debbie K. Weyl, and Andrew Eil, Jie Li

Standard ESMAP text placeholder

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Acronyms and Abbreviations

CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CFCB	Carbon Finance Capacity Building Programme
ESMAP	Energy Sector Management Assistance Program
GEF	Global Environment Facility
HPS	High pressure sodium
LED	Light-emitting diode
MH	Metal halide
MV	Mercury vapor
PBD	Government of the Philippines Bidding Documents
PELMATP	Philippine Efficient Lighting Market Transformation Project
PHP	Philippine peso
QC	Quezon City, Philippines
RFP	Request for Proposals
TCG	The Climate Group
TRACE	Tool for Rapid Assessment of City Energy
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
USD	US dollar
W	Watts
WBI	World Bank Institute

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Quezon City, Philippines: Municipal Financing Delivery Model

City name	**Quezon City, Philippines**
Project dates	**2005–18**
Project size	**25,000 being retrofitted (total of 45,070 in the City)**
Implementing agency	**Quezon City Mayor's Office**
Funding mechanism	**Self-financing from national and local taxes**
Implementation/procurement process	**Implementation by Quezon City**
Expected energy savings	**60%**

Introduction

The National Capital Region, of which Quezon City (QC) is a part, faces significant development challenges. One of the greatest is a high concentration of people in a relatively small territory: the region's population density of about 10,000 people per square kilometer is almost twice that of New York City, and is among the highest in the world compared with cities of similar size. The National Capital Region (which includes QC) had a population of 5.9 million in 1980, but it has doubled in 30 years.[1] The dense, congested character of QC and its neighbors has led to high unemployment, overcrowded and sub-standard housing, and an excess of garbage not properly managed. As a result, there are many competing priorities for QC's available funds. Within this resource-constrained context, street lighting comprised 65 percent of QC's electricity costs, or about 5 percent of its annual budget. The desire to reduce energy costs and allocate resources to other priorities was a key driver behind QC's action on energy efficient street lighting.

Even before undertaking the street lighting retrofit project, however, QC was already proactive in the adoption of environmentally friendly policies. For example, in 2009 QC became the first city in the Philippines to enact a Green Building Ordinance, which specified minimum standards, a rating system, and building inspection and evaluation procedures. In addition to QC's long commitment to environmental improvement, its recent experience promulgating energy efficiency policies and the availability of technical assistance from the World Bank Institute (WBI) were additional factors enabling the City's light-emitting diode (LED) street light initiative.

QC is therefore converting 25,000 street lights to LED technology and expanding street lighting to areas currently not illuminated. The project plans to install at least 5,000 luminaires annually from 2015 to 2018, for a minimum total of 20,000 retrofitted luminaires over four years. In addition, 5,000 luminaires were replaced with LEDs in 2013–14. As of June 2015, a total of 3,856 LED luminaires had already been installed, with a further 2,678 installations under way. The National Road Board is funding installation of an additional 2,046 LED street lights on major roads in QC that are currently not illuminated. LED lighting will significantly improve illumination on Quezon City's streets, which is expected to lead to a reduction in crime and enhancement of tourist areas at night. Meanwhile, significant energy savings achieved by LED lighting should enable Quezon City to use the budgetary savings to address other social challenges.

[1] R.B. Singh, Ed., 2014. *Urban Development Challenges, Risks, and Resilience in Asian Mega Cities* (Springer), p. 453.

Context

Quezon City, one of 17 local municipalities in the Metro Manila region, is the largest city in the Philippines—about a quarter the size of the National Capital Region and five times larger than the City of Manila. Quezon City's population, which stood at 2.8 million as of 2010, has been growing at the rapid rate of 2.4 percent annually. With over 59,000 registered businesses and as the highest-income-earning city in the Philippines, it was dubbed by the London *Financial Times* in 2007 as "one of the top ten Asian cities of the future." Once the capital of the Philippines, QC remains the seat of the Philippines Congress, House of Representatives, and the University of the Philippines. The country's major news and broadcasting companies are also located in QC.

