TOOL FOR RAPID ASSESSMENT OF CITY ENERGY – LEÓN, GUANAJUATO, MÉXICO

Table of Contents

Disclaimer

TRACE (Tool for Rapid Assessment of City Energy) was developed by ESMAP (Energy Sector Management Assistance Program), a unit of the World Bank, and is available for download and free use at: http://esmap.org/TRACE.

ESMAP
Energy Sector Management Assistance Program

Executive Summary

Bonito León Guanajuato,
su feria con su jugada,
allá se apuesta la vida
y se respeta al que gana.
Allá en mi León, Guanajuato,
la vida no vale nada.

Background

This report, supported by the Energy Sector Management Assistance Program (ESMAP), utilizes the Tool for the Rapid Assessment of City Energy (TRACE) to examine urban energy use in León, Mexico. This study is one of three that were requested by the cities, and undertaken in 2013 by the World Bank's Latin America and the Caribbean (LAC) Energy Unit (the others being Puebla, Mexico, and Bogota, Colombia), with the intention of beginning a dialogue on energy efficiency potential in municipalities in the Region. The implementation of TRACE in Puebla and León contributed to the development of the urban energy efficiency strategy by the Mexican Secretary of Energy (SENER).

The Tool for Rapid Assessment of City Energy (TRACE) is a simple and practical tool for conducting rapid assessments of energy use in cities. The tool helps prioritize sectors with significant energy savings potential, and identifies appropriate energy efficiency (EE) interventions across six sectors - transport, municipal buildings, water and wastewater, street lighting, solid waste, and power & heat. In many cities around the world, these six sectors are often managed by the city government, and as such local authorities have a large degree of influence over public utility services. TRACE is a low-cost, user-friendly, and practical tool that can be applied in any socioeconomic setting. It allows local authorities to get a rapid assessment of their city's energy performance, and to identify areas where a more in-depth analysis is warranted. The TRACE tool includes approximately 65 specific energy efficiency interventions, based on case studies and best practices around the world. The TRACE tool is targeted primarily at local authorities and local public utility service companies, but it could also be useful for state or federal authorities in order to increase their knowledge on how to make municipalities more energy efficient by developing EE strategies.

Because the TRACE assessment is rapid, there are limitations in the depth of the analysis. Recommendations made by TRACE should therefore be viewed as an indication of what could be done to improve the city's energy performance and reduce their energy expenditures. The tool does not currently assess the residential, industrial, or commercial sectors. In many cities around the world, the six TRACE sectors are under municipal jurisdiction, however, in LAC, city authorities sometimes have only a limited degree of influence over sectors such as transport, electricity, water, and sanitation.

In consultation with local authorities in León and based on sector analyses carried out by local consultants, a number of recommendations were generated through the TRACE analysis to help the municipality improve the efficiency of energy use in the provision of urban services. The three sectors identified in León with the highest savings potential and where the local administration has a significant degree of control are: street lighting, solid waste, and municipal buildings. A summary of all six sectors that were evaluated are discussed below along with the principal recommendations.

Overview of energy use in Puebla

STREET LIGHTING – Street light infrastructure is mainly owned by the Municipality of León, with a portion of the concrete light poles owned by the national electricity company, *Comisión Federal de Electricidad* (CFE). The Municipality of León is responsible for the street lighting maintenance and pays CFE for energy consumption through the creation of a local tax on residential consumers to cover this expenditure.

Although a relatively large number of the roads in the municipality of León are lit, there is not a good inventory on the number of street lights and metering needs to increase. More than three fourths of the roads (76 percent) in the municipality are lit, but only 65 percent of consumption is actually metered. The remaining street light consumption is estimated by CFE. In addition, the precise number of street lamps (light points) in León

is unclear, with the figures from the relevant municipal department being different than those of CFE (70,000 according to the city government, as opposed to 90,000 as per CFE).

In the last two decades, the city of León undertook measures to improve street lighting by replacing old, high energy-intensive bulbs with more efficient high-pressure sodium (HPS) vapor lamps, and equipped some light poles with energy saving devices for dimming purposes. The TRACE results have encouraged the Municipality of León to pursue a pilot project to replace 613 HPS with LED lamps in 10 km. along the Boulevard Adolfo Lopez Mates, one of León's main avenues.

Although León does not have full streetlight coverage, the street lighting system requires a large amount of electricity to operate, expenditures which are ultimately paid by city residents (according to the Mexican Constitution, public lighting is a responsibility of Municipalities which typically establish a tax that is included in consumers' electricity bill).

The street lighting sector uses 2.9 percent of the total electricity consumed by the municipality. According to the TRACE analysis, the street lighting sector in León has the potential to save around US$2 million per year in energy expenditures. Among the steps that the local government can take to move forward on improving street lighting are:

- *Street Lighting Audit* – Conduct an audit of all street lamps in the city.
- *Street Lighting Retrofit* – Undertake the renovation of street lamps with more efficient technology that can deliver the same lighting levels with lower energy consumption, reducing associated carbon emissions and operational expenditures.
- *Street Lighting Timing Program* (in the areas where the city controls the lamps) – A light dimming program allows street lights to be adjusted for specific needs in a particular area, according to varying weather and activity levels (more light is needed in the evenings when people are out than in the early morning hours when there is less activity on the streets).
- *Engage an Energy Service Company* (ESCO) – Under such an arrangement, a third party pays for the cost of the upgrades and recoups its investment by sharing in the savings from the retrofits.

SOLID WASTE - The solid waste system in León is done by both public and private institutions, under the control and oversight of the city government entity SIAP - *Sistema Integral de Aseo Público* (the Integrated Public Cleaning System). Industrial waste is collected by private operators, while urban waste (commercial and residential) is the responsibility of SIAP and private operators hired by the municipality that work under very short-term contracts. The city has a landfill that is managed by a private concessionaire. Given the numerous private operators, the municipality lacks accurate and reliable data on collection truck fleet, routes, fuel consumption, and overall energy use. For this reason, the TRACE diagnostic was done only considering current expenditure categories for which there is enough information.

The solid waste system in León serves 264,830 households in urban areas and nearly 15,000 families in rural communities. The amount of solid waste generated per capita in León (309 kg) is comparable to other cities in the TRACE database with similar population. Currently, the collection of waste is done by a number of private companies operating under short-term contracts, which inhibits optimal disposal, reuse, recycling, and fuel consumption. The short term contracts also inhibit the collection and monitoring of information on energy use.

Less than 3 percent of León's solid waste is recycled, and limited recycling is performed by informal collectors. Because there are no transfer stations in the city, solid waste trucks must travel long distances, of about 80 kilometers daily to the landfill using a large amount of fuel.

The solid waste system in León can be improved and provide savings to the city budget through the implementation of the following energy efficiency measures:

- *Development of Transfer Stations and Recycling Centers* – Establishing transfer stations would allow wastes to be separated (for recycling and composting), and thereby reduce the amount of

solid waste going to the landfill and consequent trips and fuel consumption by waste collectors.

- *Establishment of Medium to Long-term Concession Contracts* – As with the operation of the landfill, longer-term contracts would help to optimize collection, disposal, and infrastructure investments.

MUNICIPAL BUILDINGS - The municipal building stock in León comprises more than 500 facilities with a total area of 1.6 million square meters. Most of them are public offices, as schools and hospitals and other institutional facilities are managed by state and federal authorities. Given the mild climate, less than 10 percent of municipal buildings have heating/cooling systems. As such, León has the lowest electricity consumption (6.68 kWh per square meter) for municipal buildings in the TRACE database. However, as is the case worldwide, the city does not have reliable data on the overall floor space and energy consumption of municipal buildings. It is estimated that with modest investments, the city could save up to US$100,000 per year in energy expenditures associated with municipal buildings. Among the energy efficiency measures that could be considered by the local government include:

- *Municipal Building Benchmarking Program* - By using a number of indicators such as floor area, type of heating/cooling, electricity consumption per square meter, the Municipal Government can develop a municipal building database to obtain information on which buildings have the greatest energy saving potential.
- *Publishing and Updating a Database on Municipal Buildings* - The database can enable competition among building managers and provide data on best practices for saving energy.
- *Municipal Buildings Audit and Retrofit* - This measure would assess how resources can be allocated to improve energy performance of municipal buildings; subsequently, the city managers can assign funds for energy efficiency upgrades and for purchasing new equipment.

POWER - As other cities in Mexico, all power sector activities in Léon are under the faculties of the state-owned utility, *Comisión Federal de Electricidad* (CFE). León is largest electricity user in the state of Guanajuato, accounting for almost a quarter of the total consumption. Over 50 percent of the electricity is used by the local industry, while households account for 23 percent. Around 400,000 households in urban and rural areas have power connections. Following the growth of the population and the development of local industry and services, consumption in León has gone up by seven percent in recent years. The power sector in León is performing fairly well, as the city has the lowest electricity consumption per GDP among cities with similar climate within the TRACE database, i.e., 0.0132 kWh/$GDP. With overall losses of 10 percent (with 7 percent commercial losses), León compares favorably to other cities, but there is room for improvement.

TRANSPORT - León has developed one of the most efficient public transport systems in Mexico and was the first city to implement a Bus Rapid Transit (BRT) system in the country. In addition to the BRT system, known locally as Optibus, the public transport system includes buses operating on feeder and auxiliary routes. BRT covers almost half of the daily rides in the city. With an energy consumption of 0.1 MJ/passenger-kilometer, the public transport in León is the second most efficient system within the TRACE database.

Currently, city authorities are stepping up efforts to modernize public buses operating on secondary routes and to more fully integrate public transport with other modes of transport. It is expected, that when the integration of the public transport system is complete, it will be able to cover 80 percent of the public transport travel demand in the city. The number of people riding the BRT buses is expected to rise from 350,000 to approximately 500,000 daily. With an energy consumption of 0.77 MJ per passenger kilometer, León is the most energy efficient within the cities with similar climate from the TARCE database. However, private vehicles still dominate transport in the city, and contribute to traffic congestion and pollution, and raise the overall energy intensity of the transport sector.

León is expanding non-motorized transport, such as the large network of pedestrian paths and over 100 kilometers of bike lanes. However, not all bike lanes are in good shape, and some are not interconnected. In the future, the city plans to build additional bike

parking stations where people can rent and park bikes, and integrate them into the public transport system.

WATER & WASTEWATER – Water supply and sanitation in León is managed by a well-established and efficient public entity, SAPAL, which provides services to the city under a long-term contract. The city has good water coverage, of nearly 100 percent, as the water company serves over 382,000 residential and commercial customers. The city pays levies for extracting water from wells to the national government, which provides the majority of potable water. Although the city has the second lowest daily water consumption (99 liters/capita/day) among peers with a similar human development, it is the second highest energy consumption (1.2 kWh per cubic meter of water) from the TRACE database. This is largely due to the dependence on wells and associated electricity consumption for water pumping, which currently accounts for 25 percent of SEPAL's operational costs. The city is currently building a reservoir that would replace much of the well-water, which is expected to reduce energy consumption in the sector. In the future, the city could reduce the nearly 40 percent water losses by joining efforts with state and federal authorities to improve the water pipe network.

SAPAL operates a modern wastewater treatment plant that includes a biogas plant that provides around 75 percent of the electricity consumed by the wastewater treatment facility. In 2012, the wastewater treatment in Léon amounted to 51.3 million cubic meters, and required 15.2 million kWh of electricity. With an energy consumption of 0.297 kWh per cubic meter of wastewater, the city is placed in the middle of the TRACE database. More than one third of the wastewater treated is re-used for local industry, irrigation of green areas and farming activities.

ENERGY EFFICIENCY STRATEGY AND ACTION PLAN - The municipality of León can consolidate its energy planning through the preparation of a medium- to long-term strategy and action plan that could encompass and expand upon the energy efficiency measures outlined above. Such a plan would focus on actions and interventions in the public sectors over which the City has control, with the aim of reducing energy consumption, decreasing greenhouse gas emissions (GHG), and saving money. In addition to public utility service areas such as transport, solid waste, street lighting, municipal buildings, and water supply, the municipality can indirectly influence the energy consumption of other segments, such as industry and residential housing through information campaigns, zoning, and standards.

For the strategy to be effective, it needs to establish measurable and realistic targets, set out well-defined timeframes, and clearly assign responsibilities. Establishing clear energy savings targets, as well as the GHG emissions that could be reduced by each intervention, together with the costs incurred, and the timeframe for project implementation are relevant tasks for the strategy. It is important that the action plan designate the people within the local public administration responsible for monitoring and implementing the energy efficiency interventions, and establish rewards and penalties for good and bad performance. The action plan can comprise a wide range of activities, including improving the fuel efficiency of the municipal vehicle fleet, establish procurement guidelines for the acquisition of more efficient street lighting, replace inefficient and high energy consuming bulbs in municipal buildings, encourage energy conservation in public offices, organize awareness campaigns and programs for separating solid waste and more efficient use of water, and expand non-motorized transport networks. At the end of the day, an energy efficiency strategy and action plan would not only reduce carbon emissions and lower energy expenditures for the municipal budget, but it would also improve air quality and make León a more attractive place for its citizens and visitors.

The matrix below presents the public utility sectors identified by TRACE with the highest energy saving potential and the interventions local authorities should consider undertaking in order to reduce consumption and improve overall efficiency of the city. These interventions can be implemented over one or two years, and would require upfront investments between US$100,000 and US$1 million.

Matrix with energy efficiency priorities and proposed programs

PRIORITY 1 Street Lighting	Energy spending in the sector		Potential savings	
	$11,717,057		$2,300,000	
1. Street Lighting Audit and Retrofit	**Responsible Institution**	**Cost**	**Energy savings potential**	**Time of implementation**
	City	$$	***	1-2 years
2. Street Lighting Timing Program	City	$	***	< 1 year

PRIORITY 2 Solid Waste	Energy spending in the sector		Potential savings	
	$320,000		$110,000	
3. Fuel Efficient Waste Vehicles Operations	**Responsible Institution**	**Cost**	**Energy savings potential**	**Time of implementation**
	City	$	***	< 1 year

PRIORITY 3 Municipal Buildings	Energy spending in the sector		Potential savings	
	$2,048,992		$98,000	
4. Municipal Buildings Benchmarking Program	**Responsible Institution**	**Cost**	**Energy savings potential**	**Time of implementation**
	City	$	**	1-2 years
5. Municipal Buildings Audit and Retrofit	**Responsible Institution**	**Cost**	**Energy savings potential**	**Time of implementation**
	City	$$$	***	1-2 years

Methodology

The Tool for Rapid Assessment of City Energy (TRACE) helps prioritize sectors with significant energy savings potential, and identifies appropriate energy efficiency (EE) interventions across six sectors - transport, municipal buildings, water and wastewater, street lighting, solid waste, and power & heat. It consists of three principal components: (i) an **energy benchmarking** module which compares key performance indicators (KPIs) among peer cities (ii) a **sector prioritization** module which identifies sectors that offer the greatest potential with respect to energy-cost savings, and (iii) an **intervention selection** module which functions like a "playbook" of tried-and-tested energy efficiency measures. These three components are woven into a user-friendly software application that takes the city through a series of sequential steps: from initial data gathering to a report containing a matrix of first-order energy efficiency recommendations tailored to the municipality's individual context, with implementation and financing options. The steps in the TRACE analysis are as follows

1. Collection of Candidate City Energy Use Data

TRACE contains a database of 28 key performance indicators (KPIs) collected from 80 cities. Each of the data points that make up these KPIs is collected for the municipality prior to the application of the tool and, as TRACE is launched, this collection of information will grow with current and reliable data.

2. Analysis of City Energy Use Against Peer Cities

The performance of a city is compared with a range of peer cities—selected by the city based on population, climate, and human development—to determine their performance in each of the six sectors (3-6 KPIs per sector). The benchmarking process provides an overview of energy performance so the city can assess its relative rankings against peer cities in each sector. The Relative Energy Intensity (REI), or in simpler terms the percentage by which energy use in a particular sector could be reduced, is calculated using a simple formula. The formula looks at all of the cities that are performing better on certain KPIs (e.g., energy use per street light), and estimates the average improvement potential. The higher the number of cities in the database, the more reliable and representative the final results will be.

3. Assessment and Ranking of Individual Sectors

During the initial city visit, a number of meetings and interviews are conducted to collect additional data across city departments and agencies, augmenting benchmarking results with contextual information. At the end of the first phase, a prioritization process takes place to identify sectors with the greatest technical energy savings potential. Energy costs are also weighed, as is the ability of city authorities to control or influence the outcome. Priority sectors are reviewed in detail in the second phase.

The main frame of TRACE

4. Ranking of Energy Efficiency Recommendations

TRACE contains a playbook of over 60 tried and tested energy efficiency recommendations in each of the sectors. Some examples include:

- Buildings | Lighting Retrofit Program
- Organizational Management | Energy Efficiency Task Force, Energy Efficient Procurement
- Power & Heat | Solar Hot Water Program on Buildings
- Public Lighting | LED Replacement Program for Traffic Lights
- Transport | Traffic Restraint in Congested Urban Areas, City Bus Fleet Maintenance
- Waste | Waste Management Hauling Efficiency Program
- Water & Wastewater | Pump Replacement Program

The TRACE Benchmarking Module

Recommendations are then assessed based on five different factors: *finance; human resources; data* and *information; policy, regulation* and *enforcement;* and *assets and infrastructure*. This step helps cities better assess potential measures that are within its capacity to implement effectively. TRACE then allows recommendations to be plotted on the basis of two attributes on a 3x3 matrix (energy savings potential and first cost), with an additional filter that enables the user to sort recommendations based on the speed of implementation.

Recommendations in each priority sector are quantitatively and qualitatively evaluated based on key data, including institutional requirements, energy savings potential, and co-benefits. The recommendations are supported by implementation options, case studies, and references to tools and best practices.

5. Report Preparation and Submission

A Final City Report incorporates the various sections outlined above along with the review of the findings and recommendations by the city authorities. The intention of the TRACE report is to identify, together with the city, high-priority and near-term actions to improve the energy efficiency and overall management of municipal services.

The report includes:

- City background information, such as city contextual data, key city development priorities, energy efficiency drivers, and barriers.
- An analysis of the six sectors, including a summary of the benchmarking results.
- A summary of sector prioritization based on the city's objectives.
- A draft summary of recommendations provided in the City Action Plan
- An Annex including more in-depth information on energy efficiency options and best-practice case studies.

The limitations of TRACE

The fact that TRACE is simple and easy to implement, also means that there are limitations with respect to the depth of analysis. For example, the tool may identify Street Lighting as the a priority sector in terms of potential energy savings, but it does not go into city-specific details on the required costs to undertake street lighting rehabilitation projects. Thus, even if the energy savings potential is assessed to be high, the costs may be even higher, and an investment in the sector may not be warranted. Similarly, although TRACE specifically focuses on the service areas that fall within the purview of local authorities, the tool cannot factor in the institutional and legislative mechanisms that may be needed to implement specific energy efficiency actions.

While TRACE seems to apply well in cities in Eastern Europe and CIS countries, where most of public utility services are under the city government and thus the local public administration has a high-degree of control over the TRACE sectors. In other parts of the world, such as in Latin America, there is less municipal control over the TRACE sectors, either because they are managed at a state or federal level, or because the service is provided under contract by a concessionaire. In 2013, TRACE was implemented in seven largest cities in Romania where important utility services, such as public transport, district heating, street lighting but also municipal buildings are under the local government. In some cases, even if operation and maintenance of a certain sector is outsourced to a private concessionaire (as it is the case of street lighting), the municipality owns the related infrastructure and can make decisions over the sector. In Romania, the TRACE studies helped the local authorities and national government prepare local energy efficiency measures to be implemented with support from funds from the European Union, with the scope of reducing greenhouse gas emissions (GHG) and energy related costs, as part of Europe 2020 Strategy with the objective of reducing GHG emissions by 20 percent over the next few years.