QC's political and administrative climate has been very stable over the past 15 years. This has enabled it to develop a long-term commitment to green initiatives and build a record of developing and implementing successful environmental projects. For instance, in 2007, one of the World Bank's carbon funds purchased emission credits for €1.8 million (US$2 million) for a project registered under the United Nations Framework Convention on Climate Change's (UNFCC) Clean Development Mechanism (CDM) consisting of a facility to capture, process, and generate electricity from methane embedded in the Quezon City Controlled Disposal Facility. The successful project yielded an average of 110,000 certified emission reduction credits (CERs) per year over a period of 10 years.

Given the success of the CDM project, QC approached the WBI to participate in the Carbon Finance Capacity Building (CFCB) Program in Emerging Megacities of the South, a sub-program of the World Bank's global capacity building program, Carbon Finance Assist (CF-Assist).[2] This program provided hands-on technical assistance for developing carbon finance programs, commencing with a workshop co-sponsored with QC on September 28, 2009. At the workshop, the Mayor of Quezon City expressed concern about a key municipal budgetary issue: the expense of the City's street lighting system, which accounted for upwards of 60 percent of its electricity costs.

Meanwhile, on a parallel track, the Philippines Department of Energy was about to conclude the Philippine Efficient Lighting Market Transformation Project (PELMATP). Co-funded by the Global Environment Facility (GEF) and United Nations Development Programme (UNDP), PELMATP had since 2005 sought to address barriers against widespread utilization of energy efficient lighting systems in the country. An evaluation of the five-year project concluded that the involvement of a large number of stakeholders, from a vast array of Philippine government officials and private firms, was one of the major achievements of PELMATP.[3] The broadened awareness of the potential for energy efficient lighting and the technologies involved helped to set the stage for Quezon City's LED street lighting initiative.

[2] From 2005 to 2009, the Carbon Finance Assist program helped developing countries participate in carbon markets and benefit from the CDM and Joint Implementation (JI) flexible mechanisms under the Kyoto Protocol. More information about the current status of this program is available at http://wbi.worldbank.org/wbi/about/topics/carbon-finance-assist

[3] CREARA, December 2011. *Final Evaluation: Philippines Efficient Lighting Market Transformation Project (PELMATP).* UNDP.

As part of its participation in the WBI technical assistance program, QC became one of the pilot cities in the Energy Efficient Cities Initiative funded by the World Bank's Energy Sector Management Assistance Program (ESMAP). This initiative had produced an innovative Tool for Rapid Assessment of City Energy (TRACE) that provides an inter-city benchmarking facility, a playbook of proven energy efficiency interventions, and simple models for the interventions. Improvement in street lighting was one of the recommendations coming out of this pilot project.[4]

Tracing the development and implementation process in QC

The implementation process in QC is summarized in Figure 1:

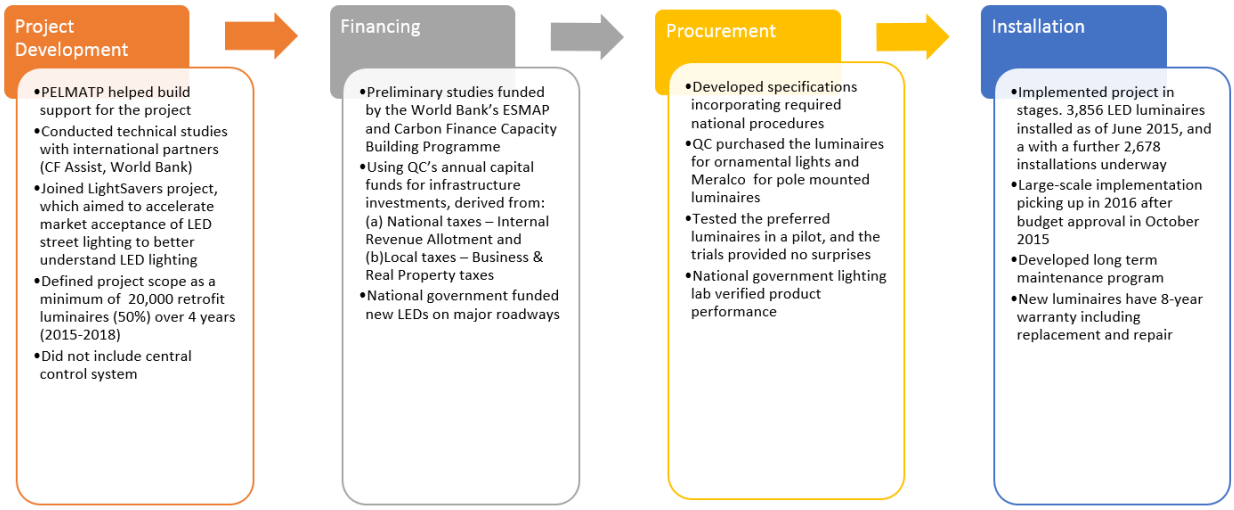


Figure 1: Summary of the LED implementation process in Quezon City

Project development

QC had been actively exploring and implementing upgrades to its street lighting system since 2005. Many streets and roads[5] were not lit at night, so public safety was an ongoing concern. In 2005, the Mayor issued *Executive Order No. 10,* creating the Task Force on Installation, Repair and Maintenance of Street Lighting. This administrative body was charged with overseeing an initiative to expand nighttime lighting coverage across the city, including formulating policies for site selection, extensions of electrical facilities, and monitoring results. QC subsequently embarked on a citywide street lighting program to illuminate 80 percent of the public road network, totaling about 1,700 kilometers in length. It involved installing 3,000 new street lights, with an additional 1,000 street lights retrofitted by Meralco, a private electricity utility.

At the end of 2009, QC had a baseline total of 45,070 street lights, as shown in Table 1.

[4] ESMAP, 2010. *Annual Report* (Washington, DC: World Bank).

[5] The term *street* is generally used in an urban context, whereas a *road* is a strip of land connecting two or more destinations over which people and goods are transported.

Description (charging mechanism)	Owner	Number of points	Annual Cost in PHP *(US$)*	Percentage of total
Pole-mounted (flat rate)	Meralco	26,780	127.7 M (*$2.75 M*)	49%
Ornamental (flat rate)	Meralco*	3,995	61.7 M (*$1.33 M*)	23%
Ornamental (metered)	QC	14,335	72.9 M (*$1.57 M*)	28%
Total		45,070	262.3 M ($*5.66 M*)	100%

*Ownership of these street lights was turned over to Quezon City in 2013.
Note: PHP = Philippine pesos.

Table 1: Baseline data for street lights in Quezon City at the end of 2009

In the past, QC had relied on traditional lighting technologies such as high-pressure sodium (HPS), metal-halide (MH), and mercury-vapor (MV) luminaires. However, the emergence of the first generation of LED street lights in 2007 and 2008 prompted a rethinking, since any improvements in energy efficiency would translate into desirable budget savings.

Following the WBI/CF-Assist–sponsored September 2009 workshop, the CFCB Programme in Emerging Megacities of the South funded a study to determine the feasibility of upgrading Quezon City's street lighting to more efficient technology. The project's 2010 report, *Upgrading of Quezon City's Streetlighting Facilities*,[6] provided the first comprehensive inventory of the City's street lighting and investigated the potential for new HPS, MH, and LED luminaires to reduce energy use by 20–50 percent.

The 2010 Zabala study compared the potential costs and benefits of three technologies: ceramic metal-halide lamps, induction lamps, and LEDs. The study also examined centralized control systems. Table 2 summarizes the results of the analysis. This table shows that as of 2010, the payback period for metal-halide lamps was high at 26.2 years, but it was much lower for induction lamps (10.4 years) and LEDs (12.8 years).