Background

México is the fifth largest country in the Americas, after Canada, the U.S., Brazil, and Argentina. A large share of the Mexican territory consists of mountains, as the country is crossed by *Sierra Madre Oriental* and *Sierra Madre Occidental* mountain ranges (from north to south), by the Trans-Mexican Volcanic Belt (from east to west), and by the Sierra Madre del Sur in the south-west. México is also intersected by the Tropic of Cancer, which divides the country into two climatic areas, namely the temperate continental and tropical. This enables México to have a very diverse weather system, allowing the northern part of the country to experience cooler temperatures during the winter, and fairly constant temperatures year around. Most of the central and northern parts of México are located at high altitudes.

An upper middle income country with macroeconomic stability, México is the world's 14th largest economy in nominal terms, and ranks 10th by purchasing power parity, and with the second highest degree of income disparity between rich and poor among OECD countries. The economy is characterized by a mix of both modern and outdated enterprises in the industrial and agricultural sectors. México was severely affected by the 2008 economic crisis, with the country's GDP dropping by more than 6 percent. Currently, the government is working to reduce the large gap between rich and poor, upgrade infrastructure, modernize the tax system and labor laws, and reform the energy sector. The country has an export-oriented economy with more than 90 percent of trade taking place under free trade agreements with 40 countries, including the United States and Canada, the European Union, Japan and other Latin American countries. Services account for up to two thirds of the country's GDP, with industry's share 30 percent, and agriculture for only 3 percent. The country is a large tourist hub, attracting millions of visitors every year, and is the second most visited nation in the Americas, after the U.S.

México is a federal country consisting of 31 states and the Federal District (México City). According to the 2010 census, México is home to 118.8 million people. The most populous municipalities in México are:

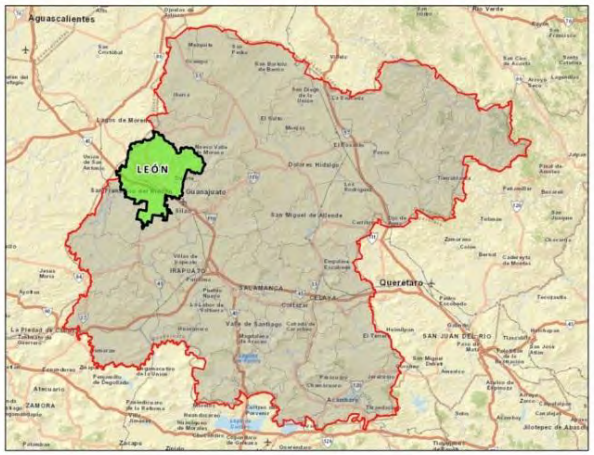
City	2010 census
México City	8,851,080
Ecatepec	1,655,015
Guadalajara	1,564,51
Puebla	1,539,819
León	1,436,733
Juárez	1,321,004
Tijuana	1,300,983
Zapopan	1,155,790
Monterrey	1,130,960
Nezahualcóyotl	1,109,363

Today, México is the most populous Spanish speaking country in the world, as well as the third most populous nation in the Americas, after the U.S. and Brazil.

León is located in the state of Guanajuato in North-Central México, and is approximately 1,800 meters altitude in a mountainous area. León is the 5th most populous municipality in México and the largest in Guanajuato. The metropolitan area of Léon neighbors the municipalities of San Felipe and San Francisco del Rincon, as well as the state of Jalisco to the north, Guanajuato and Silao to the east, and Romita to the south. León has a sub-humid tropical climate, with summer rainfalls. The climate has a bimodal pattern, with a large string of dry years, followed by a few rainy years related to the El Niño phenomena. The average annual temperature is around 18 Celsius.

The León Metropolitan Area was established in 2008 and includes, in addition to León, the localities of Purisima Del Rincon, and San Francisco del Rincon. The Metropolitan area comprises of more than 2.1 million people, spread over 1,883 square kilometers of which the Municipality of León is a part of.

Geographical location of León



The municipal area of León is spread over 1,220 square kilometers, with a density of 1,217 people per square kilometer. According to the 2010 census, the city has 1,436,733 inhabitants, of which 93 percent are Catholic. The TRACE analysis considered the local authorities projections for 2012 of 1,485,490 people.

León is a regional provider of financial services, education, health, and business tourism. The city is renowned for its leather products, and is popularly referred to as the "Shoe Capital of the World." According to the National Survey of Occupation and Employment (ENOE), most of the labor force in the city is employed by the leather industry, followed by the food & beverage sectors, and commerce. The plastics & rubber manufacturing industry has increasingly become important to the local economy, and today is the second largest industrial sector within the municipality. By the end of 2010, León had 16 industrial clusters, including three large industrial parks.

Arco de la Calzada de los Heroes in León

Source: wikimedia.org

According to data from ENOE, in 2012 more than a third of the city residents (accounting for almost 65 percent of the total population of working age) were employed and had a 5.6 percent unemployment rate. At the end of 2012, 62 percent of the labor force was engaged in services – shops, restaurants, financial and corporate sector -- while 37 percent was employed by the manufacturing and extractive industry, and energy sector. Less than one percent is engaged in agriculture, a sector that has faced serious challenges in the past decades due to climate variability and a lack of modern irrigation systems. Almost two-thirds of the working age population (370,000 people) is active in micro and small enterprises, while 28 percent is engaged in the informal sector. Lately, the unemployment rate has been roughly 6.5 percent, according to the National Institute for Statistics and Geography (INEGI).

The Mexico Institute for Competitiveness' (IMCO) urban competitiveness index 2012 (which ranks cities according to local government effectiveness, labor market, infrastructure, and economy) placed León 7th among municipalities with over one million inhabitants, just below Monterrey, México City, San Luis Potosi, Queretaro, Guadalajara and

Toluca.[1] According to the ENOE survey, León has the best average income for women in the country (the income of women relative to men is 0.86 percent).

Temple of the Sacred Heart

Source: wikimedia.org

In recent years, León has faced challenges such as the growth of the informal sector and the migration of inhabitants to other cities in search of better opportunities. The 2010 census reported a 3.5 percent migration rate among city residents. With support from the federal government, city managers are currently implementing a 15 million peso program aimed at employing people in the construction and maintenance of green areas.

León is home to eight universities, several soccer teams (including the current Mexican league champion), and a number of beautiful architectural works, including the Cathedral, the Municipal Palace, and the Bicentennial Park.

[1] Urban Competitiveness Index 2012, The City: an Institution Designed for Failure - Proposals for Professional Management of Cities. Mexican Institute of Competitiveness, IMCO (p. 17)

National Energy Framework

The power sector in Mexico is dominated by the Federal Electricity Commission (CFE), a state-owned utility which is the sole provider of electricity. CFE provides services to over 35 million households in the country, covering 98 percent of the population. In 2011, the overall electricity consumption in the entire country amounted to 229,318 GW, a 7.2 percent increase from 2010,[2] while electricity consumption in the residential sector increased 7.7 percent. Overall, the industrial sector accounts for 57.8 percent of total consumption, while the residential sector represents 26 percent.

By the end of 2011, México's national installed capacity was 61,568 MW, of which 52,512 MW was destined for the grid ("public service"), including 11,907 MW owned by independent power producers (IPPs) and 9,056 MW by other private producers. Electricity from clean sources represents roughly 15 percent of total generation.

Mexico's Constitution provides the main legal provisions with respect to the development and use of energy.[3] In addition, there are a number of laws regulating the energy sector, of which the most important ones are the Law on Public Electricity Service and the Petroleum Law. The Federal Government has stepped up efforts to promote energy from renewable sources, in order to mitigate climate change effects as well as to diversify supply and improve the security of the country's energy. The main legislation on renewable energy includes the Law on the Use of Renewable Energy and Energy Financing, the Law on Promotion and Development of Bioenergy, the Law on the Sustainable Use of Energy, and the Law on Rural Energy.

[2] Electricity Sector Prospect 2012-2026, México, SENER 2012 (p. 63)

[3] Legal and regulatory framework of the energy sector in México available at: http://www.cre.gob.mx/articulo.aspx?id=12

Energy Regulations in the Private Sector

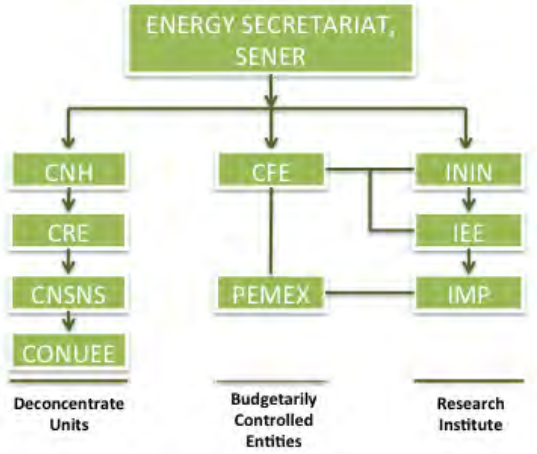
The Public Service Electricity Law provides the legal framework for generation and import of electricity. Private participation is currently only allowed in the following cases (it should be noted that recent changes to the Constitution and legislation currently being discussed in Congress will greatly amend the sector):[4]

a) *Co-generation*: Electricity produced from co-generation is intended for individuals or private entities who own the facilities;
b) *Independent Production Energy* or *PIE*: This is the generation of electricity from a plant with an installed capacity greater than 30 MW, and aimed exclusively for sale to CFE or export;
c) *Small production*: Defined as electricity produced that is: (a) sold to CFE (with the installed capacity less than 30 MW); (b) supplied to small communities in rural or isolated areas (the installed capacity should not exceed 1 MW); and (c) exported (within the maximum limit of 30 MW).
d) *Export*;
e) *Import*.

Structure of the Energy Sector in México

There are several key institutions in Mexico's energy sector. The *Secretaría de Energía* (SENER, Ministry of Energy) is responsible for planning and formulating electricity and other energy policies. SENER is supported by other regulatory and technical bodies, such as the *Comisión Nacional para el Uso Eficiente de la Energía* (CONUEE, National Commission for the Efficient Use of Energy), which drafts the National Program for the Sustainable Use of Energy (*Programa Nacional para el Aprovechamiento Sustentable de la Energía*, PRONASE) and is tasked with promoting the sustainable use of energy in all sectors and government levels by issuing guidance and providing technical assistance. The *Comisión Reguladora de Energía* (CRE, Energy Regulatory Commission) is responsible for the regulation and oversight of the electricity subsector, while the *Comisión Nacional de Hidrocarburos* (National Hydrocarbons Commission, CNH) regulates the oil sector. The state-owned power company, CFE, is responsible for the generation, transmission and distribution of electricity and serves the entire country, while *Petróleos Mexicanos* (PEMEX), Mexico's largest company, dominates the hydrocarbons subsector. Finally, the *Fideicomiso para el Ahorro de Energía Eléctrica* (FIDE, Energy Savings Trust Fund) – a public-private trust fund – provides technical and financial solutions for the deployment of energy efficient actions.

The structure of energy sector in México



Energy Legislative Framework

The ***National Development Plan 2013-2018*** outlines measures needed to increase the state's capacity to supply crude oil, natural gas and gasoline, and promote the efficient use of energy from renewable sources by employing new technologies and best practices.[5]

The ***National Energy Strategy 2013-2027*** (ENE) supports social inclusion in the use of energy, and the reduction of greenhouse gas emissions and

[4] Official Site of the Energy Regulatory Commission, available at: http://www.cre.gob.mx/pagina_a.aspx?id=23

[5] The Sixth Working Report - SENER 2012 (p. 8-13)

other negative impacts on health and the environment associated with energy production and consumption.[6] The overall objective of ENE is to develop a more sustainable and competitive energy sector, meet energy demand, and contribute to the country's economic growth and thus help improve quality of life for all Mexicans.

Latest developments in the energy sector in México

The energy sector has faced serious challenges in recent years. Oil production has declined, while consumption has continued to increase. Investments in the energy sector have picked up in recent years to compensate the decline and new regulations are now in place to encourage increased energy production from renewable sources – in the power sector, 35 percent of electricity is to be generated from non-fossil sources by 2024. Refineries have undergone major restructuring, and a large program to expand the transport of natural gas is being implemented.

Between 2000 and 2011, energy consumption in México increased by an average of 2 percent per year, while primary energy production declined by 0.3 percent. If this trend continues, México is likely to face an energy deficit by 2020. The oil production reached its peak between 2000 and 2004, and then declined to 2.5 million barrels per day in 2012, despite the fact that hydrocarbon exploration and production related investments tripled over the last 12 years (from 77,860 million to 251,900 million pesos). Proven oil reserves have also decreased by more than 30 percent, from 20,077 million barrels of oil equivalent (Mmboe) to 13,810 Mmboe. Estimated reserves also went down by 27.2 percent, from 16,965 Mmboe to 12,353 Mmboe. In recent years, México has become a net importer of gasoline, diesel, natural gas, liquefied petroleum gas (LPG) and petrochemical products.

According to SENER, overall energy consumption in 2011 amounted to 4,735.71 Petajoules (PJ).[7] Transport is the most energy intensive sector, accounting for almost 50 percent of total consumption. Industry represented 28.8 percent of overall energy use, while the residential sector was 28 percent and agriculture approximately 16 percent. The commercial and public sectors represent less than 3 and 0.6 percent, respectively. The demand for gasoline and naphtha has gone up by 31.7 percent as a result of both population and economic growth.

According to the National Inventory of Greenhouse Gas Emissions (INEGI), between 1990 and 2006 energy sector was the main source of GHG emissions in the country, accounting for 60.7 percent of the total. In 2011, total GHG emissions from the energy sector amounted to 498.51 Tg CO_2eq, 3.5 percent less than in 2010. The transport sector represented the highest emitting sector (nearly 40 percent), followed by power generation (30.8 percent) and industry (12.6 percent). México has set an aspirational goal of reducing emissions by 30 percent (under the business-as-usual scenario) by 2020.

The Level of Authority of Federal Government and Local Authorities regarding Public Utility Services

The Law on Fiscal Coordination is the legal framework in Mexico that regulates the relationship between states and municipalities on financial and fiscal issues. The law establishes the contributions to be made by states and municipalities to the federal budget, and defines the fiscal institutions at the state, municipal and federal level. Some public service utility services are regulated at the national level, through a number of federal entities, such as SCT (freight transport), CONAGUA (water), and SEMARNAT (solid waste). In addition, the recently created SEDATU has been tasked with promoting the development of urban transport policies.

The federal government provides support for the development of public service projects and related infrastructure. Municipalities usually obtain federal support for economic, social, real estate, and infrastructure projects (e.g., transport, waste, water, public lighting, municipal buildings, and power). For example, 75 percent of municipal budgets are typically funded by national government funds, while less than 3 percent come from the state, and the rest from local revenues.

[6] National Energy Strategy 2013-2027. SENER 2013 (p. 63 – 64)
[7] National Energy Balance 2011 – México - SENER 2012 (p.39 -49)

Some of the sectors targeted by TRACE are regulated by the Federal Government, while others are managed by local authorities. The level of influence of local governments in public utility services is outlined below.

1. Transport

Public transport is coordinated and funded by federal and state authorities. The national government has a monopoly for air, rail, and sea transportation. In a few cases, municipalities (in the states of Guanajuato, Baja California, Coahuila, and Quintana Roo) are responsible for public transport. Since 2008, federal funds have been available for integrated public transport systems through PROTRAM (*Programa Federal de Transporte Masivo*). In these city-level cases, the sector is organized by private operators under concession agreements, with oversight from local authorities. The local administration is responsible for enforcing transport regulations for public transport, while private transport typically remains under the purview of state governments.

2. Solid Waste

At the national level, solid waste is regulated by the Secretariat of the Environment and Natural Resources (SEMARNAT). At the local level, the sector is under public and private concessionaires. Landfills are usually managed a private operators. Public companies usually collect solid waste from residential households, while private operators deal with industrial and commercial waste.

3. Water

The water sector in México is regulated at the federal level by the National Water Commission, CONAGUA. All water sources in México are considered the property of the state. Cities pay levies to CONAGUA for extracting water from wells. A service agency under the local government typically manages the distribution of potable water, wastewater treatment, sewage and drainage in the city.

4. Power & Heat

The power sector is under the Federal Electricity Commission (CFE). CFE is responsible for the overall production, transmission and distribution of electricity in the country. Most cities in México do not require heat. Municipalities can partner-up with private companies for self-supply electricity projects.

5. Municipal Buildings

The municipal buildings stock managed by cities comprises primarily local public administration offices. Schools and hospitals are typically under federal and state authorities.

6. Street Lighting

Power for street lighting is typically provided by CFE while assets are operated, maintained, and owned by local authorities. In some municipalities, private concessionaires are responsible for maintenance of systems. Most municipalities charge a public lighting tax known as *Derecho sobre Alumbrado Publico* (DAP). Under DAP, all electricity users (including residential clients and private companies) are required to pay for public lighting in the form of a levy included in the monthly electricity bill or local taxes. The fee, which varies from state to state, is collected for municipalities by CFE.

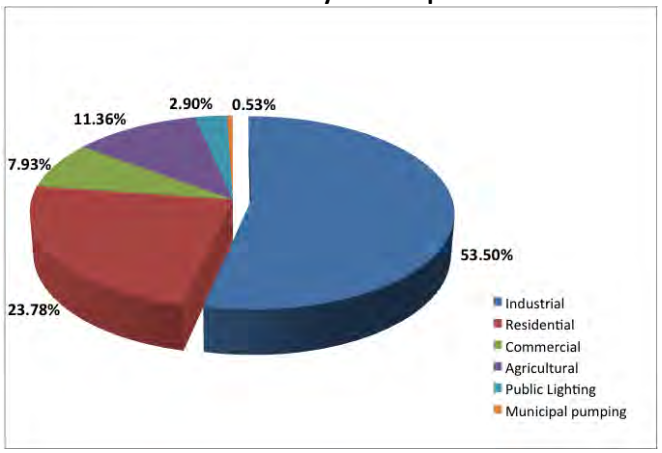
In the particular case of León, the DAP is: (a) collected by CFE through the electricity bill (or by the Municipal Treasury, in case a plot or property does have electricity service); (b) a new formula has been introduced that establishes the expected cost of the public lighting service to be equally divided between the number of CFE customers plus the number of properties that do not have service, and divided equally among all of them; (c) DAP resources are used to pay the municipal lighting expenditures, operation and maintenance, and improvement of the system; (d) CFE manages all resources collected and only in the case that these surpass the cost of the street lighting electricity consumption, it returns them to the Municipality of León.

Sector Diagnostics

Power Sector

There are no district heating or power generation facilities in León. All electricity distribution activities in León are under the faculties of CFE. A very small part of electricity used in the city is generated from local and small renewable energy projects (biogas and photovoltaic), totaling 1.9 million kWh per year.

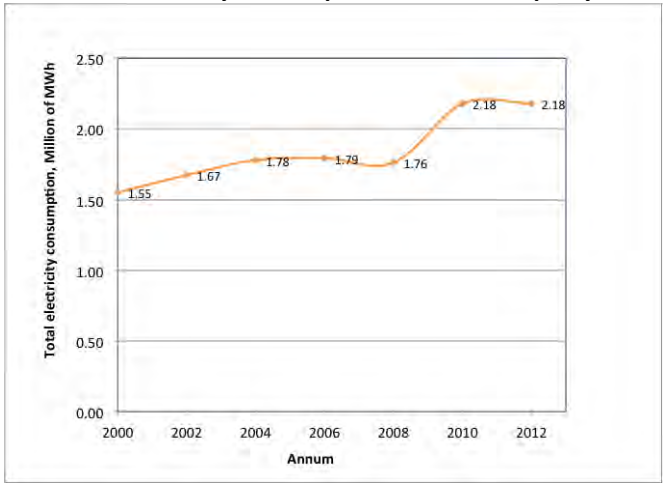
Distribution of total electricity consumption in León in 2012



Source: Data from INEGI and Federal Electricity Commission (CFE)

The overall energy consumption in León in 2012 amounted to 2.18 billion kWh, which makes the city the largest user in the state of Guanajuato (23 percent of state consumption). More than 50 percent of electricity was used in the industrial sector. Households accounted for 23 percent of the total consumption, agriculture for11 percent, the commercial sector 7 percent, and street lighting together with water pumping less than 3 percent. 401,812 households in the León metropolitan area are connected to the grid, of which 370,748 are in the urban area and over 31,000 in rural communities. Electricity consumption went up by 7 percent in recent years, as a consequence of population growth and the development of local industry and services.

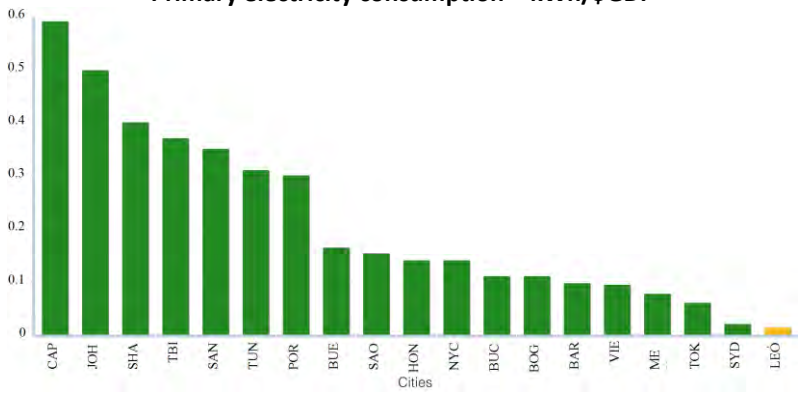
Evolution of electricity consumption in the municipality of León



Source: Making own with data from INEGI and CFE

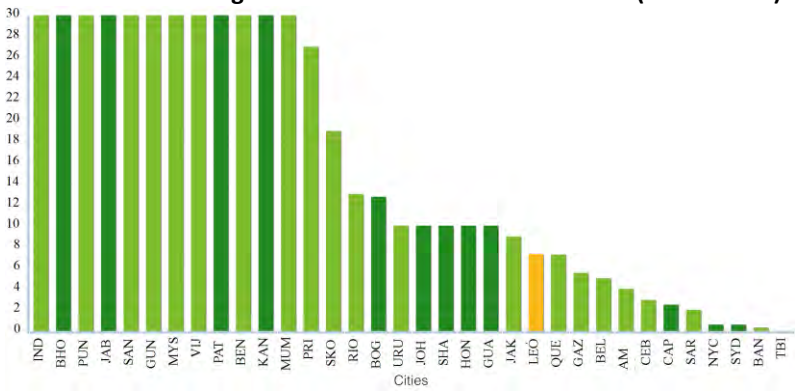
With an average consumption of 1,438 kWh of electricity per capita, León is performing better than some of the cities in the region with similar climate (e.g., México City, Bogota, and Sao Paulo). León has the lowest electricity consumption per GDP among cities with similar climate within the TRACE database, i.e., 0.01329 kWh/per $GDP.

Primary electricity consumption – kWh/$GDP



The overall energy losses in the transmission and distribution system account for 10.3 percent, a figure that places León in the middle of the TRACE database. When it comes to commercial losses, León is in the lower side of the TRACE database, with 7.3 percent. The city is performing fairly well compared to some cities worldwide, such and Skopje or Bangalore, although there is room for improvement, especially when compared to other cities such as, Gaziantep, Belgrade or Amman.

Percentage of T& D loss due to non-technical (commercial)



Energy tariffs are regulated nationally, depending on region, weather, actual consumption, category of users, time of day, type of electricity, and voltage level. Residential customers pay on average 1.089 pesos (8.5 US cents) per 1 kWh of electricity, while clients from the commercial sector pay almost three times more, i.e., 2.982 pesos (23.2 US cents) per kWh. Industrial clients are charged 1.374 pesos (10.7 US cents) per kWh of electricity.[8] Except for tariffs pertaining to the agriculture sector, all other electricity rates are subject to monthly adjustments. Federal tariffs adjustments tend to reflect changes in fuel price, inflation, energy demand, regional differences and season. Monthly tariff changes are based on the global price fluctuations of petroleum. Residential clients and farmers benefit from high subsidies. Depending on season and temperatures, there are different categories of subsidies. Consumption blocks are larger in regions with higher temperatures. As of 2006, electricity subsidies -- defined as the difference between the cost of generation and tariffs -- amounted to around US$9 billion, most of which was for residential consumers.[9]

The State of Guanajuato is actively promoting the use of renewable energy. In 2011, the state approved regulations to allow a better coordination between municipal, state and federal authorities to advance renewable energy as a tool to improve the quality of life of people, enhance preservation of environment, and encourage sustainable human development.[10] However, only 0.65 percent of the energy used in León in 2012 was generated from renewable sources.[11] Of this, 32 percent was produced through biomass (wood and coal), 2.1 percent was generated by biogas, and less than one percent by photovoltaic panels. The largest amount (64 percent) was produced by solar water heaters. The city has a good solar energy potential, with an irradiation of 6 kWh per square kilometer.

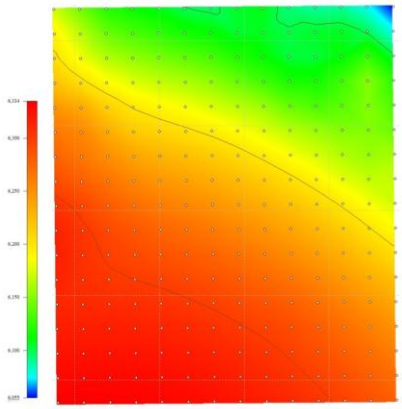
[8] Federal Electricity Commission–CFE available at: http://www.cfe.gob.mx/paginas/home.aspx.

[9] Komives et al. Residential Electricity Subsidies in Mexico: Exploring Options for Reform and for Enhancing the Impact on the Poor, The World Bank, 2009.

[10] Law for the Promotion and Use of Renewable Energy and Energy Sustainability for the state and the municipalities of Guanajuato - Official newspaper of the Government of the State of Guanajuato, Number 178, Guanajuato, November 8, 2011

[11] Prospective Natural Gas Market 2012-2026 - SENER 2013 (p. 67 -70)

Map of Solar Energy Potential for León



Source: Clean Power Research (CPR) and Solartronic

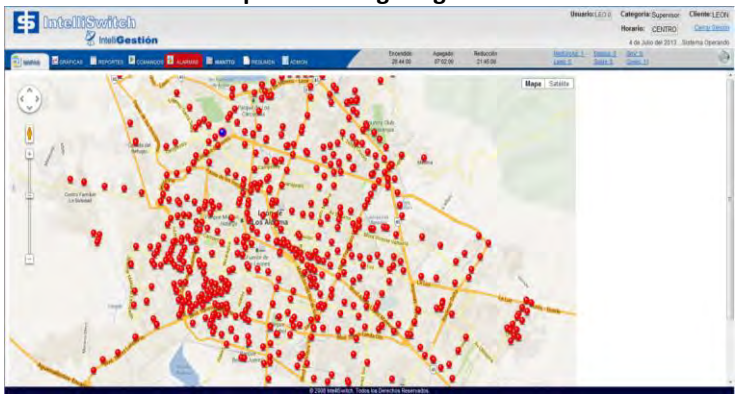
Street Lighting

In León, street lighting is managed by the municipality's Public Works Directorate. Léon was one of the first cities in México to have an electric street lighting system, which was established in 1884. In the mid-1950s Léon implemented a mercury-based lighting system which was extended throughout the city by 1960. Today León has two thirds of the streets lit; 2,042 kilometers out of 2,665 kilometers total.

The municipality is the owner of the street lighting infrastructure (except for a portion of concrete light poles that belong to CFE) and responsible for its maintenance. Through the *Derecho sobre Alumbrado Publico* (DAP) a local tax was charged to end use consumers and was collected by CFE. This collected amount is compared to municipal consumption, and if any surplus remains at the end of the fiscal year, CFE returns it to the Municipality. The DAP in León for residential customers and small users residing in urban areas was 8 percent of monthly electricity consumption and 5 percent for industrial clients. However, the DAP charter has recently been declared unconstitutional by the Supreme Court (as consumption is not directly linked to the public service and thus the DAP was ruled inequitable) and it should be reviewed in the near future.

Today in León, about 2,042 kilometers of the total 2,665 kilometers of streets in the city are lit. The 76 percent street lighting coverage places León in the middle of the TRACE database, in the same range as East European cities of Sarajevo and Banja Luka, and behind other peer cities, such as Gaziantep and Skopje.

Map of street lighting in León



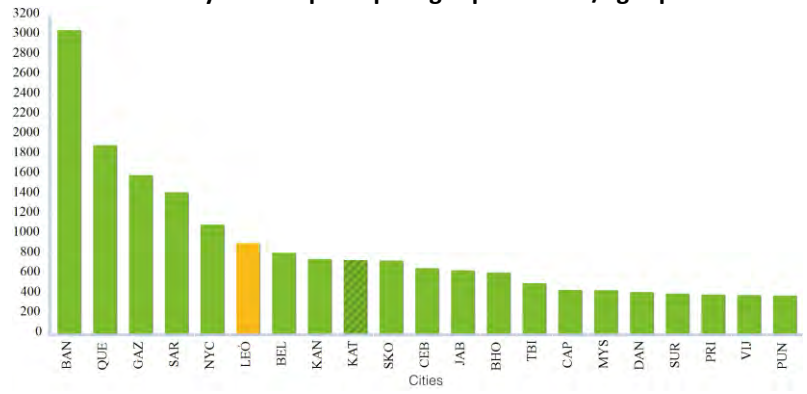
Source: Public lighting monitoring system in León

The municipality of León and CFE do not agree on the number of lighting poles in the city. According to the City there are roughly 70,000 lamps, while CFE reports 90,000. Interestingly, regardless of the number of lamps, both parties agree on total energy consumption. Roughly 99 percent of the lamps operate on high pressure sodium (HPS), 0.3 percent use LED technology, while a handful consists of metal-halide bulbs. In 2011, the city had plans to start a pilot project to replace around 200 HPS with LED lamps. According to local authorities, these LED lamps could save between 40 and 50 percent of electricity consumption. However, the project was put on hold due to financial reasons. Since 2009, the light poles on the main boulevards (roughly 22,000 lamps) are monitored through a centralized system, which allows for timing and dimming as required.

In 2012, the total electricity consumption necessary to operate the public lighting system in León amounted to 54.8 million kWh at a cost of 153

million pesos (approximately US$11.6 million). With 909 kWh of electricity consumption per light pole, León is at the higher end of the TRACE database. The city uses nearly twice the energy per light pole as Tbilisi and Cape Town, but less than Sarajevo or Gaziantep. In terms of energy per kilometer of lit road, León uses more electricity than most of the cities in the database, i.e., 28,000 kWh. León is performing better than Bhopal in India, Gaziantep or Sarajevo, but is way behind some other cities, including Tbilisi, Pristina or Belgrade.

Electricity consumption per light pole - kWh/light pole



The city has instituted several programs over the years to improve street lighting in the city. A large program was launched in 1992 aimed at replacing old, energy-intense lamps with modern high pressure sodium (HPS) vapor bulbs. Two years later, some of the light poles (in the main avenues) were equipped with energy saving modules, which has resulted in the saving of roughly one million US dollars. In 2007, approximately 2,500 old lamps on major avenues were replaced with HPS, achieving 40 percent in energy savings.

About 65 percent of the overall light poles in the city have meters, which is high by Mexican city standards, but still not optimal from an efficiency perspective. For the remaining poles, CFE uses a formula to estimate consumption. The lack of metering makes it more difficult for León to institute energy efficiency strategies, including efficient lamps, and timing and light dimming programs.

The financial viability of replacing sodium vapor lamps with LED in the long run will depend on several factors, including the capacity to finance investments with the energy savings, external resources (multilateral development banks/International Financial Institutions), and implementation of a new DAP. Other issues to be considered include developing local capacity to procure and install LEDs (currently, most lamps are installed through third parties, such as housing developers and through public works), enforcement of local building codes and public lighting regulations, and operation and maintenance capacities.

In the near future, local authorities plan to expand street lighting in the city by 316 kilometers and an additional 8,100 light poles. A national energy efficiency project helps governments to replace inefficient lighting throughout the country. The project brings together a number of stakeholders, including the National Bank of Public Works and Services (BANOBRAS), CFE, and the National Commission for the Efficient Use of Energy (CONUEE). The program aims to reduce power consumption, improve cost savings, and decrease greenhouse gas emissions. Municipalities can qualify to receive support for efficient street lighting from SENER, e.g., up to 15 percent of the investments or the equivalent of 10 million pesos.

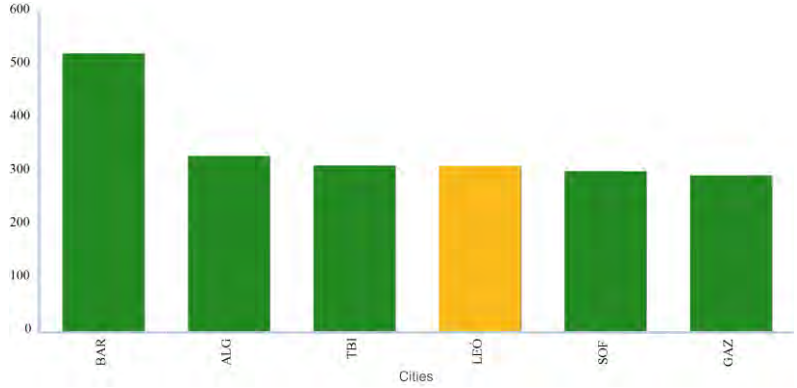
Solid Waste

The solid waste sector in León is managed by both public and private institutions. Solid waste collection is performed by a number of private operators, under the control and oversight of SIAP - *Sistema Integral de Aseo Público* (the Integrated Public Cleaning System), a public entity that is under the municipal government. Private companies operate 118 (91 percent) of the collection routes, while SIAP is responsible for the collection of solid waste from households in 11 (6 rural and 5 peri-urban routes) using 30 trucks. Private operators handle solid waste collection from commercial and industrial sectors. The landfill is managed by a private company under a concession agreement. The system serves

264,830 households in urban areas and nearly 15,000 families in rural communities.

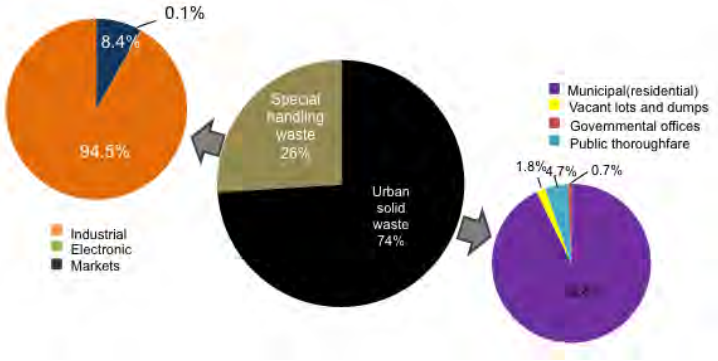
In 2012, the total solid waste generated in León amounted to 460,380 tons. Of this, 76 percent (351,653 tons) was produced by the residential sector, and 24 percent (108,660 tons) by the industrial sector (including hazardous materials). According to city authorities, 13,000 tons of waste is generated by visitors. In 2012, the city generated 309 kg of solid waste per capita, a figure comparable with cities within the TRACE database with similar population, including Sofia and Tbilisi. Solid waste is collected daily in urban areas and suburbs from designated collection points (large trash bins) placed on the sidewalks, and once every three days in rural communities.

Waste per Capita – kg/capita



Urban waste accounts for 74 percent of the total amount, while 24 percent is categorized as special handling solid waste including industrial and hazardous waste. Urban waste is generated mostly by residential households (92 percent). The waste generated by public offices accounts for less than one percent, while the waste collected from public spaces represents 4.7 percent. Nearly 5 percent of the solid waste comes from vacant lots within the city.

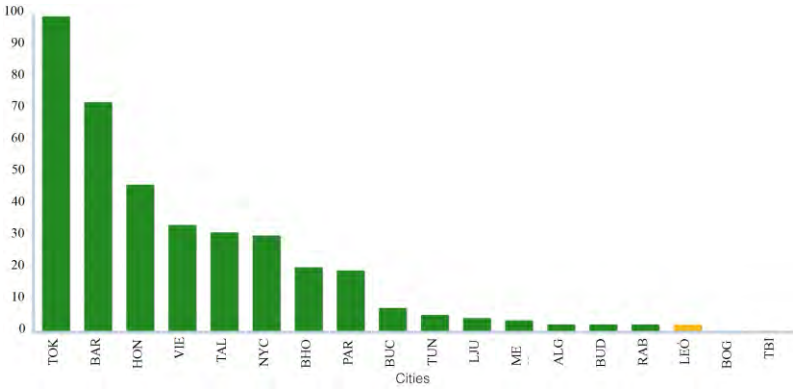
Structure of solid waste in León



Source: Local Government Program 2012-2015

Except for industrial waste, 99 percent of the municipal solid waste in León goes to the landfill. However, the city is doing poorly when it comes to selective collection, as only 2 percent of the waste is recycled. This figure places León in the lower end of the TRACE database within cities with similar climate.

Percentage of recycled waste (percent)



The percentage of recycled waste in León is low and comparable to México City and Rabat; it is three times lower than in Bucharest, and 15 times lower than in Tallinn. Recycling is also done by informal collectors who pick through waste directly from the trucks on their way to the landfill; estimates of the quantity of this "informal" recycling is uncertain.

The collection, transportation, and disposal of waste are free of charge for residential customers. Commercial customers, such as private companies and shops, pay a monthly fee of 124 pesos (approximately US$9.3) for the first 10 kg of waste, and 24 pesos per kg after exceeding this ceiling. Companies pay 553 pesos for a 200-liter container of waste, nearly 1,400 pesos for a 500-liter trash can, and over 7,200 pesos for a large 2,600-liter waste bin. Solid waste operators charge 85.5 pesos for a cubic meter of industrial waste.

Informal recycling

SIAP also manages construction and demolition waste, charging 2.1 pesos per kg (US$0.15). Since 2009, construction and demolition waste is dumped at a special facility, called "La Concepción." On average, 60,000 tons of construction related waste is generated annually in León.[12]

[12] Sistema Integral de Aseo Publico - SIAP - available at: http://siapLéon.gob.mx/2012/

Due to a large number of collection companies, the municipality of León lacks accurate and reliable data, such as the collection truck fleet, routes, and fuel consumption. City managers are trying to identify the best ways to improve the solid waste collection system in León, and are evaluating a number of options, including concession agreements and performance-based contracts. Currently, most of the solid waste collection fleet is old, poorly maintained, and needs to be replaced. According to local estimates, in 2012, SIAP needed 166,000 liters of diesel to cover their solid waste collection activities from residential clients, for which the agency spent approximately 1.94 million pesos (US$147,000). The fuel for the overall collection, transportation, and management of the solid waste in León, operated by both public and private entities, cost 14.9 million pesos (almost US$1.1 million).