Type of Lamp	Metal-Halide	Induction Lamp	Light-Emitting Diode
Scenario 1: 14,335 Streetlights			
Energy savings @ 4380 hours per year (kWh),	1,996,636.14	3,516,088.80	5,902,006.20
Annual energy cost savings @ PHP 10.00 per kWh	19,966,361.40	35,160,888.00	59,020,062.00
Total investment in PHP	523,227,500.00	365,542,500.00	752,587,500.00
Payback period in years	26.2	10.4	12.8
Scenario 2: 18,330 Streetlights			
Energy savings @ 4380 hours per year (kWh),	2,553,075.72	4,495,982.40	7,546,827.60
Annual energy cost savings @ PHP 10.00 per kWh	25,530,757.20	44,959,824.00	75,468,276.00

[6] Arturo M. Zabala, June 2010. *Upgrading of Quezon City's Streetlighting Facilities* (World Bank/CF-Assist).

Total investment in PHP	669,045,000.00	467,415,000.00	962,325,000.00
Payback period in years	26.2	10.4	12.8
Scenario 3: 21,330 Streetlights			
Energy savings @ 4380 hours per year (kWh),	2,970,927.72	5,231,822.40	8,781,987.60
Annual energy cost savings @ PHP 10.00 per kWh	29,709,277.20	52,318,224.00	87,819,876.00
Total investment in PHP	778,545,000.00	543,915,000.00	1,119,825,000.00
Payback period in years	26.2	10.4	12.8

Table 2: Summary of energy savings study in Quezon City for total luminaire replacement

The study concluded that ceramic induction lamps would be a suitable replacement for HPS street lighting, while LED luminaires, which were quite expensive at the time of the study, would only be suitable for new installations:

> *"Currently [as of 2010], the cost of an LED lamp for street lighting is relatively high. Such investment, however, can be justified if the lifecycle cost were to be considered. For one, the life of LED (and induction lamp) is double that of the HPS (i.e., only one LED is needed for every two HPS and for every four MH). The one area in which LED technology offers a significant advantage over induction lamps and other street lighting is ruggedness. Since the LEDs are solid-state devices, they are more resistant to vibration and impact compared to the induction lamps, which are made of glass. LED lamps are, therefore, more suitable for applications where there is high vibration, such as in roadway lighting."*[7]

Other key recommendations included:

- Any replacement options should be subjected to rigorous laboratory and field testing before upgrading the system to ensure proper performance.
- The Task Force should conduct a public survey of pedestrians and motorists to determine their visual preferences regarding warm white light versus cooler daylight. This was flagged as a possible issue given the variety of color temperature options available with LED lighting and negative feedback from cities that had installed cool daylight street lights.
- Ornamental lights owned by the utility, Meralco, should be transferred to QC's ownership and operated on a metered rather than a flat billing rate. This would maximize savings, reduce the overall cost of the fixtures, and eliminate the disincentives associated with the utility's flat-rate billing approach.

Meanwhile, in early 2011, QC joined 11 other large cities in The Climate Group's (TCG) international LightSavers project, which aimed to accelerate market acceptance of LED street lighting. QC staff participated in various TCG workshops, including a global summit held in Shanghai in May 2011 organized by LightSavers, as well as other technical assistance programs and conferences. As a result, their knowledge of, and familiarity with, LED lighting increased. While QC staff remained open to induction technologies—induction lamps were being tested on the streets—the declining costs and clear optical benefits of LED luminaires became decisive. A WBI mission visited QC in June 2012 and recommended a set of technical specifications for LED street lights that QC eventually incorporated

[7] Zabala, *Ibid.,* p. 23.

into its procurement approach. Momentum was now under way towards the use of LED luminaires both for new installations, as recommended by the 2010 Zabala study, as well as retrofits.

A constraint arising from the conversion of QC's street lights to LEDs was the split ownership of the assets and the flat rate charged by Meralco on a portion of the assets, as identified in the 2010 Zabala study. To solve this, in March 2013 the Mayor of Quezon City signed a Memorandum of Agreement with Meralco that turned over the nearly 3,000 ornamental street lights owned by the utility to the QC government for a price of PHP 5.7 million (US$126,000). Meanwhile, the City installed meters on all of the ornamental street lights so that savings from the retrofit of LEDs would yield energy cost savings. For the remaining pole-mounted street lights that are owned by Meralco, the utility on its own authority has undertaken a project to convert the street lights in its ownership to LEDs. Since QC continues to pay Meralco a flat rate per pole, the LED retrofit undertaken by Meralco increases their profit, and the city benefits from better lighting.