Because the city does not have transfer stations, waste trucks must drive long trips to the landfill. According to TRACE analysis, garbage trucks drive around 86 kilometers round trip daily, spending $ 0.2 per liter of diesel. Construction of transfer and sorting stations would help increase the recycling rate and reduce fuel consumption.

The landfill, called CTR *La Verde* ("The Green" Waste Treatment Center), is a new, modern facility, managed by a private operator under a 15-year concession agreement that has recently been renewed.

La Verde landfill

The facility is located in El Verde, about 15 kilometers northwest of the city limits of León. The landfill became operational in 2001, when it replaced the old solid waste facility. The landfill is spread over 60 hectares and has two large cells, each divided into five smaller cells of 5 hectares.

The facility has a leachate plant where wastewater from the landfill is treated and discharged.

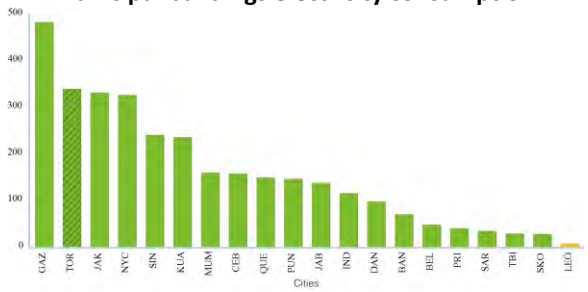
Leachate plant at la Verde landfill

Although the landfill can capture and flare biogas, electricity generation is yet to start. In order to do so, both the operator and the city authorities have recently agreed (April 8, 2014) on how investments will be financed and how to use the electricity produced, which should be used for public lighting purposes. It is expected the project could provide up to 30 percent of current public lighting needs in the municipality.

Municipal Buildings

The municipal building stock under the city government in León comprises more than 500 facilities with a total area of 1.6 million square meters. Most of them are public offices that belong to the municipality, in addition to sports halls and other facilities. Schools and hospitals in León are managed by state and federal authorities. León has the lowest electricity consumption for municipal buildings in the TRACE database, with 6.68 kWh per square meter. The city needs nearly 10 million kWh of electricity for its municipal building stock. Due to a mild climate throughout the year, municipal buildings require almost no air conditioning or heating. In 2012, the amount of fuel used for heating or cooling the local public buildings amounted to only 208,597 kWth (0.13 kWth per square meter). Overall, energy expenditures related to municipal buildings in León was a little over $ 2 million, which accounts for 0.5 percent of the city budget.

Municipal buildings electricity consumption – kWh/square meter



Although the number of buildings with air conditioning is quite limited, the city managers could still implement basic improvements, mostly through lighting equipment replacements. The city could benefit from improving current local regulations and their enforcement.

There are regulations at the local, state, and national level aimed at increasing sustainability of public buildings.[13] Municipalities can set urban development regulations, establish sustainable energy programs, and promote energy from renewable sources. The National Commission for the Efficient Use of Renewable Energy (CONUEE) has set some energy efficiency standards that target savings in central administration institutions by employing a number of measures, such as using energy saving bulbs and changing external lighting of buildings.[14]

[13] The 6th Working Report - SENER 2012 (p. 8-13)
[14] CONUEE available at: http://www.conuee.gob.mx/wb/CONAE/da_a_conocer_la_conuee_las_disposiciones_administr

City Hall in León

Source: blog.mexicodestinos.com

CONUEE developed a guidebook on measures for administrative institutions (2012) that promotes and monitors energy efficiency in public buildings and vehicle fleets. Currently, there is a national level pilot program that includes 6,000 public buildings with a surface larger than 200 square meters, and 90,000 cars covering more than 900 fleets from several federal agencies and departments.

León is also interested in encouraging residential, industrial and commercial sectors to implement energy efficiency interventions by developing new codes and regulations that could also promote solar water heating.

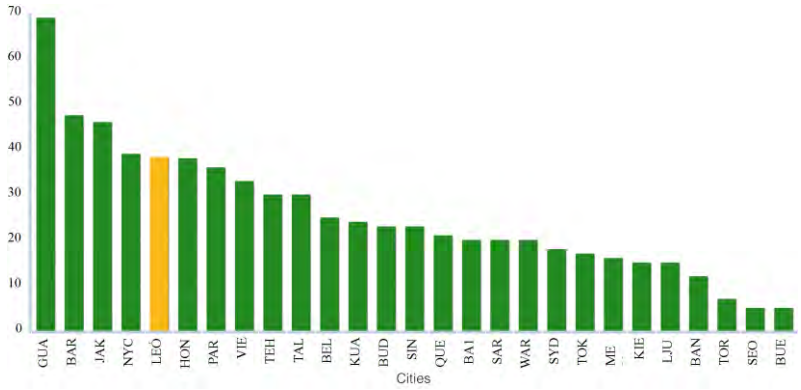
Urban Transport

Public Transport

León has a functional, sustainable public transport system privately operated under concession agreements with 15 operators, under the control and oversight of the City through the General Directorate for Mobility. Today, León has a fairly well integrated public transport system called *Sistema Integrado de Transporte* (SIT) or *Optibús*, based on Bus Rapid Transit (BRT). *Optibús* includes three main typologies of routes, namely BRT, auxiliary, and feeders. The system also counts with a number of conventional routes that operate on the same parameters as *Optibús*, except for transfer (not free). A fully integrated public transport system is currently under implementation as the city is moving towards cleaner and more efficient technologies.

According to the TRACE analysis, almost one third of commuters in León rely on public transport (29.8 percent). The figure places León on the higher side of the TRACE data base compared to cities with similar Human Development. Approximately 800,000 people use public transport every day.

Public Transport Mode Split (percent)

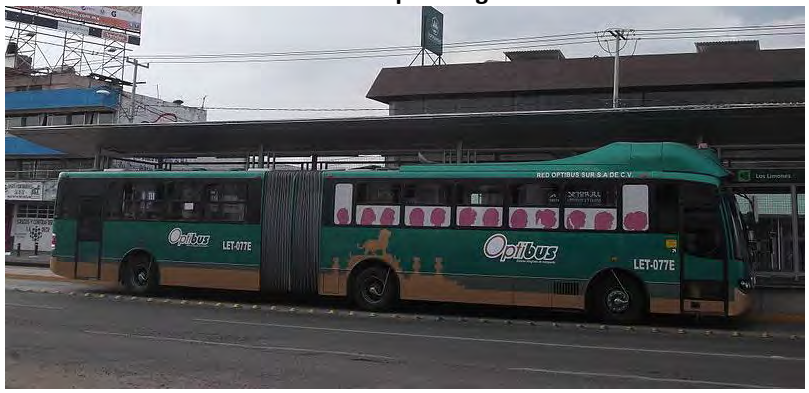


The city has a good experience in developing and implementing a sustainable and reliable public transport system. In early 2000s, León embarked on a complex process to improve the system in the city, as part of the Strategic and Urban Plan "León in the future", a document envisioning a new urban mobility network based on sustainable development model.

The first phase of SIT, implemented in the early 2000s focused on BRT. León acted as a pioneer in the field of sustainable transport in México when the city launched the first BRT system in the country in 2003, with 52 buses and 52 stations spread over 26 kilometers. The *Optibús,*

popularly *known as* “La Oruga” (the caterpillar), operates on dedicated bus lanes and high-platform platform stations, as well as on regular streets. The system uses articulated diesel buses comprising two rigid sections linked by a pivoting joint, and which can carry up to 175 passengers. After *Optibús* started operations, the public transport system was able to accommodate 200,000 passengers per day (daily trips).

BRT operating in León



Source: es.wikipedia.org

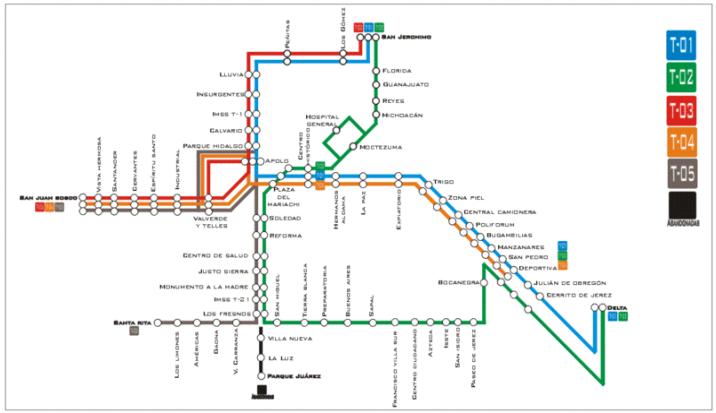
When the number of daily trips exceeded the capacity of the system, the city managers decided to restructure the feeder and auxiliary routes. After BRT was implemented, private operators had to reorganize their companies, and made structural changes to the feeder and auxiliary services.

Feeder *(left)* and auxiliary *(right)* buses in León

During the second stage of *Optibús*, the BRT network expanded with 10 new stations, an additional 5 kilometers of dedicated bus lanes, and 29 modern, high-quality articulated buses that were expected to remove more than 100 polluting old public vehicles from the road.

With low operations costs per kilometer, the BRT is the most energy efficient transport in the city, with service on five routes and 65 stations located on the main avenues in the central area. Today, of the 800,000 people using the public transport system in León each day, 350,000 ride *Optibús*. The integration of the BRT, feeder and auxiliary routes has helped not only to expand the public transport network in the city, but has also brought about significant environmental benefits. Today, 69 out of 100 public bus routes in León are integrated with the BRT buses.

Map of BRT system in León



Source: wikipedia.org

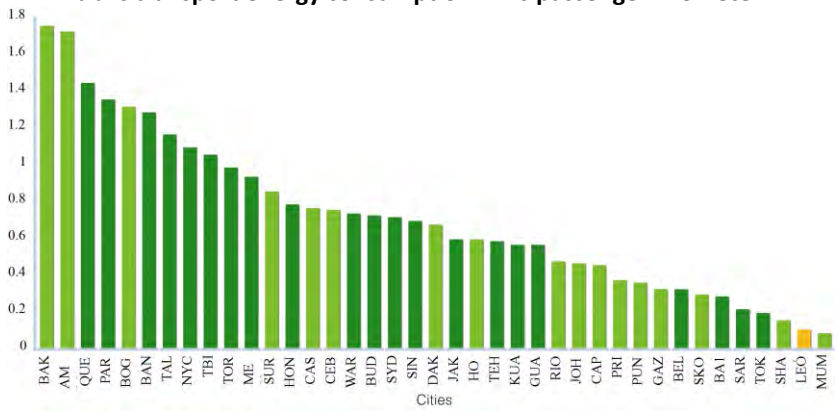
Private operators work together with the local authorities to provide a sustainable and reliable public transport. The operators purchase the buses, while the city government takes the lead in the modernization and maintenance of streets, stations and terminals. The BRT system requires significant investments, with costs for buses for the *Optibús* system ranging between 2 to 5 million pesos (US$150,000 to 380,000) each, depending on the chosen technology.

The city has three permanent transfer stations (San Jerónimo, Delta de Jerez, and San Juan Bosco), two micro-stations (at Santa Rita and Parque Juárez, which are also the endpoints for the BRT system), feeder routes and auxiliary routes. At these stations people can transfer for free from any of these lines. León also has a number of conventional routes that circulate throughout most of the city.

BRT bus stop in León

With an energy consumption of 0.1 MJ/passenger-kilometer, the public transport system in León is the second most efficient system within the TRACE database, after Mumbai. León is performing better than many cities in the world, including Toronto, Hong Kong, and Singapore. The system in León was awarded the "Sustainable Transport Award 2011" along with Guangzhou, China, and beating cities such as Zurich and San Francisco. Also, the Financial Times ranks León first among large Latin American cities in terms of the cost-effectiveness of public transport.

Public transport energy consumption – MJ passenger kilometer

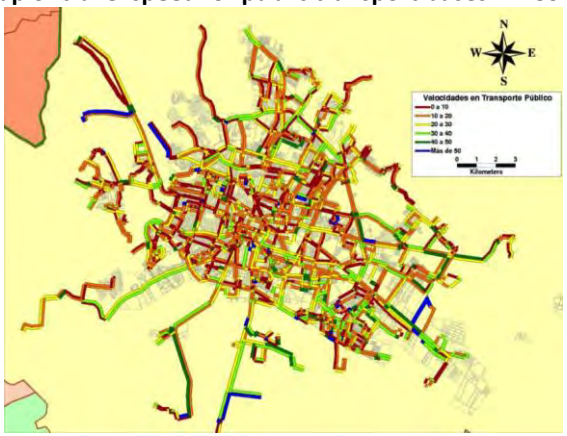


The city has approximately 105 kilometers of high transit lanes. With 70.68 kilometers per 1,000 people, León ranks in the middle of the TRACE database compared to cities with similar Human Development Index. The figure is higher than in Tallinn or Belgrade, but about half that of Budapest or Warsaw. Buses in León travel at 10 to 50 kilometers per hour, while commuters using private cars travel at 19 kilometers per hour on average.

Most of the public transport rolling stock is dominated by buses between 7 to 8 years old. The BRT buses are 7 years old and use Euro 4 technology, however, there are no enforced emission standards in the city. Congestion and heavy traffic, especially during peak hours, often lead to bottlenecks. In 2012, the overall amount of fuel needed to operate the public transport system in León cost 293,083,998 (approximately US$22.2 million).[15] One liter of diesel cost approximately 10.2 pesos (US$0.77) per liter.

[15] Using an exchange rate of $ 1= 13.2 pesos – average exchange rate for 2013 according to the National Bank of Mexico

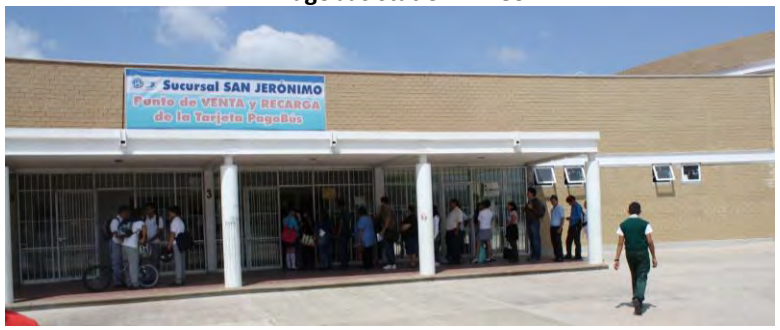
Map of travel speed for public transport buses in León



Source: General Directorate of Mobility, City of León

Private transport operators established a company called Pagobus, in charge of the fare collection system in León that introduced e-ticketing. Trips cost 6.95 pesos on average (US$0.5). Pagobus users pay 7.3 pesos per trip. Roughly half of all transactions use this system. The maximum cost per trip is 8 pesos (except for cash payments, which are usually higher and can go up to 9 pesos). Students, the elderly and disabled receive a 10 percent discount. The e-ticketing system allows easier access to stations and buses and saves money. The e-ticket also allows for free transfer within the *Optibús* system. Fare collection is off-board at BRT stations, and on-board in the feeder and auxiliary buses.

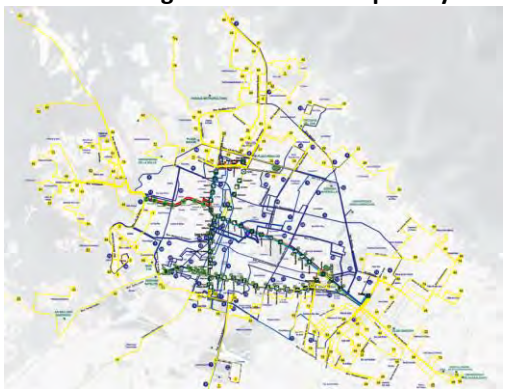
Pagobus station in León



The General Directorate for Mobility within the Municipality of León is responsible for the overall management and supervision of the public transport system and sets bus fares.

There are approximately 4,000 taxis in León. On average, taxis charge around 40 pesos per trip (US$3). They must obtain authorization from the City, which also regulates the tariffs. In 2012, estimates indicate that the fuel used by all taxis in León cost 617 million pesos (approximately US$46.7 million).

Routes within the Integrated Public Transport System in León



Source: General Directorate of Mobility, City of León

Although public transport is quite efficient, the bus fleet itself could be upgraded to reduce fuel consumption and emissions. City managers are considering amending the current concession agreements to include energy efficiency related provisions for bus operators. Recently, local authorities managed to reduce fuel consumption through a maintenance program and by decommissioning some older buses. The City of León started a pilot program with 50 vehicles aimed at monitoring fuel consumption in order to reduce the use of gasoline/diesel. The local government is planning to extend this program to other public vehicles in the future.

Currently, the city is preparing for the third stage of the integrated transport system (SIT) under which the BRT system would expand and be further integrated with the feeder and auxiliary routes. The project requires investments of approximately 720 million pesos (US$55 million).[16] Upon completion, SIT will be able to cover more than 80 percent of the daily public transport demand in the city, with the number of people riding the BRT buses daily expected to rise to 500,000.

Private Transport

According to INEGI data, the number of cars tripled in León over the last twenty years, from 134,563 in the mid-1990s to almost 380,000 vehicles in 2011, of which 248,863 are privately owned. The increase in the number of cars has intensified traffic congestion and increased greenhouse gas emissions (GHG). Currently, 61 percent of GHG emissions in León are generated by the transport sector. The increase in the number of cars has not only increased congestion and air pollution, but has also damaged the road infrastructure. Moreover, there are a number of unregistered cars, known as "chocolates" (illegally imported from the U.S.), that are adding to traffic congestion and pollution in the city.[17] In addition, there are approximately 12,000 motorcycles in León.

Traffic in León

Source: www.milenio.com

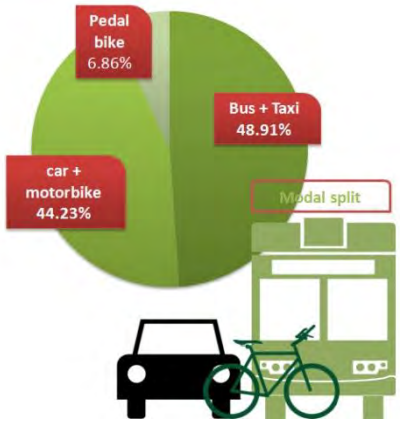
[16] The Léon City Hall, General Directorate for Mobility available at: http://oruga-sit.Léon.gob.mx/EtapaIII.html

[17] Governmental Program for the period 2012 – 2015, Municipality of León, Guanajuato (p.42- 46)

Most cars in León are old, with a low level of emission standards (Euro 1 and Euro 2). More than 44 percent of the city residents use their own cars and motorbikes for their daily commute, while almost seven percent rely on bicycles. The road network in León is spread over 350 kilometers, but city managers plan on expanding it by an additional 300 kilometers in the near future.

According to the TRACE analysis, León has the most energy efficient transport among cities with similar climate.

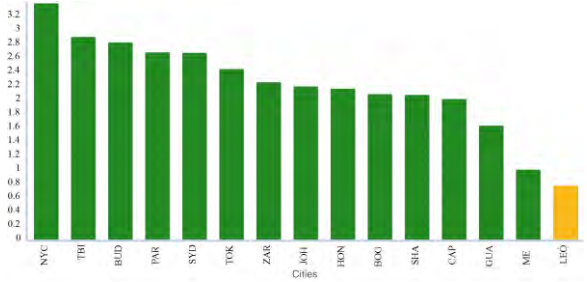
Transport mode split in León



Source: General Directorate for Mobility, City of León

With an energy consumption of 0.77 MJ per passenger kilometer, León is performing better than peer cities in the TRACE database, including México City and some European cities such as Budapest and Paris. However, the high number of vehicles in León requires a large amount of fuel. In 2012, the cost of fuel for private transport in the city is estimated at over 1.5 billion pesos (approximately US$119 million).

Private transport energy consumption – MJ/passenger kilometer



The registration of vehicles and the issuance of license plates and driver's licenses are done by the state of Guanajuato. Municipalities process the application, conduct the driving test, and deliver the driver's licenses. Like many cities in México, León is struggling with traffic congestion, especially during peak hours. In recent years above-ground bridges were built to help ease traffic and improve safety in the city. The second beltway on the northern side of León is currently under construction, and is hoped to reduce congestion in the city. Traffic is monitored through a traffic management system operated by the City.

León is one of the most bike-friendly cities in Latin America. Currently, there are 107 kilometers of bike lanes and 23 docking stations in the city, including a 7-kilometer cycling path in the Metropolitan Park.

Cycling in Metropolitan Park in León

Source: yumping.com.mx

There are 14 intersections which are passed by 100,000 cyclists daily.[18] Roughly 7 percent of the people in León use bikes for their daily commutes. The number of bike users could increase by improving existing infrastructure. Around 27 kilometers of bike networks require major rehabilitation work, while some of the existing lanes are not fully interconnected. City managers plan to address this issue by developing 30 kilometers of cycling lanes in the near future and better connecting the bike network to the public transport system. According to the Biking Master Plan, León is to have 540 kilometers of bike lanes by 2020. Meanwhile, city managers plan to install docking stations in some of the most popular venues in the city, where people can rent bikes. Moreover, new docking stations should be considered for the *Optibús* system, where people could transfer to the SIT network.

Bike network in León

Source: Municipality of León

[18] Functional Design of the Third Phase of SIT- Optibus (2012)

One of the main pedestrian networks in León is located in the old downtown district, which is spread along 4 kilometers among historical buildings and recreational spots.

Historical center in León

Source: www.mexicodesconocido.com

The local government is planning to expand the pedestrian network and connect it to a number of important sites in the area.

Pedestrian network near the Museum of Archeology in León

Source: www.panoramio.com

The development of non-motorized transport has helped León improve air quality in the city, and mitigate the effects of the increasing amount of greenhouse gas emissions. In 2008, the Federal Government, the State of Guanajuato and the City of León signed the PROAIRE 2008-2012 agreement aimed at improving the air quality and reduce pollution in the city.[19] The plan included, among other things, planting of trees, encouraging cycling, and having more people using people transport and biking. The program enforced penalties for car owners who miss their annual vehicle inspection. As a consequence, the percentage of vehicle inspections went up.

The city managers of León can continue to develop non-motorized transport to increase the quality of life in the city. In the cities of Cluj and Timisoara in Romania the development of pedestrian networks encouraged business development in and around the newly established pedestrian areas, including additional leisure and entertainment spots, such as restaurants and shops. Today, pedestrian networks are the most attractive areas in the cities in terms of leisure, entertainment, and cultural activities.

Water Sector

Potable Water

The water sector in León is coordinated by SAPAL, the independent public water utility operating in the Municipality. SAPAL is in charge of the distribution of potable water and wastewater management, as well as sewage and drainage. Although it is part of the Board of Directors, the municipality of León is not involved in the management of SAPAL nor does it financially support the company. The company has a well-established operational and management model that provides an excellent example for other public utility providers in the country.

[19] The Institute of Ecology of the State of Guanajuato

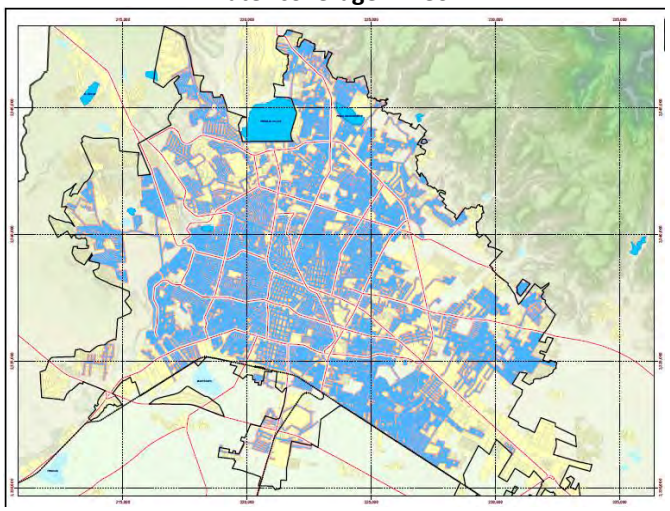
Almost all the water supply (99 percent) in León comes from a network of 132 wells with an overall capacity of 3,617 liters per second. The wells supply nearly 80,000,000 cubic meters of water. Given that all water sources in Mexico are considered property of the nation, Léon pays a levy to CONAGUA (the National Water Commission) for using water from the wells. There are 182 water tanks spread across the city with an overall storage capacity of 208,000 cubic meters.

The main surface water source for León is the Palote Dam, with a capacity of 135 liters per second. The dam is mostly used during hot seasons, depending on available water volume. For example, in 2012 the water level in the dam was very low and was not used at all.

In the future, an alternative water source could be El Zapotillo dam on the Rio Verde in the state of Jalisco. The dam is currently under construction, and would cover all current needs and replace the use of wells in León. The project is expected to be completed in the next three years and should guarantee an adequate drinking water supply for the next 25 years to over 2.8 million people in the states of Guanajuato and Jalisco. Upon completion, the dam it is expected to provide water to León at a rate of 3.8 liters per second.

The water coverage in León is nearly 100 percent. SAPAL serves 382,000 customers in the city, of which 361,467 are residential and 17,868 are commercial. Residential clients pay 17.8 pesos (US$1.32) per cubic meter of water. Industrial sector clients pay 38.82 (US$2.89) per cubic meter, while commercial customers pay 39.81 (US$2.97) pesos per cubic meter.

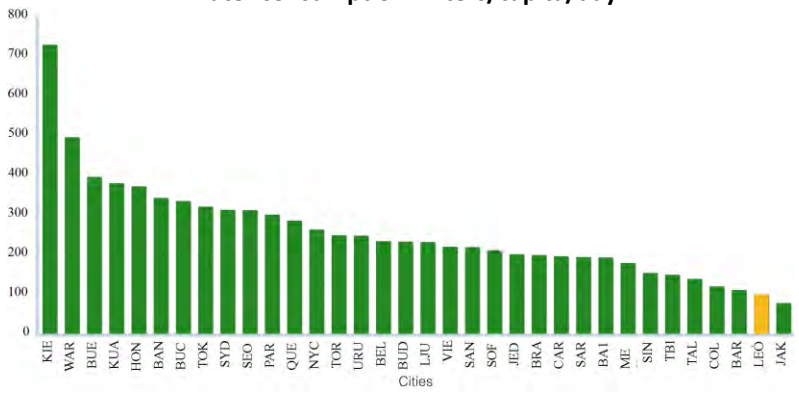
Water coverage in León



Source: Municipal Planning Institute IMPLAN

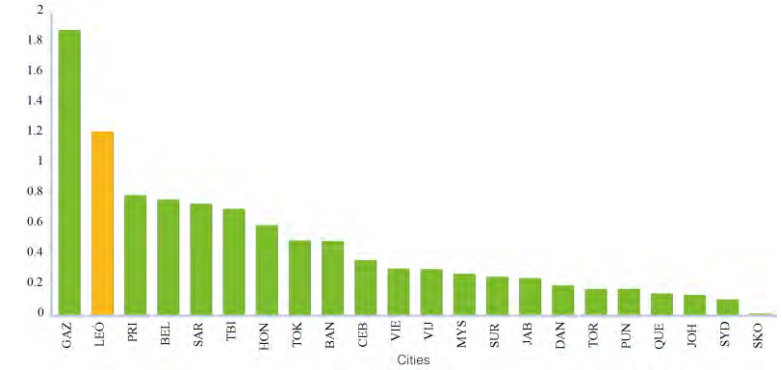
The number of water connections increased by 15 percent between 2007 and 2012. In 2012, the total amount of water sold in León amounted to 53.6 million cubic meters. León uses 98.9 liters per capita per day, a figure that places the municipality in the lower side of the TRACE database. The city has the second lowest daily water consumption among peers, and requires less than half the water used in Barcelona, Sofia, Bratislava or Santiago.

Water consumption – liters/capita/day



The overall extraction, treatment, and water supply process in León requires 1.21 kWh of electricity per cubic meter, second highest value in the TRACE database, after Gaziantep in Turkey. According to the TRACE analysis, León needs four times more electricity to obtain one cubic meter of potable water than Vienna, three times more than Banja Luka in Bosnia and Herzegovina, and twice as much as Tbilisi in Georgia. In 2012, SAPAL used almost 100 million kWh of electricity to extract and distribute potable water.

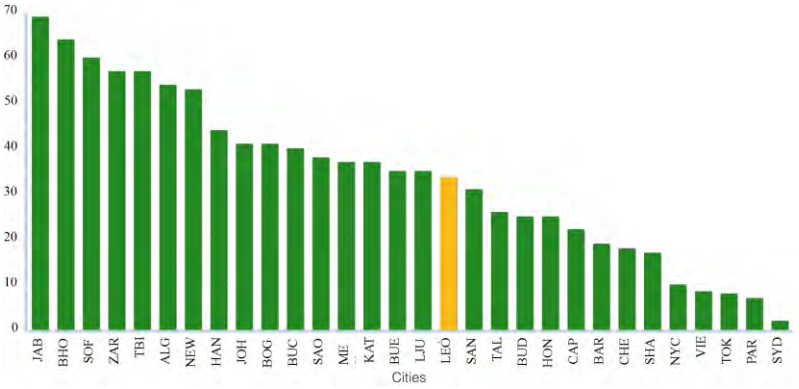
Energy consumption for potable water production – kWh/cubic meter



Pumping water from wells requires a significant amount of energy. The overall electricity consumption for the entire water system in Leon is high, accounting for 25 percent of SAPAL's operational costs. In 2012, the water company spent US$12.3 million for electricity for total water production and wastewater treatment in León.

As for water losses, León ranks in the mid to lower side of the TRACE database compared to similar cities. Although the city has higher losses than Santiago or Budapest, it is performing better than Ljubljana and México City.

Percentage of water losses (percent)



In recent years, SAPAL has worked to improve the water system in León and increase its efficiency. The company managed to reduce losses by implementing modern technology-based solutions aimed at identifying leaks in the network, through the use of GIS and SCADA systems. To this end, a Monitoring and Control Center was established to remotely collect information from all water facilities and supervise the network. Any system problems can be identified in real time by dispatchers sitting in the monitoring room. Thus, SAPAL is able detect in a timely manner the technical problems and avoid water supply shortages. The system provides the company with automatic reports, data collection, and access to readily-accessible information on the use of energy. Although the SCADA and GIS systems have improved the overall operations of the water

sector in León, there is no evidence whether they were actually able to address water complaints in a timely manner or save energy.

SCADA system monitoring the water system in León

SAPAL is organizing training and educational programs to teach water users how to diminish water consumption, and to promote the re-use of dry sludge as fertilizer. In addition, the company has stepped up efforts to improve water services, improve the relationship with customers, and increase revenue collection.

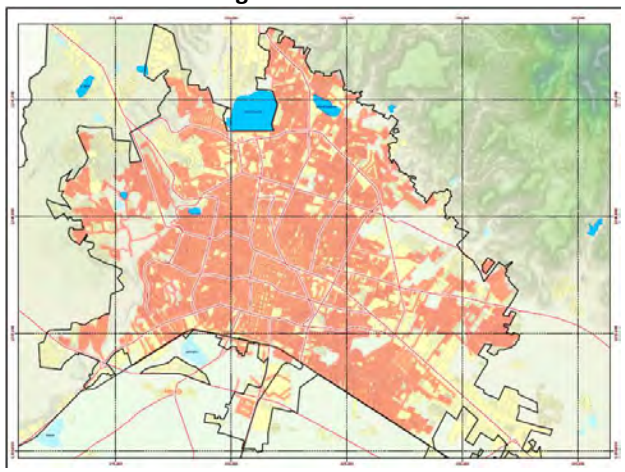
Wastewater

As with potable water, the wastewater network in León is operated by both public and private sector, under the control and oversight of SAPAL. There are 11 wastewater treatment plants in the municipal area. The main wastewater plant in the city, known as the PTAR, is privately operated under a concession agreement. The plant holds a capacity of 2,500 liters per second for the primary treatment and 1,000 liters per second for the secondary treatment.

Wastewater treatment plant in León

Since 2009, León has been operating a plant with a capacity of 150 liters per second to treat the highly polluted water generated by the city's leather industry. Most of the wastewater plants have small treatment capacities ranging between 1.3 liters per second (Ciudad Industrial) and 70 liters per second (Las Joyas). Two of the wastewater treatment facilities cater to rural communities.

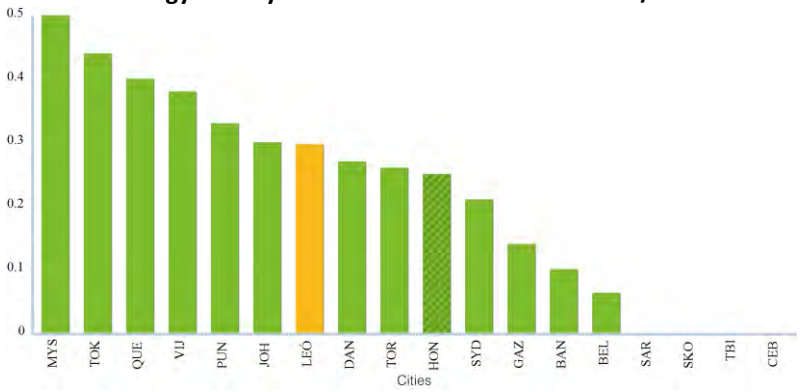
Sewage network in León



Source: Municipal Planning Institute

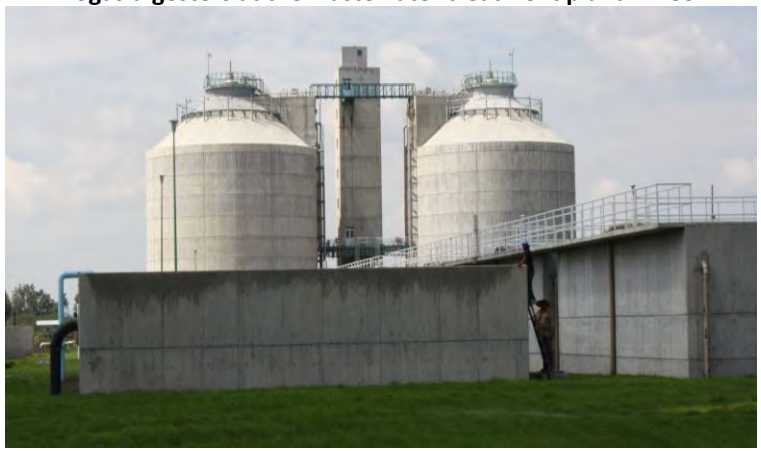
In 2012, wastewater treatment in León amounted to 51.3 million cubic meters, and required 15.2 million kWh of electricity. With an energy consumption of 0.297 kWh per cubic meter of wastewater, the city is in the middle of the TRACE database. León is performing better than Johannesburg, Pune, and Tokyo, but requires more energy to treat one cubic meter of wastewater than Belgrade, Banja Luka or Gaziantep.

Energy density of wastewater treatment – kWh/cubic meter



Perhaps the most noteworthy aspect of the PTAR complex is its capability to produce biogas. Since 2011, methane has been captured and used for electricity generation in the facility. Currently, the energy produced covers 75 percent of the amount needed to operate the plant.

Biogas digesters at the wastewater treatment plant in León



The wastewater treated in León (nearly 19 million cubic meters in 2012) is used for different purposes close to the plant. Approximately 336,000 cubic meters of wastewater were used by the local industry (especially for leather tanning), nearly 120,000 cubic meters to irrigate green areas in the city, while the rest went to farming activities.

Energy Efficiency Recommendations

Following the estimation of the savings potential for each sector and indicator, a sector prioritization was done in TRACE. The most promising three sectors where the local government in León can improve energy efficiency are Street Lighting, Solid Waste, and Municipal Buildings. All priorities identified by TRACE were presented and discussed with local public administration officials in León.

Together with city managers, seven principal recommendations were identified, which are discussed in detail below.

Sector prioritization

City Authority Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	Street Lighting	20.0	11,717,057	1.00	2,343,411
2	Solid Waste	36.1	320,000	0.96	111,070
3	Municipal Buildings	4.8	2,048,992	1.00	98,351

City Wide Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	Private Vehicles	15.0	117,718,366	0.16	2,825,240
2	Potable Water	70.3	12,487,690	0.21	1,844,608
3	Public Transportation	25.0	1,500,000	0.87	326,250
4	Wastewater	37.7	2,173,350	0.21	172,463
5	Power	38.3	0	0.01	0

It should be noted that all of the recommendations made in this section should be seen as indicative. While the TRACE tool enables a quick assessment of key energy efficiency issues within a municipality, it does not allow an in-depth analysis of each intervention and sector. The analysis provides an overview of the savings potential, with examples from other cities worldwide, and to the extent that information is a barrier, the municipality could then take specific energy efficiency actions. The decision to implement a recommendation or not should be done only after a comprehensive feasibility study is completed. At the same time, energy efficiency interventions should not be viewed or conceived in a vacuum, since energy efficiency interventions often have other benefits (and costs) that cut across sectors. For example, interventions that aim to improve the energy efficiency of a municipal building could be done in tandem with measures to make buildings more efficient in their use of water or resilient to natural disasters.

Street Lighting

Street Lighting Audit and Retrofit

One of the principal TRACE recommendations in León is to improve street lighting in the municipality. According to TRACE calculations, an upgrade of the street lighting system would result in up to US$3 million in annual savings, with the potential to reduce electricity consumption by 26 percent. Currently, León needs 54.8 million kWh of electricity to light the streets in the city; after the retrofit process the consumption could be reduced to 40 million kWh.

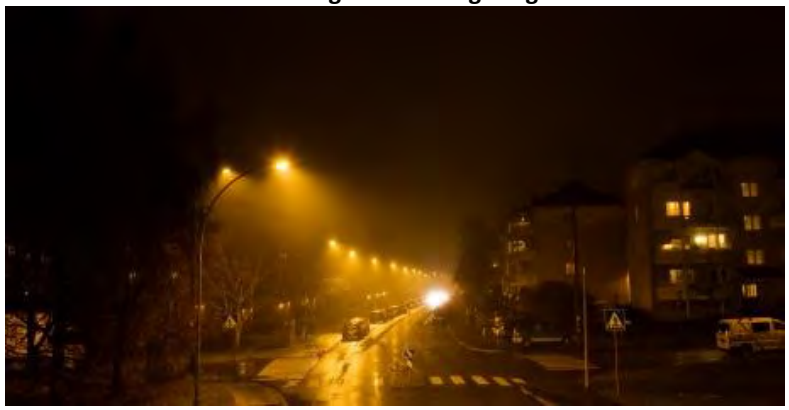
Although the street lighting sector in León is performing fairly well, there are some issues that are challenging the system, such as defining the DAP (the public lighting local tax) calculation formula and the determination of the actual number of light poles. The electricity consumption for one kilometer of street lit and per light pole is fairly high, and there is room to improve in this area. In recent years, the local public administration has replaced old, inefficient bulbs with more efficient sodium vapor lamps, and now the city has taken a further step towards implementing a pilot project with LED bulbs. Before going further, the local public administration in León should consider performing an audit of the lighting system, and subsequently undertake retrofits where appropriate.