Financing

The LED street light project is financed mostly from QC's own capital funds, with the national government providing funding for installation of new LED luminaires and poles on the major roadways. QC's annual capital funds for infrastructure investments are derived from national and local taxes. The main sources of revenue for infrastructure are the Internal Revenue Allotment, which is a national tax, and Business and Real Property taxes, which both come from local taxes. Figure 3 summarizes the overall flows:

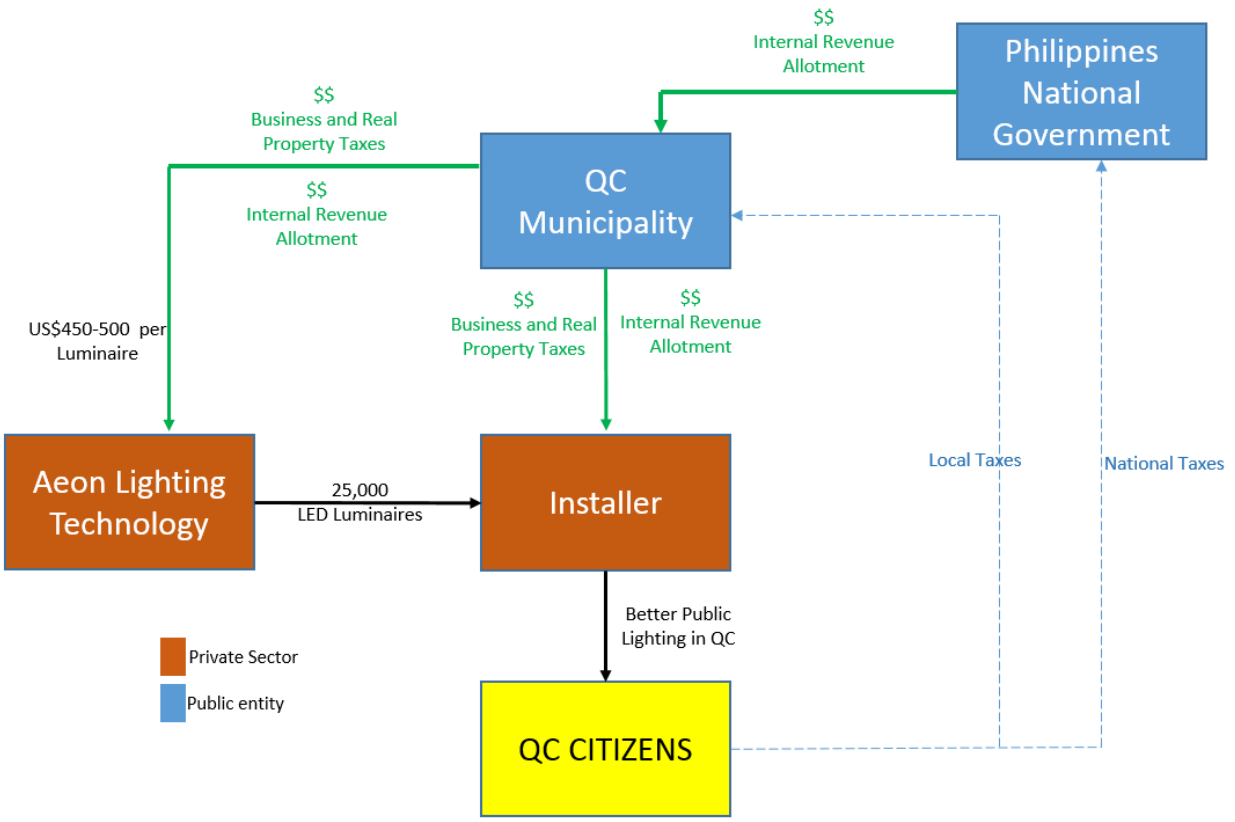


Figure 2: Notional flows for the street lighting retrofit in Quezon City

QC has an excellent international credit rating of A+ from Standard & Poor's (S&P) for its solid liquidity levels, strong budgetary performance, debt-free position and financial flexibility. S&P noted in its 2009 evaluation that while QC had kept its rates and charges low, with property valuation among the lowest in Metro Manila, the City enjoys a degree of financial flexibility that is substantially higher than its peers. Its liquidity position remains strong, with free cash and liquid assets covering an average of 98.5 percent of operating expenditures from 2003 onwards.

Despite this excellent credit rating, however, QC prefers to raise capital for infrastructure investments from tax revenue, rather than by issuing debentures, which would entail additional interest costs to the municipality over time.

Procurement process

From 2012 to 2015, QC staff planned and began preparing for a full-scale retrofit of existing street lights by continuing to test various LED luminaires, undertaking two procurement cycles, and preparing to submit requests for capital during QC's annual October budget call.

After a comprehensive baseline study and subsequent technical assistance, both funded by the WBI, QC staff undertook extensive LED trials. Once these steps were concluded, QC launched its LED street light renewal project in 2014 under the auspices of the Task Force on Streetlights.

Bidding on government contracts in the Philippines is restricted to Philippine companies or ventures in which at least 60 percent of the ownership is vested in Filipino citizens. This is a major constraint for foreign lighting companies, which would have needed to form joint ventures or partnerships with Philippine companies in order to qualify, thus adding costs and administrative layers to their bids.