The retrofit program could help the city reduce the annual amount of electricity used for public lighting. One of the main advantages of the retrofits is that they can deliver the same lighting levels for lower energy consumption levels, and reduce associated carbon emissions and operational costs. Maintenance costs and service interruptions for energy efficient lights (CFLs and LEDs) have been found to be lower as well, thus improving the efficiency of the system.

If the city decides to self-implement the retrofit program, city authorities would need to bear most of the expenses, such as bulb or fixture replacement, control system upgrade or replacement, and labor for installation. By self-implementing, the city receives all of the financial benefits, but must also finance the program and bear the operational and financial risks. Other ways of handling the retrofit program would be through a joint venture, a long-term concession, or engaging an Energy Service Company (ESCO). By engaging an ESCO, the city can partially or fully avoid the upfront capital costs (depending on the nature of the ESCO contract), as well as eliminate operational risks through a "shared-savings" contract, whereby the city does not have to pay unless the savings are realized. Given that the city does not own the entire street lighting infrastructure, ESCO could be considered only for the lighting poles that belong to the municipality.

A good example of how to approach lighting retrofit is the city of Oslo, where the municipality set up a joint-venture with Hafslund ASA, the largest electricity distributor in Norway. Old fixtures containing PCB and mercury were replaced with high performance high pressure sodium lights and an advanced data communication system using power line transmission that reduces the need for maintenance.

Intelligent street lighting in Oslo



Source: telenor.com

Intelligent communication systems can dim lights when climatic conditions and usage patterns permit. This diminishes energy use and increases the life of the bulb, and reduces maintenance requirements. The system in Oslo is now fully equipped and is being calibrated to sort out some minor problems related to failure of communication units.

León has been exploring the new, highly efficient LED-based technology. The local government is having discussions with SEMERNAT to ger financing to implement a pilot project to replace 613 HPS with LED lamps in 10 km. along the Boulevard Adolfo Lopez Mates, one of León's main avenues. Although it is acknowledged that environmentally friendly LED lamps are more efficient than vapor-sodium bulbs and have small energy consumption, they are also a costly solution that requires large upfront investments. Therefore, local authorities should undertake a rigorous cost-benefit analysis before making this move as to expand LEDs to more lighting poles in the city. At present, due to financial constraints, the LED project in León was put on hold for the time being. In the meantime, the city may consider preparing a procurement guidebook for street lighting that could be used when replacing the lamps.

Best practices worldwide confirm that retrofitting works better when there is a partnership or a joint-venture between the city government and a private entity, such as the case in Los Angeles. Under a partnership between the Clinton Climate Initiative and the municipality, Los Angeles is developing the largest streetlight retrofit program undertaken by any city to date, replacing traditional streetlights with environmentally-friendly LED lights. The project is estimated to reduce CO_2 emissions by 40,500 tons and save US$10 million annually through 40 percent energy savings and reduced maintenance costs.

Street Lighting Timing Program

A second TRACE recommendation focuses on a light timing program that would reduce the light intensity according to the specific needs of a particular area. This is an inexpensive method whereby electricity consumption for street lighting can be diminished substantially. With initial investments of minimum US$ 100,000 the annual electricity

consumption for the public lighting in León could be reduced by at least 200,000 kWh. This program would best be implemented in areas where consumption is metered, and taking into account the experiences and lessons that León has gathered on the topic over the last 10 years. At the same time, the local government is encouraged to expand street lighting to the neighborhoods where there is currently no coverage. At present, only three-quarters of the city streets are lit; expanding overall coverage would be one of the main priorities in the short-medium term.

The light timing program has the advantage of being able to be tailored to the specific needs for lighting in a particular area at a particular time. The level of lighting can be adjusted through a monitoring system, according to varying weather and activity levels. Most light systems have astronomic timers with geographic positioning that allow for adjustments in the light according to the season and time of day. More light is required during the winter season when days are shorter, and less light is needed in the summer when days are brighter and longer. Intensity of the lamps in the city may vary based on demand at a particular time of day. For instance, after midnight, when there are less people and cars out on the street, the light can be diminished automatically from a command center. By dimming the lights gradually, eyes are able to adjust to lower lighting levels, and the dimming is barely noticeable.

LED Street Light Timer

Source: ledoes.com

In addition to León, several cities in the world have turned to street lighting timing programs. An example is the city of Kirklees, U.K., where the municipality chose to dim lights to varying levels throughout the day. The local government installed retrofit systems on each existing light pole and used wireless technology to monitor and dim the street lights. The retrofitting process simply requires adding a small antenna to the lamp heads, which is plugged into the electronic ballast, with no need for additional wiring. The lights are switched on at 100 percent at 7PM, dimmed to 75 percent at 10PM, and then to 50 percent at midnight. If the lights are still on at 5 AM in the morning they are increased again to 100 percent lighting. Light dimming programs are very efficient because they save both energy and money, reduce the brightness of bulbs at times of low road or street usage, and fluctuate bulb brightness at varying times. TRACE made this recommendation in many cities in Eastern Europe where the tool has been recently implemented, and city managers are currently taking steps to put it into practice.

This system could be employed in certain areas in León, such as neighborhoods with reduced pedestrian traffic (such as parking lots). Through a motion-sensor, the light turns on only when someone is walking by, and it stays off when nobody is there. Such automatic lighting systems are implemented in some neighborhoods in Bucharest, Romania along small alleys and paths around residential buildings.

Solid Waste

Fuel Efficient Waste Vehicles Operations

One of the key recommendations made by TRACE to the local authorities in León is to improve efficiency of the overall solid waste management system, and thus reduce related energy consumption. An initial observation is that the City can improve the solid waste collection system by contracting a small number of companies on medium- to long-term contracts. In addition, city managers could develop and enforce new collection practices for waste vehicle drivers in order to help reduce fuel use per ton of waste collected and transported.

This recommendation focuses on improving the management and planning of waste collection and transport, without vehicle fleet replacement or expansion.

Waste truck in León

The benefits include less fuel consumption, lower greenhouse gas emissions, increasing vehicle payloads and reduced number of heavy goods vehicles in residential areas, which would free up resources to increase solid waste collection from additional neighborhoods.

Improving the efficiency of the solid waste vehicle fleet can be done in several ways, such as setting fuel use reduction targets, optimizing the transport routes, and driver training.

For example, the city of Oeiras in Portugal developed US$45,000 project to review the performance of the municipal fleet, including waste collection trucks. The project assessed fuel consumption by vehicle type, set performance indicators (such as kilometers per liter), recommended activities to improve efficiency (e.g., eco-driving training), and evaluated the use of alternative fuels. Based on refueling data and mileage records, the city was able to estimate the total diesel consumption for solid waste trucks and the cost to the city. City authorities plan to use GPS-based technologies to allow for better control of fleet operations. Results indicate that a 10 percent reduction in fossil fuel consumption could be obtained by processing and using existing frying oils in the region into biodiesel, and subsequently use it in some of the waste trucks. The project helped the city of Oeiras to understand how the waste truck system works and identify potential issues regarding its management.

In another example, the city of Trabzon in Turkey managed to optimize waste collection trucks by using a software application to process GPS collected data. The objective was to lower fuel consumption by reducing the distance traveled by 25 percent and the time for collection and hauling-related activities by 44 percent, with an overall 25 percent savings in total expenditure. In some cities in Romania, where solid waste is managed by both private and public sector, trucks are equipped with GPS systems that monitor the collection and transportation process. In Romania, solid waste collection companies must pay a tipping fee at the landfill, and some of the revenues are used to improve the overall solid waste management system, including developing transfer stations and sorting facilities.

Waste truck equipped with GPS system in Timisoara, Romania

Source: opiniatimisoarei.ro

In addition to improving fleet vehicles operations, León is evaluating the building of transfer stations. At present, solid waste trucks must carry the solid waste from the collection points all the way to the landfill, which is located 30 kilometers away from the city. Transfer stations would significantly reduce the time traveled by the waste trucks, decrease fuel consumption, and improve overall efficiency of the system. It is estimated

that transfer stations would allow fuel consumption to be reduced by 2.5 million liters of fuel (94.2 million MJ). This would result in 39 million MJ or 10.8 million kWh in energy savings, which would translate into around US$200,000 in annual savings.

Municipal Buildings

Buildings Benchmarking Program

A common TRACE recommendation is the preparation of a municipal buildings energy database, where all energy-related information can be tracked and monitored. In most cities worldwide, local authorities do not keep reliable records on energy consumption and expenditures related to municipal buildings. Often, the local public administration does not know the actual heat or electricity consumption per square meter and the related expenditure for the given floor area. As such, it is not possible to know if completed energy efficiency investments are effective.

León does not have a reliable database with accurate information on municipal buildings floor area and energy use. In fact, city managers do not keep track of the energy/electricity consumption and expenditures related to municipal buildings.

An energy database is useful not only for keeping a record of energy-related consumption and expenditures for public buildings, but is essential for the implementation of almost any energy efficiency program. Thus, a full audit of municipal buildings in León is warranted. The public buildings benchmarking would require an investment of approximately US$100,000 that would bring potential energy savings between 100,000 kWh and 200,000 kWh per year.

The Municipal Palace in León

Source: panoramio.com

The building benchmarking could be done by a small team of one or two people from the City or external consultants can take responsibility for this task, and various departments should be involved, including the Environment Directorate. The benchmarking would track information on the consumption of electricity, natural gas, and water, in addition to specific data on building construction and renovation, floor area, forms of cooling/heating (if the case), energy bills for recent years, and lighting system modes. With such information, it should be possible to identify the most suitable energy saving options. Publishing the analysis and updating the data on regular basis can enable competition among building managers, and, find ways for a productive exchange of data and collaboration.

This is the first step for a program that may aim to decrease energy expenditures in these buildings. The database is valuable in benchmarking buildings against each other and determining the highest potential in terms of energy savings at the lowest cost. The analysis should identify the most appropriate energy saving options that can be supported by the city.

Municipal Buildings Audit and Retrofit

Once the municipal building benchmarking is prepared, the City can consider an audit and retrofit process. The building audits should show specific energy consumption for end users and activities, such as computers, lighting, air conditioning and heating systems, server rooms and cooling of servers, and appliances (fridges, water coolers). Depending on results, the city government may have to allocate money for energy efficiency upgrades, purchasing of new equipment, and some building renovation.

The retrofit program can be executed in a cost-effective manner, through Energy Service Companies (ESCOs), who will pay for the first cost of the upgrades and will share in the savings from the retrofits. Prior to that, the local government should assign a person within the City or hire someone to be responsible for execution and delivery of energy efficiency projects in municipal office buildings.

According to TRACE calculations, implementation of the municipal buildings audit and retrofit program in León (targeting only local administration offices) could save some 330,000 kWh of electricity per year, as the amount of energy used should go down from nearly 10 million kWh to 9.6 million kWh. In order to further reduce utility bills for municipal buildings, local authorities may consider replacing remaining incandescent bulbs with more efficient fluorescents or LEDs.

Audit and retrofit programs can yield large energy savings. The World Bank helped the city of Kiev in Ukraine audit 1,270 municipal buildings and provided support with the implementation of interventions on both the demand side (automation and control system) and the supply side (metering, tariffs). The project diminished heating consumption 26 percent per year, for a total saving of 387,000 MWh.

The XXX Theatre in León

The city of Stuttgart is saving 7,200 tons of CO_2 every year through an innovative form of internal contracting that is using a revolving fund to finance energy and water-saving measures. The city invests the savings directly into new activities, thus enabling additional environmental improvements and emissions reductions. In other countries, like Romania, a building can be sold or rented provided if has an energy audit certificate and an energy performance certificate, thus, audit and retrofit come along to fulfill this requirement.

Transport

Municipal Vehicle Fleet Efficiency Program

This recommendation suggests that city authorities can improve the fuel efficiency of the municipal vehicle fleet, and thereby reduce fuel consumption and related expenditures. The city has quite a large municipal transport fleet, mostly consisting of police cars that require a large amount of fuel. There is a fleet of around 2,500 vehicles, including 1,700 cars and a few dozen large trucks. In 2012, city data indicates that

the fleet used 7.8 million liters of diesel that cost 78.8 million pesos from the city budget (almost US$6 million).

One way of reducing fuel consumption and related expenditure can be done by setting engine performance standards, such as the Euro standards adopted by many European Union (EU) countries and non-EU states, including China and India. Today, most cars in the EU countries use Euro 4 or 5 standards. The stricter the standards, the more efficient the engine technology and the less fuel consumed.

The city of León could adopt stricter standards with minimum requirements for procurement for all cars within the municipal fleet, including police cars, emergency vehicles, and solid waste collection trucks. Based on a feasibility study, the city authority could determine the most appropriate engine performance standard for the different classes of vehicles. The city could also promote efficient driving trainings to stimulate efficient fuel consumption saving driving behavior to their municipal fleet.

Another way of increasing efficiency of the municipal fleet is by enforcing maintenance standards to be performed weekly, monthly, and yearly. Such standards may include checking the oil, water, engine coolant/antifreeze level, and tire condition once a week; verification of the transmission and brake fluids, windshield wiper blades every month, in addition to reviewing the condition of belts and battery cables. At the same time, car drivers should check the brake system and inspect tires every six months or at every 6,000 miles. Other interventions could include inspection of automatic transmission, changing transmission fluid (at every 15,000 miles), and checking engine timing every 30,000 miles.

Police car in León

Source: unionguanajuato.mx

The city of León could choose a maintenance program that would work best for the local fleet profile, and advertise compliance with the objectives of the maintenance program, in order to lead by example. Subsequently, the program could be extended, on a voluntary basis, to other types of vehicles, such as taxis and buses in the city. León could replicate some of the measures employed successfully by other cities in order to contain pollution and reduce emissions.

In Jakarta two bus companies have initially developed their own maintenance program and internal inspections of their vehicles by checking them for engine malfunctions and excessive smoke, and measuring their exhaust capacity. The program aimed at raising awareness among drivers and technicians with regard to pollution, by training them on how to conduct proper maintenance programs and inspections, and implement fuel saving driving practices. Between 2001 and 2002 more than 13,000 buses were checked, and nearly 1,400 drivers and technicians trained. This initiative achieved 30 percent reduction of diesel soot and 5 percent decrease in fuel consumption. The improved driving methods added another 10 percent decrease in fuel consumption. Later, the inspection program extended to nine bus companies, as the economic benefits of inspections became more evident.

The city of Brașov in Romania is another good example where local authorities figured out how to make public transport more energy efficient by training bus drivers with the result of reducing fuel consumption by 2 percent. The local public transport company has a computer-based system through which they can monitor the daily and monthly diesel consumption, and observe any variation and whether the consumption is going up or down. The company employed a reward system for the bus drivers who achieve a significant diesel reduction. They also offered a salary raise of 10 percent for those drivers who successfully brought down monthly fuel consumption.

Another good example for improving municipal fleet energy efficiency and reducing air pollution is New York City, where hybrid cars replaced fuel-powered police patrols vehicles. The new hybrid car produces between 25 to 30 percent lower greenhouse gas emissions compared to conventional vehicles from fuel savings, and can drive twice the distance per gallon.

Hybrid police car in New York City

Source: mossynissan.com

The City of New York spent approximately $25,000 per vehicle, and the payback period for the capital investment was a little over one year. The City deployed the new hybrid cars in precincts with large coverage areas and those with heavy stop and go traffic, thus maximizing the vehicles' economic and environmental benefits.

Energy Efficiency Strategy and Action Plan

One of the key recommendations made to the public administration in León is the development of an Energy Efficiency Strategy and Action Plan. Many cities around the world have developed energy efficiency (EE) strategies and action plans that help local public administrations set targets and provide them with a set of measures aimed at reducing energy consumption and related expenditures.

The drafting of the plan could be led by the Environment Directorate and implemented within a year. It would result in a series of benefits including reduced carbon emissions, improved air quality, and enhanced public health and safety. The energy action plan should support public employment opportunities and contribute to financial savings.

One of the best examples in this respect is the Covenant of Mayors that brings together thousands of local and regional authorities across Europe to increase the energy efficiency of their municipalities, as well as the use of renewable energy resources. The main target of this movement is to reduce local greenhouse gas emissions (GHG) by 20 percent by 2020 and, thus, make cities more climate-friendly. After the mayor signs the Covenant, within two years the local government must prepare an action plan that translates the political commitments into actions and concrete measures. As of March 2014, there were nearly 5,500 signatories to the Covenant of Mayors, comprising over 182 million people across Europe. More than half of the cities have already prepared their energy action plans.

The energy strategy should put together measurable and realistic targets, set out well-defined timeframes, and clearly assign responsibilities. The plan should outline what actions should be taken to reduce energy consumption and outline the projects that should be implemented to this end. Ideally, the plan should state from the beginning what is the potential energy savings and the amount of GHG emissions that could be reduced in connection to each project, together with the costs incurred, and the timeframe for project implementation. The document could also

mention the people within the local public administration responsible with the monitoring and implementation of the plan. Representatives from across the municipality and from other groups who will be responsible for the execution of the plan, as well as the stakeholders who will be affected by the plan should come together and develop the energy strategy in a collaborative manner.

It is important that the EE plan should monitor carefully the way the city is going to achieve the reduction in emissions mentioned in the plan, in order to ensure that intermediate targets are reached and that progress is made towards overall strategy goals. A monitoring plan together with a host of performance indicators that can be tracked at regular intervals is required.

It is important that targetsindicate the level of expected progress over a given timeline. Monitoring should take into account performance indicators, means of measurement, a schedule for measurement activity, and assignment of responsibilities. The city authority could think about appointing a senior officer to monitor energy usage and efficiency within local public administration departments and public organizations. The collection and management of energy related data should be incorporated of the municipal employees who are responsible for EE initiatives.

A well-designed plan with a set of concrete measures aimed to tackle energy consumption could also help enhance the economic competitiveness of the city and open ways to greater local energy independence. The plan could be a good opportunity to translate various initiatives into a coherent plan for citywide energy efficiency. At the end of the day, the strategy could be an internal and external promotion tool for the city to gain support for future work on EE.

Once city authorities undertake an EE strategy and begin preparation of the action plan, they can begin by focusing on high-priority public service areas, such as municipal buildings, street lighting, and solid waste. The measures taken in each of these sectors should include certain indicators, such as total city energy use, overall savings achieved from EE initiatives, and percentage of energy efficiency initiatives for which data is collected every year. The TRACE indicators offer a good starting point, with a number of energy efficiency key performance areas, such as urban transport, municipal buildings, street lighting, water, solid waste, power, which can be used to monitor the city's energy performance. In addition, other indicators should be introduced in the action plan, such as those with regard to energy efficiency in private buildings and industrial enterprises.

Several cities worldwide have prepared their energy action plans, setting clear targets on how to reduce energy consumption, and the measures that should be implemented to help the municipalities meet such goals. As a signatory of the Covenant of Mayors, the city of Stockholm has prepared an integrated city planning and management plan, with urban vision, environmental programs, and concrete actions to reduce greenhouse gas emissions and tackle climate change. The capital city of Sweden executed the plan in the southern district of Hammarby Sjöstad, which aims to double the goals of Swedish best practices in 1995. The district integrated resource management (such as waste, energy, water, and sewage) through systematic and cyclical stakeholder collaboration. According to the first assessment, the district has achieved between 28 percent to 42 percent reductions in non-renewable energy use, in addition to 29 percent to 37 percent decrease in GHG emissions.

The City of Philadelphia is another good example of best practices where the local public administration implemented a series of measures that helped the municipality to make progress in their goal to reduce energy consumption by 30 percent by 2015. These measures included a wide range of activities from retrofitting municipal buildings, replacing the municipal vehicle fleet, encouraging conservation among employees, switching to LED light-bulbs, developing energy efficiency building guidelines and provide tax incentives to energy efficiency star performers, creating neighborhood competitions to reduce energy use, developing an energy efficiency marketing campaign, and building energy efficient public housing.

ANNEX TRACE LEÓN RECOMMENDATIONS

Detailed Recommendations from TRACE

Improving Energy Efficiency in León, Guanajuato, México

ANNEX 1: STREET LIGHTING AUDIT AND RETROFIT

DESCRIPTION

Traditionally used incandescent bulbs in street lights, are highly inefficient by producing little light and much heat energy from their significant power consumption. They are also often poorly designed and unnecessarily spread light equally in all directions, including the sky above, which further increases their energy inefficiency. New bulb technologies can significantly increase their efficiency as well as extend their design life. The aim of this recommendation is to both assess current lighting efficiency and act to retrofit where appropriate.

Retrofits can deliver the same lighting levels for lower energy consumption levels, reducing associated carbon emissions and reducing operational costs. An increased design life reduces maintenance requirements and costs and also reduces interruptions to service, improving public health and safety.

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum
First Cost
US$100,000-1,000,000
Speed of Implementation
1-2 years
Co-Benefits
Reduced carbon emissions
Enhanced public health & safety
Increased employment opportunities
Financial savings

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Self-implementation	The main expenditures associated with a street lighting retrofit are bulb / fitting replacement, control system upgrade / replacement, and manual labor for installation. These expenses along with consulting fees are funded directly by the city, which means the city accrues all financial benefits, but also bears the financial risks.
Energy Services Company Retrofit	Enlist an ESCo to take on the project. There are multiple tactics for engaging an ESCo, including part- and full-ownership of the system therefore there are varying levels of benefit in terms of risk mitigation, upfront capital cost, and financial savings over the life of the project. The presence of local ESCos will help streamline the process and make the upgrade more feasibly. Similarly, the presence of a local credible and independent Measurement & Verification agency minimizes contractual disputes by providing performance verification. See Akola Street Lighting Case Study for further details.
Supply and Install Contract	A supply and install contract gives the city flexibility to set performance parameters and review contractor performance as part of a phased project. This type of approach will require upfront spending and establishing an appropriate financing

	plan is essential. See City of Los Angeles Case Study for further details.
Long-term Concession	Long-term concessions free the city from financing pressures but will pass on financial savings accrued through energy saving to the body carrying out the upgrade. This strategy can be beneficial for cities without the financial resources to bear the upfront cost and engages an informed stakeholder to inform the process.
Joint Venture	A joint venture allows the city to maintain a significant degree of control over upgrade projects while sharing associated risks with a partner that is experienced in street lighting issues. Joint ventures are effective in situations where both parties stand to benefit from improved energy efficiency and do not have competing interests. See Oslo Case Study for further details.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- $/km - Benchmark annual energy cost on a per liner km basis.
- Lumens / Watt - average efficacy of illumination for the current operational city street lighting inventory.

CASE STUDIES

ESCO street light retrofit, Akola, India Source: Energy Sector Management Assistance Program (ESMAP) (2009). "Good Practices in City Energy Efficiency: Akola Municipal Corporation, India - Performance Contracting for Street Lighting Energy Efficiency" The Akola CA enlisted an ESCO to replace over 11,500 existing street lights (standard fluorescent, mercury vapor, sodium vapor) with efficient T5 fluorescent lamps. The selected contractor financed 100 percent of the investment cost, implemented the project, maintained the newly-installed lights, and received a portion of the verified energy savings to recover its investment. Under the energy savings performance contract, the CA paid the ESCO 95 percent of the verified energy bill savings over the 6-year duration of the contract. AEL was also paid an annual fee for maintaining the lamps and fixtures. Initial investments were estimated at $ 120,000 and the retrofit was completed within a 3-month period. Annual energy savings of 56 percent were achieved, delivering the equivalent of $ 133,000 in cost savings. This gave a very attractive payback period of less than 11 months.
Street light retrofits, Dobrich, Bulgaria

http://www.eu-greenlight.org - Go to "Case Study" In 2000, the City of Dobrich performed a detailed audit of the current state of the entire street lighting system. The results informed a project which commenced the following year which reconstructed and modernized the street lighting system. Mercury bulbs were replaced with high pressure sodium lamps and compact fluorescent lamps. In total, 6,450 new energy efficient lamps were brought into operation. The street lighting control system was also upgraded, as well as two-tariff electric meters installed. The implemented measures delivered an illumination level of 95 percent whilst yielding annual energy savings of 2,819,640 kWh. This saved the CA 91,400 EUR/year.
Street Lighting LED Replacement Program, City of Los Angeles, USA Clinton Climate Initiative, http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/i/cci-la-lighting A partnership beween Clinton Climate Initiative (CCI) and the city of Los Anglese, this project will be the largest streetlight retrofit undertaken by a city to date, replacing traditional streetlights with environmentally friend LED lights. It will reduce CO2 emissions by 40,500 tons and save $10 million annually, through reduced maintenance costs and 40 percent energy savings. The Mayor of Los Angeles and the Bureau of Street Lighting collaborated with CCI's Outdoor Lighting Program to review the latest technology, financing strategies, and public-prive implementation models for LED retrofits. CCI's modelling and technology analysis, as well as its financial advisory, serves as key reference sources for the development of this comprehensive retrofit plan. The phased nature of the project allows the city to re-evaluate its approach on a yearly basis. This gives enviable flexibility to the municipality when selecting contractors and the street lighting systems for upgrade. Los Angeles also capitalized on its government status to attract financial institutions offering favourable loans and funding mechanisms as these institutions were looking to establish positive relationships with the city. Due to these and other factors the City of Los Angeles was able to establish a well-developed business case for the retrofit.
Lighting Retrofit, City of Oslo Clinton Climate Initiative, Climate Leadership Group, C40 Cities http://www.c40cities.org/bestpractices/lighting/oslo_streetlight.jsp The City of Oslo formed a joint-venture with Hafslund ASA, the largest electricity distribution company in Norway. Old fixtures containing PCB and mercury were replaced with high performance high pressure sodium lights and an advanced data communication system using power-line transmission that reduces the need for maintenance. Intelligent communication systems can dim lights when climatic conditions and usage patterns permit. This reduces energy use and increases the life of the bulbs, reducing maintenance requirements. The system is now fully equipped with all its components and is being calibrated to sort out some minor problems related to production failure in communication units. Overall the system has performed well under normal operating conditions.

TOOLS & GUIDANCE

Tools & Guidance
European Lamp Companies Federation. "Saving Energy through Lighting", A procurement guide for efficient lighting, including a chapter on street lighting. http://buybright.elcfed.org/uploads/fmanager/saving_energy_through_lighting_jc.pdf
Responsible Purchasing Network (2009). "Responsible Purchasing Guide LED Signs, Lights and Traffic Signals", A guidance document for maximizing the benefits of retrofitting exit signs, street lights and traffic signals with high efficiency LED bulbs. http://www.seattle.gov/purchasing/pdf/RPNLEDguide.pdf

Tools & Guidance
ESMAP Public Procurement of Energy Efficiency Services - Guide of good procurement practice from around the world. http://www.esmap.org/Public_Procurement_of_Energy_Efficiency_Services.pdf

ANNEX 2: LIGHTING TIMING PROGRAM

DESCRIPTION

Public lighting usually only has two states of operation, i.e. 'on' and 'off', and only switches between these states in the early evening and early morning. The demand for lighting varies significantly throughout the day, however, with periods of very little use of public space during the middle of the night. A program with strategic timing and/or dimming tailored to the specific needs for lighting in specific areas can significantly reduce energy consumption whilst still delivering appropriate levels of lighting for e.g. providing safety and sense of security in public areas. An intelligent monitoring system can be used to adapt the levels of lighting according to varying weather and activity levels. The aim of this recommendation is to identify public space usage patterns and adjust the lighting system levels accordingly. Often lighting timing programs are integral to a full audit and retrofit program, but for cities that already have energy efficient public lighting systems, a lighting timing program may still be a small and effective program.

Lighting timing programs can reduce energy consumption, and subsequent carbon emissions as well as operational costs. Such programs often also increase the design life of light bulbs, reducing maintenance requirements and associated costs. The use of intelligent monitoring systems also enables quick detection of faults, allowing for quick replacement, enhancing the quality of the public lighting service.

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum
First Cost
< US$100,000
Speed of Implementation
< 1 year
Co-Benefits
Reduced carbon emissions
Enhanced public health & safety
Increased employment opportunities
Financial savings

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Study illumination timing alternatives	Prepare a study to estimate the types of streets and luminaires that have the opportunity to have reduced timing and dimming during late night hours.
Install timers and dimmers on existing street lights	Allocate funding to implement upgrades and retrofits for dimming and timing opportunities. Roll out upgrades over the course of multiple years to achieve 100 percent coverage of all city public lighting and street lighting installations. See Kirklees and Oslo case studies for further details.
Standards for new lighting	Set up timing and dimming standards for new installations of public illumination and street lighting that confirm to global best practice for energy efficiency and IESNA illumination guidelines.
Monitor and publish energy savings	Measure on an annual basis the energy savings achieved by this program and encourage private sector owners to follow the model of the CA.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- Hours per year street lights are illuminated at maximum output;
- Hours per year street lights are illuminated at less than 50 percent of maximum output.

CASE STUDIES

Control system for public lighting, Kirklees, UK

http://www.kirklees.gov.uk/community/environment/green/greencouncil/LightingStoryboard.pdf

Instead of switching off street lights at certain times of the day, as has been done by other CAs, the Kirklees CA decided instead to dim lights to varying levels throughout the day. This was done partly because not switching public lighting off completely during times of low activity would provide increased safety in the community by preventing crime. Retrofit systems were installed on each existing lighting pole which used wireless technology to monitor and dim the street lights. The retrofitting of these systems simply required the addition of a small antenna to the lamp heads, which plugged into the electronic ballast with no need for additional wiring. Generally the lights are switched on 100 percent at 7pm, thereafter dimmed to 75 percent at 10pm, and then to 50 percent at midnight. If the lights are still on at 5am, they are increased again to 100 percent lighting. By dimming the lights gradually, eyes are able to adjust to lower lighting levels, and the dimming is barely noticeable. The remote monitoring system also provides accurate inventory information and enables street lighting engineers to identify failed lamps quickly and easily. This reduces the need for lighting engineers to carry out night scouting and has also reduced other on-site maintenance costs. A dimming of lights as implemented in Kirklees can save up to 30 percent of the electricity used annually. By replacing 1,200 lights, Kirklees CA estimates savings of approx $ 3 million in energy costs per year.

Intelligent outdoor city lighting system, Oslo, Norway

http://www.echelon.com/solutions/unique/appstories/oslo.pdf

An intelligent outdoor lighting system has replaced PCB and mercury containing fixtures with high-performance high-pressure sodium lights. These are monitored and controlled via an advanced data communication system which operates over the existing 230V power lines using specialist power line technology. An operations centre remotely monitors and logs the energy use of streetlights and their running time. It collects information from traffic and weather sensors, and uses an internal astronomical clock to calculate the availability of natural light from the sun and moon. This data is then used to automatically dim some or all of the streetlights. Controlling light levels in this way has not only saved significant amount of energy (estimated at 62 percent), but has also extended lamp life, thereby reducing replacement costs. The CA has been able to use the monitoring system to identify lamp failures, often fixing them before being notified by residents. By being able to provide predictive failure analyses based on a comparison of actual running hours versus expected lamp life, the efficiency of repair crews has been increased. 10,000 replacements have cost the CA approx. $ 12 million.

Currently the program saves approximate $ 450,000 in running costs per year. However, it is estimated that if the program is rolled out to the entire city, the increased economies of scale will yield a payback period of less than five years.
Motorway intelligent lights retrofit, Kuala Lumpur, Malaysia http://www.lighting.philips.com.my/v2/knowledge/case_studies-detail.jsp?id=159544 The project implemented a lighting solution for highways leading to Kuala Lumpur International Airport. The total length of the dual carriage highway covers 66 km. The main requirement for the project was that each individual lamp along the entire 66 km stretch of highway should be independently dimmable. This called for a network linking all 3,300 positions to a central control facility. There was also a need for greater maintenance efficiency while ensuring optimal visibility without compromising on visual comfort on the road. An intelligent lighting system that uses tele-management control was employed. Tele-management makes it possible to switch or control every individual light point in the system from a central PC. It also enables specific dimming profiles adjusted to suit conditions on the road for different lamps, instant reception of failure messages, and the creation of a database where all system data is stored. It allows a significant reduction in energy consumption in addition to the 45 percent savings as a result of the use of dimming circuits.

TOOLS & GUIDANCE

Tools & Guidance
N/A

ANNEX 3: FUEL EFFICIENT WASTE VEHICLE OPERATIONS

DESCRIPTION

Improving the working practices of waste vehicles and their crews can reduce fuel use per ton of waste collected and transported. An assessment of current waste collection systems will be required to identify what alterations can be made. Upgrades can include improvements to driver training, route planning and/or management of service.

This recommendation offers the potential for affordable but reasonable energy use improvements without the need for vehicle fleet replacement or expansion, as options for improvement can be made via softer actions such as better management and planning.

Direct benefits include reduced fuel use, better productivity leading to increased vehicle payloads and reduced numbers of heavy goods vehicles in residential areas, and release of resources to collect more or segregated waste from larger or additional areas.

Indirect benefits include reduced accident rates and lower air emissions.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Set fuel use reduction targets for waste collection and transportation fleets	The city authority sets targets for fuel-efficiency of waste collection and transfer operations. Defining targets over 5-year periods is an effective approach; for example, reduce fuel use per ton of waste by 20 percent in 5 years. The city authority can appoint a Fleet Manager or a Maintenance Manager to measure fuel use, total waste collection quantity per year and distance travelled in order to set a baseline KPI for fuel-efficiency of operations. This should be completed for individual vehicles and the entire fleet. This system can be established internally and used in conjunction with the "Waste Vehicle Fleet Maintenance Audit and Retrofit" recommendation. See Oeiras case study for further details.

ATTRIBUTES

Energy Savings Potential
>200,000 kWh/annum

First Cost
< US$100,000

Speed of Implementation
< 1 year

Co-Benefits
Reduced carbon emissions
Improved air quality
Enhanced public health & safety
Increased employment opportunities
Financial savings
Improved working conditions
Reduced waste vehicle traffic

Route selection optimization	Encourage waste operators to appoint resource or utilize in-house capability to plot out and digitize all collection points and routes on a map base. This is best done using a Geographic Information System (GIS) and it is important to seek route optimization improvements, for example, ensure all waste vehicles are full at disposal points, eliminate vehicle backtracks and minimize long distance haulage of waste in small vehicles. Consider alternative modes of transport such as via waterways to save energy and reduce heavy traffic on roads. The city fleet manager should regularly review routes with operators to ensure best use of resources. See Trabzon, Daventry, Oeiras and Paris case studies for further details.
Continued driver training and improvement	The city authority requires waste operators to provide a driver training and improvement program in conjunction with the human resources team and fleet manager. A staff training team can be employed to create and manage an accredited training program after an initial assessment. The city authority might also appoint a third party to install vehicle trackers and monitor all drivers following staff training. In addition, encourage operators to incentivize good driving where possible, for example, by providing drivers with a share in fuel costs saved. This implementation activity works well with educating operators about the benefits of efficient operations. See General Santos City and Oeiras case studies for further details.
Inform operators about the advantages of fuel-efficient operations	The city authority raises awareness amongst operators about the benefits of fuel-efficient operations. This can be done by one-to-one sessions or arranging a conference for key players in waste sector showcasing the energy and cost-savings from efficient operations including eco-driving, correct operation of vehicles, route optimisation, bulk transfer stations, etc. Set up a website or have an officer available to provide more information and advice after the event. See Maribor and General Santos City case studies for further details.

Incentives: charging	The city authority levies a surcharge on waste, for example a gate fee or eco-taxes for waste disposed at landfills. This is used to generate revenue and direct to new infrastructure improvements and waste monitoring/policing department. This implementation activity might also be used to encourage fleet operators to ensure that vehicle movements to landfills are kept to operationally efficient levels. See Paris and Italian Local Authorities' Waste Management case study for further details.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- Fuel use per ton of waste collected and transferred and per km travelled
- Improvement in fuel use per ton of waste collected and transferred

Measure current performance utilizing data from Maintenance Department, where is feasible. If this information is not readily available, it is advisable to measure current fleet performance over a reasonable period, for example, annual reviews over 5 years.

Produce monthly management targets and schedules to help identify how the program is performing and the magnitude of effort that will be required to achieve initially set KPI.

CASE STUDIES

Energy Study on Oeiras' Municipal Fleet, Oeiras, Portugal

ManagEnergy 2010 "Good Practice Case Study: Energy Study on Oeiras' Municipal Fleet, Portugal" http://www.managenergy.net/download/nr263.pdf

The Municipality of Oeiras (CMO) worked in partnership with the Technical University of Lisbon (IST) on a project to carry out a review of the current performance of the municipal fleet, which included waste collection trucks. The objectives were to assess the fuel consumption by vehicle type, establish performance indicators (km/L), propose simple measures to improve efficiency (eco-driving training), study the potential of implementing alternative fuels (biodiesel and natural gas), and perform an environmental assessment. In the absence of complete data, the project used refueling data and mileage records to estimate the total fuel consumption of waste collection trucks and its impact on the municipality's budget. A more advanced fleet management system was planned for the later phases, utilizing technologies supported by GPS to allow for better control over fleet operations and improve the data available. The total project costs amounted to US$ 45,384, fully supported by the Municipality.

By the end of 2006, the project allowed OEINERGE (the project coordinator) to estimate that simply by processing the existing used frying oils in the County into biodiesel and using it to fuel some of the fleet's waste trucks, a reduction of approximately 10percent in fossil fuel consumption could be achieved. In addition to allowing the municipality to understand the full functionality of the waste vehicle fleet and helping identify the potential problems in its management, the project has an important role for best practice dissemination, emphasizing the importance of accurate data recording and monitoring to introduce fuel and cost savings.

Route Optimization for Solid Waste Collection, Trabzon City, Turkey

Global NEST 2007 "Route Optimization for Solid Waste Collection: Trabzon (Turkey) Case Study" http://www.gnest.org/Journal/Vol9_No1/6-11_APAYDIN_388_9-1.pdf

As part of the municipal solid waste management system, a study was undertaken to determine whether waste collection costs could be decreased through route optimization in Trabzon. Data related to present spending, truck type and capacity, solid waste production, number of inhabitants and GPS receiver data for each route were collected and recorded (using GIS software) over 777 container location points. The solid waste collection/hauling processes were optimized using a shortest path model with "Route View Pro" software. The optimization process produced fuel savings of 24.7 percent in distance and 44.3 percent in time for collection and hauling. The improvements also provided savings of 24.7 percent in total expenditure

MasterMap Integrated Transport Study, Daventry, United Kingdom

Ordinance Survey 2010 "Optimizing waste collection using OS MasterMap Integrated Transport Network Layer Case study" http://www.ordnancesurvey.co.uk/oswebsite/products/osmastermap/layers/Docs/DAVENTRY.pdf

Daventry local authority worked with the Northamptonshire Waste Partnership (NWP) to rationalize the number of domestic waste collection routes from nine to eight, reducing diesel costs by 12 percent and increasing spare capacity by 14 percent without increasing labor hours. The project was carried out by an external environmental advisory and management company using the OS MasterMap Integrated Transport Network (ITN) Layer with Road Routing Information (RRI) - which includes detailed road routing and drive information such as width, height and weight restrictions, taking account of delays from left and right turns and intersections. This allowed each waste vehicle route to be optimized by balancing the workload between routes on a daily or on a weekly basis.