The first procurement bid was issued in October 2012 in conformance with the Government of the Philippines Bidding Documents (PBD), which outlines procedures and regulations mandatory for all branches of governments, including local government units. The Bidding Documents require definition of: (a) the objectives, scope, and expected outputs and/or results of the proposed contract; (b) the eligibility requirements of bidders, such as track record, to be determined by the Head of the Procuring Entity; (c) the expected contract duration; (d) the estimated quantity (and in the case of procurement of goods, delivery schedule and/or time frame); and (e) the obligations, duties, and/or functions of the winning bidder.[8]

After issuance of the LED street light Request for Proposals (RFP) in October 2012, nine bidders bought the bidding documents, and subsequently five bidders submitted official proposals. All, however, were disqualified by the QC Bids Awards Committee, as none of the proposals met the requirements of the RFP. Some of the requirements of the bid relating to local manufacture and green job creation may have discouraged potential bidders. The bids that were submitted failed mostly because the proponents were unable to demonstrate experience in installing LED luminaires in a large project such as this one.

[8] Government of the Republic of the Philippines, December 2010. *Philippine Bidding Documents, Procurement of Goods*, Fourth Edition.

QC staff therefore undertook a second bid on July 29, 2013, with more flexible requirements on local manufacturing. Seven bidders purchased the bidding documents this time, and four eventually submitted bids. The winning bid was from a wholesale firm that partnered with Aeon Lighting Technology, a Taiwanese company, offering the lowest price of US$450 to US$500 per luminaire while meeting all technical requirements of the bid. The bidder offered an eight-year warranty, including replacement and repair of defective units free of charge for equipment and labor. As a part of the procurement process, the national lighting laboratory administered by the Philippines Department of Energy assisted in the testing of the Aeon luminaires to ensure that they met bidding technical specifications.

Installation

The project aims to install a minimum of 5,000 luminaires annually from 2015 to 2018, for a minimum total of 20,000 retrofitted luminaires. Some LED replacements were accomplished in 2013–14, prior to the formal start of the current initiative, so the total of retrofitted luminaires through 2018 is expected to be around 25,000 units. HPS lamps with nominal wattages of 150 watts, which primarily illuminate secondary roads, are being replaced by LED luminaires from Aeon Lighting. Meanwhile, the 250-watt HPS lamps on primary roads are being replaced by the National Road Board, which will then turn over ownership of the new luminaires to the local government. The responsibilities for installation and maintenance of the project are summarized in Figure 3.

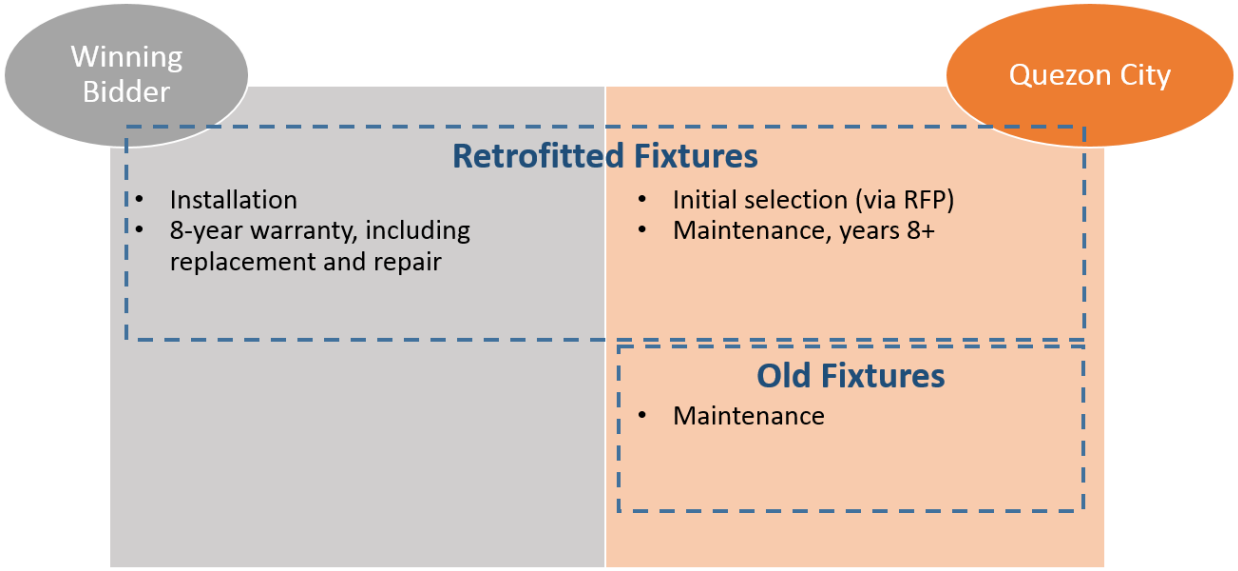


Figure 3: Responsibilities for installation and maintenance of street lights in Quezon City

By 2018, it is expected the city will have more than 50 percent of its lighting points retrofitted. The total estimated cost of the four-year retrofit project is PHP 800 million (US$17.8 million).[9] This does not include funds budgeted and spent for new installations. QC originally expected energy savings of 50 percent (for retrofitted lighting points), but to date staff report they are seeing higher savings in the range of 60 percent on average.

[9] Quezon City, *Project Brief Summary*, 2014.

As of June 2015, a total of 3,856 LED luminaires had already been installed, with a further 2,678 installations under way. The National Road Board is funding installation of an additional 2,046 LED street lights on major roads in QC that are currently not illuminated. In the future, the Road Board may fund additional LED street light projects depending on the type of roads to which they seek to expand illumination.

Lessons Learned

Quezon City's street lighting retrofits with LED luminaires, almost fully funded with capital derived from national and local taxes, will enable the City to lower its electricity utility costs, reduce its carbon emissions, improve the quality of streetscape lighting, and enhance public safety. This program is a model for other cities that have the political stability, motivation, and financial capacity to form and successfully implement partnerships with national and international agencies. The planning process can be accelerated by aligning incentives by addressing metered vs. deemed consumption challenges with the utility, and undertaking procurement that seeks to maximize opportunities for local and international lighting companies to bid their products in response to a tender. Several lessons can be learned from QC's experience.

Consistent local and international support over time can have an impact

In the case of QC, technical assistance from the WBI, LightSavers, GEF and UNDP over a period of time appears to have played a decisive role in expanding local awareness, disseminating technical knowledge, and reinforcing staff leadership.

Technical knowledge is key for a successful procurement process

The support of a well-equipped lighting laboratory and testing capability, in this case managed by the national government through the Philippines Department of Energy, was indispensable in enabling QC staff to test and verify the performance of LED luminaires proposed in bid responses. Such verification was needed in order to increase confidence in LED luminaires, and increase the likelihood of successful program outcomes.

Ownership and electricity rate structures can decide program success

The flat electricity rate structure employed by Meralco for much of QC's street lighting meant that energy savings would not yield proportionate budget savings for QC. Fortunately, Meralco was able to accommodate QC's desire for metered billing by transferring ownership of the ornamental lights to QC, which were then converted to metering. The remaining non-ornamental street lights will remain in Meralco's ownership. Therefore, Meralco will enjoy the savings from its LED retrofit, while QC will continue to pay its normal flat rate[10] for those street lights and get better lighting.

The potential integration of a remote monitoring and adaptive control system with LED luminaires may provide an effective alternative to flat-rate billing. Such controls can accurately track and store data related to the usage of each individual luminaire, from hour to hour and day to day. Although the utility may eventually lose revenue (due to reduced consumption), networked controls improve

[10] In some cases, cities are able to negotiate a reduced flat rate after installing LEDs.

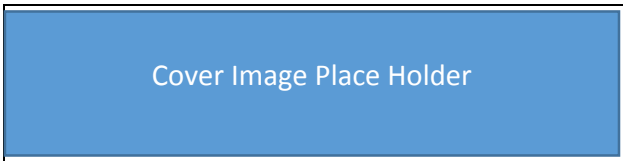
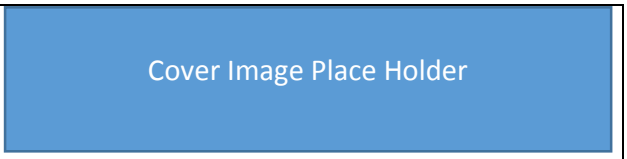
customer service, reduce energy and maintenance costs, and create a platform for novel revenue-generating applications in the future.

Consider national policy and municipal needs in project design

The procurement process was hampered by national policy that impeded many reputable international companies from bidding on QC's tender. Requirements in the tender favored by QC proved challenging for local lighting companies registered in the Philippines to meet. Therefore, a second tender round was required, and the pool of bidders was limited to those lighting companies that were able to form ventures with Philippines wholesale firms qualified to bid under national law.

Series of Case Studies on Public Lighting Delivery Models

"**Municipal Financing Delivery Model Case Study; Quezon City, Philippines**" is one in a series of seven knowledge products produced by ESMAP in an attempt to help cities work through the challenges associated with implementing LED programs. The publications include six case studies and a synthesis report which summarizes and synthesize the case studies. Each case study describes the context in which decisions were made, then recounts the problems encountered and solved in order to realize the implementation of the programs. The challenges include real-life examples of cities managing to attract private sector participants to provide necessary financing and technical expertise; examples of programs implemented in municipalities that are not creditworthy and have limited policy and institutional support; examples involving small municipalities of about 2,500 residents as well as cities with several million residents; examples of cities managing the perceived risk; and finally, examples of cities effectively handling the measurement and verification of electricity savings accruing from the implementation of more efficient LEDs. These case studies are available online:

	
Proven Delivery Models for LED Public Lighting: Synthesis of Six Case Studies Illustrating ESCO, Joint Procurement, PPP, Lease-to-Own, Municipal Financing, and Super-ESCO Models	Public-Private Partnership Delivery Model Case Study; Birmingham, United Kingdom
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	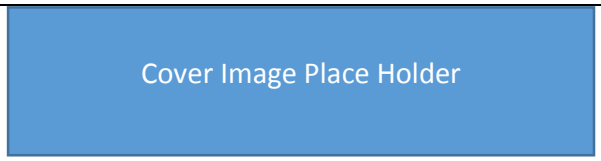
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