The system enabled optimization of existing waste collection procedures, resulting in increased spare capacity which could be retained for areas of new housing growth, in turn reducing the need for new routes. The project produced savings of over US$ 154,136 per annum for Daventry alone (not

including savings by neighboring local authorities). Since the project was funded by procuring regional public funds, the overall savings are identified to be greatly in excess of the sum of the contract value and authority time.

Eco-Driving Project, Maribor, Slovenia

Recodrive 2009 Press Release, "Eco-driving leads to fuel savings in waste management in Maribor, Slovenia" http://www.recodrive.eu/index.phtml?id=1039&study_id=2596

Maribor's public waste collection, management and transport company (Snaga) conducted a comprehensive 3 month training program for drivers to implement and test eco-driving. Carried out as part of the EU-wide "Rewarding and Recognition schemes for Energy Conserving Driving, Vehicle procurement and maintenance" (RECODRIVE) project, the program achieved an average 4.27 percent reduction in fuel consumption over 8 months. The savings in fuel costs were used to provide wage bonuses to fuel-efficient drivers. In addition, by making additional changes in their optimized routing plan, Snaga is able to collect the same amount of waste in the same area using one less vehicle.

The RECODRIVE project also constitutes information dissemination to achieve fuel savings beyond 10 percent in municipal fleets across Europe. Participating fleet owners further the RECODRIVE concept by inviting other fleet owners to hands-on workshops and conferences on eco-driving and fuel-efficient vehicle operations. Despite being an EU-wide scheme, RECODRIVE's knowledge hub (internet-based information dissemination) could be applied on a city-wide scale to achieve fuel efficient-operations amongst municipal waste management operators.

Garbage Collection Efficiency Project, General Santos City, Philippines

USAID "Introducing Measures To Improve Garbage Collection Efficiency" http://pdf.usaid.gov/pdf_docs/PNADB349.pdf

USAID "Moving Towards an Integrated Approach to Solid Waste Management" http://pdf.usaid.gov/pdf_docs/PNADB344.pdf

General Santos City Solid Waste Management Council organized a series of hands-on workshops to formulate ways of improving efficiency of the current collection system and management of dumpsite operations. Formerly, waste collection was concentrated only in the CBD with no regular routing or collection schedule. With the help of various stakeholders, the city formulated new collection schedules and routes and identified pre- and post-collection intervention strategies for the community. Routes were modified to reduce the number of left turns and U-turns taken by the trucks to increase speed of collection and reduce accidents. The number of staff per compactor truck was reduced from five to a maximum of three people, and waste collection trips were reduced from six trips to two-three trips per day. The enhanced collection efficiency allowed coverage of a wider area without increasing the number of trips, accelerated waste collection and provided more time for vehicle maintenance and crew rest. High levels of community representation and coordination of working groups were very important to producing more efficient solutions to the current collection system.

The above improvements were complemented by simultaneous campaigns for segregation and recycling. The city government also improved management of the dumpsite while a new landfill is being prepared.

Isseane EfW and Materials Recycling Facility, Paris, France

The Chartered Institution of Waste Management "Delivering key waste management infrastructure: lessons learned from Europe" http://www.wasteawareness.org/mediastore/FILES/12134.pdf

The Associate Parliamentary Sustainable Research Group, "Waste Management Infrastructure: Incentivizing Community Buy-in" http://www.policyconnect.org.uk

In 2008, the Isseane EfW (Energy from Waste) and Materials Recycling Facility was opened on the banks of the Seine by SYCTOM (Intercommunal

Syndicate for Treatment of Municipal Waste) to replace an existing incinerator that had been in operation for over 40 years. The project was approved by the municipal council of Issy-les-Moulineaux in July 2000 with a total investment cost of US$ 686 million, which will be financed over a seven year period by a type of prudential borrowing, based upon gate fee revenues from the communes. Isseane is conceived on a proximity principle so that waste travels no more than six miles to be treated. The design of the facility also takes traffic movements into careful consideration. Waste deliveries taking place below ground level to control dust, noise and odor levels. The location of the facility makes use of the river Seine, with barges taking away inert bottom ash from the incineration process for use in ancillary projects.
Local Authorities' Waste Management, Italy The Chartered Institution of Waste Management "Delivering key waste management infrastructure: lessons learned from Europe" http://www.wasteawareness.org/mediastore/FILES/12134.pdf Waste services in Italy are delivered through public bodies known as 'ATOs' which are funded directly by local authorities, responsible for defining the services required managing local authority waste streams. New waste management infrastructure is often funded directly from the local authorities' own resources, although for large facilities there may also be some private finance, in effect through a form of prudential borrowing. In some cases waste facilities or services may be procured through a tendering process from private sector waste management companies, with contracts in place either directly with a local authority or the relevant ATO. An ATO can also fund a waste infrastructure project either in part or completely, through the use of eco-taxes. The CONAI scheme, for example, raises US$ 324million annually from an eco-tax on all packaging that sets aside funds for new waste infrastructure.

TOOLS & GUIDANCE

Tools & Guidance
"Integrated Toolbox for fleet operators" http://www.fleat-eu.org/downloads/fleat_wp3_d32_toolbox_updated.pdf
"Policy mix for energy efficient fleet management" http://www.fleat-eu.org/downloads/fleat_wp3_d33_policymix_final.pdf
RECODRIVE online knowledge hub http://www.recodrive.eu/window.phtml?id=1008&folder_id=38

ANNEX 4: MUNICIPAL BUILDING BENCHMARKING PROGRAM

DESCRIPTION

Develop a municipal buildings energy benchmarking program which collects and reports on an annual basis the energy use, energy bills, water use, water bills, floor areas, and names of building facility managers (if any). The goal of the program is to identify the highest energy intensive buildings in the CA portfolio so as to focus on the best energy efficiency opportunities.

The benefits of the program are to use energy efficiency program resources most effectively and to spend time and money on the easy wins first. The program will also establish annual data for use in energy/carbon footprint for municipal operations.

This recommendation is best-suited to larger cities with the size and capacity to implement such a program. Regular monitoring and analysis of building energy consumption and identifying improvement opportunities is a good starting point for most cities. However, setting a proper benchmark requires detailed analysis because similar buildings can have significantly varying underlying factors, for example, types of tenants, occupancy density (people per square meter).

ATTRIBUTES

Energy Savings Potential
100,000-200,000 kWh/annum

First Cost
< US$100,000

Speed of Implementation
1-2 years

Co-Benefits
Reduced carbon emissions
Efficient water use
Improved air quality
Financial savings

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Appoint Benchmarking Leader	Appoint, or allocate 1-2 staff with the skills, experience and personality required to be able to gather a wide variety of data from many departments across the city administration. Alternatively hire an external consultant as a leader for the below activities.
Identify Benchmarking Requirements	Define essential and desirable information useful for an energy benchmarking database. Electricity bills are only one part of the benchmarking database, and many other key data points are required to contextualize the information. Data may include: • building name and address • electrical, gas, water utility account numbers • electrical, gas, water utility bills for past 3 years • building floor areas • energy and water meter locations and associated floor areas

	• date constructed and date of major renovation • building facilities manager (if any) • building heating, cooling, lighting system types
Set data collection strategy	Set up an efficient process to collect data for the database. Identify which department and which individuals are likely to have access to desired information. Define which data should be collected every year and set up a method to receive the data every year. Set up a method to check and verify data and allow time for validation. Some data may not exist in CA departments, and if so, primary data must be collected by Benchmarking Team (i.e. floor areas, areas allocated to meters).
Begin collecting data	Appoint junior staff to begin the arduous process of requesting data, receiving data, checking data, and collecting primary data from the source. Alternatively write an RFP and award a contract with a specific scope of work to gather energy benchmarking data for all municipal buildings. Data can be stored in spreadsheets or dedicated energy software tools. Care should be taken to ensure quality checks are undertaken at a detailed level to ensure accuracy of data entry.
Analyze and Interpret Data	Conduct an analysis of collected data to ensure accuracy and begin to identify opportunities. Some examples of analysis include: • compare kWh/m2/yr electricity consumption by building type • compare kWh/m2/yr heating energy by building type • compare total $/m2/yr energy consumption by building type Starting with buildings with the highest and lowest performance, verify the floor areas allocated to the utility meters and note any special situations which may increase or decrease energy use (server rooms, unoccupied space, renovations, etc.)
Formulate a Bespoke Benchmark	The results of the analysis stage must be used to formulate a benchmark suitable for the underlying factors affecting energy use in the city. This is required as these factors may vary significantly from city to city and between different buildings. These factors could include: • types of tenants • occupancy density (persons/m2) • building energy management This benchmarking is usually done for the purposes of building labeling. See

	Singapore case study for further details.
Present Benchmarking Internally	One of the most significant motivators for energy efficiency in building operations is peer pressure as no building owners or operators want to be seen as having the worst performing buildings. So sharing building energy intensity internally across departments and operators will inherently improve energy consumption. This will also allow operators to share experiences to allow knowledge sharing across the CA.
Publish Benchmarking Publically	The boldest statement to show leadership in building energy efficiency is to publish energy performance data to the public, press, voters, and potential political opponents. This last stage of the benchmarking program may be many years after the commencement of the program when the data shows improvements and tells a good story of progress toward efficiency in government operations. The CA could then challenge (or require as some cities have begun to do) private building owners to benchmark their buildings and publish their results.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- kWhe/m2 - annual electrical energy intensity by type of building (Schools, Offices, Residential, Hospital, Misc);
- kWht/m2 - annual heating energy intensity by type of building;
- $/m2 - annual energy cost intensity by type of building.

CASE STUDIES

Energy Efficiency in Public Buildings, Kiev, Ukraine

Source: ESMAP (2010). "Good Practices in City Energy Efficiency: Kiev, Ukraine - Energy Efficiency in Public Buildings", available online from http://www.esmap.org/esmap/node/656

Under the Kiev Public Buildings Energy Efficiency Project, 1,270 public buildings in the city of Kiev--including healthcare, educational and cultural facilities—were retrofitted with cost-effective, energy-efficiency systems and equipment. The project focused on the supply-side, such as automation

and control systems, and demand-side measures, including installation of metering and weatherization, as well as a sound heating tariff policy. The project was undertaken by the Kiev City State Administration (KCSA). Savings from the retrofitting were estimated at 333,423 Gigacalories (Gcal)/year by 2006--normalized by degree/days in the base-line year--or about a 26 percent savings compared to the buildings' heat consumption before the project. These upgrades also improved the buildings' comfort level, helped foster an energy efficiency services industry, and raised public awareness of the importance of energy efficiency.
The project cost US$27.4 million and was financed through a World Bank loan, Swedish Government grant, and KCSA funds. Based on the project's success, many other cities in Ukraine have requested information on the project and expressed interest in implementing similar ones for their public buildings.

Building Energy Efficiency Master Plan (BEEMP), Singapore
http://www.esu.com.sg/pdf/research6_greece/Methodology_of_Building_Energy_Performance_Benchmarking.pdf
http://www.bdg.nus.edu.sg/BuildingEnergy/energy_masterplan/index.html
The Inter-Agency Committee on Energy Efficiency (IACEE) report identified strategic directions to improve the energy efficiency of the buildings, industries and transport sectors. The Building Energy Efficiency Master Plan (BEEMP), formulated by the Building & Construction Authority (BCA), details the various initiatives taken by the BCA to fulfill these recommendations. The plan contains program and measures that span the whole life cycle of a building. It begins with a set of energy efficiency standards to ensure buildings are designed right from the start and continues with a program of energy management to ensure their operating efficiency is maintained throughout their life span. The BEEMP consists of the following programs:

- Review and update of energy standards
- Energy audit of selected buildings
- Energy efficiency indices (EEI) and performance benchmark
- Energy management of public buildings
- Performance contracting
- Research and development

Energy Smart Building Labeling Programme, Singapore
http://www.e2singapore.gov.sg/buildings/energysmart-building-label.html
The Energy Smart Building Labeling Programme, developed by the Energy Sustainability Unit (ESU) of the National University of Singapore (NUS) and the National Environment Agency (NEA), aims to promote energy efficiency and conservation in the buildings sector by according recognition to energy efficient buildings. The Energy Smart Tool is an online benchmarking system that can be used to evaluate the energy performances of office and hotel buildings. It enables building owners to review the energy consumption patterns within their buildings and compare them against the industry norms. An Energy Smart Building Label, reviewed every three years, is awarded to winners as part of an annual awards ceremony.
Apart from helping to reduce energy consumption and carbon emissions within the buildings sector, Energy Smart Buildings stand to:

- Reap energy savings due to active energy management
- Enjoy higher satisfaction levels by occupants
- Enhance the company's corporate image

Municipal Energy Efficiency Network, Bulgaria

http://www.munee.org/files/MEEIS.pdf

Thirty-Five Bulgarian cities have established the Municipal Energy Efficiency Network (MEEN). EnEffect is the Secretariat of the Network. Since April 2001, MEEN has admitted four municipal associations as collective members. In order to create a successful municipal energy plan, MEEN promotes the development of two key elements: an energy database and a training program for municipal officials.

General information is collected into municipal "Passports". This information is gathered through surveys of various organizations and entered into a database, or energy efficiency information system (EEIS). The EEIS has two layers: database and analysis. The database, a Microsoft Access application, contains objective, technical information, and the analysis contains non-technical information, such as financial, institutional and regulatory documents generated at the national level. This information is organized into three categories: municipality-wide consumption, site-specific consumption, and municipality-wide production.

Energy Management Systems in Public Building, Lviv, Ukraine

Source: ESMAP (2011). "Good Practices in City Energy Efficiency: Lviv, Ukraine - Energy Management Systems in Public Buildings", available online from http://www.esmap.org/esmap/sites/esmap.org/files/Lviv%20Buildings%20Case%20final%20edited%20042611_0.pdf

The Ukrainian city of Lviv was able to reduce annual energy consumption in its public buildings by about 10 percent and tap water consumption by about 12 percent through a Monitoring and Targeting (M&T) program to control energy and water consumption. This generated an estimated net savings of 9.5 million UAH (US$1.2 million) as of 2010. The M&T program was launched in December 2006 and became fully operational by May 2007. It provided the city management with monthly consumption data for district heating, natural gas, electricity and water in all of the city's 530 public buildings. Under the program, utility use is reported and analyzed monthly; targets for monthly utility consumption are determined annually based on historical consumption and negotiations on an adjustment (in cases of foreseeable changes in consumption patterns). Actual consumption is reviewed monthly against the target, with deviations spotted and acted upon immediately and the performance of buildings is communicated to the public through a display campaign.

The M&T program achieved significant savings with minimal investment and recurring program costs. These utility bill reductions have been valuable in light of fiscal constraints and increasing energy prices. The program benefited from a crucial initial condition where most of the city's public buildings were already metered for energy and water consumption and that the city had been collaborating with international aid programs in municipal energy since the late 1990s.

Strong city government leadership and commitment were key success factors of Lviv's public buildings energy and water M&T program. A new Energy Management Unit (EMU) was established within the city administration and resources were mobilized to train all personnel with line responsibility on building utility use in an administrative division, unit, or building. The M&T system established responsibility, created transparency, and enabled informed control of energy and water use in public buildings, laying a solid foundation for sustained improvements in energy and water efficiency.

Public Building Energy Management Program, Lviv, Ukraine

http://www.ecobuild-project.org/docs/ws2-kopets.pdf

As part of the Energy Efficiency Cities of Ukraine initiative, launched in 2007 as initiative of 4 cities, supported by MHME, NAER and European Association of local authorities "Energie-Cites", Lviv has promoted sustainable energy policy and action plans at a local level.

The city has developed a Public Building Energy Management Program through the Energy Efficiency Cities of Ukraine initiative. These involve regular data gathering through various agencies and a subsequent monitoring and analysis of building energy consumption in order to identify easily achievable improvement opportunities.

SMEU Software, Romania
http://www.munee.org/files/SMEU-romania.pdf
The SMEU software was created to set priorities for municipal energy action plans and to assess global energy costs and consumption. The goal of this software is to gather, organize and use energy data so that decision-makers could analyze trends in energy use by consumers and by resources and accurately predict the energy budget for the following period.
The SMEU software divides data into individual and interacting modules to collect data on various aspects of the energy cycle. The Locality Module collects information on an annual basis, including area, population, and average temperature, as well as general information on the municipality such as number of buildings and number of dwellings per building.

NYC Greener Buildings, USA
http://council.nyc.gov/html/releases/prestated_4_22_09.shtml
New York City Municipal Buildings were benchmarked for Energy Efficiency. The project, initiated on December 9, 2009 with the passage of the "Greener, Greater Buildings Plan" (formally known as Intro. No. 476-A, Benchmarking Energy and Water Use), puts the city at the head of a national effort to improve building energy efficiency aimed at reducing America's carbon footprint and its use of highly pollutive fossil fuels to generate electricity.
The project used the U.S. Environmental Agency's (EPA's) Energy Star Portfolio Manager energy management tool, which is integral to the LEED (Leadership in Energy and Environmental Design) certification process, as established and managed by the U.S. Green Building Council, or USGBC.
The Plan aims to reduce the city's total carbon footprint by 30 percent by 2030 (originally 2017), with five percent of that reduction coming from government, commercial and residential building. After the initial phase is completed, building owners will be required to benchmark yearly.

TOOLS & GUIDANCE

Tools & Guidance
Target Finder helps users establish an energy performance target for design projects and major building renovations. http://www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder
Portfolio Manager is an interactive energy management tool to track and assess energy and water consumption across the entire portfolio of buildings. http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
A presentation by Berlin Energy Agency on Berlin's Energy Saving Partnership - "a Model of Success" , June 29th, 2010. http://siteresources.worldbank.org/INTRUSSIANFEDERATION/Resources/305499-1280310219472/CArce_BEA_ENG.pdf

ANNEX 5: MUNICIPAL BUILDINGS AUDIT AND RETROFIT PROGRAM

DESCRIPTION

Develop an audit and retrofit program focused on all Offices to survey and implement opportunities for energy efficiency retrofits and upgrades. The benefits of the program will be cost savings for municipal government offices and reduction in carbon footprint of the CA. The program will identify immediate savings opportunities, and implement rapid payback items to yield cost savings that can go to other municipal services.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Identify Offices Program Leader	Identify a CA staff position or hire a new position to be responsible for execution and delivery of energy efficiency projects in municipal office buildings. This individual must be able to work across agencies, understand building systems and manage subcontractors.
Identify Preliminary Opportunities	Using results from the Benchmarking Program or data collected on office buildings by Office Program staff, identify preliminary opportunities for energy efficiency such as: new lighting systems, new air conditioning systems, new heating systems, new computers, server cooling opportunities, etc. Offices buildings can be more complex buildings and can have a high variety of system types, for example some may have simple window A/C (or no A/C) and others may have larger central A/C systems with chillers, cooling towers, air handlers and ductwork.
Perform Detailed Energy Audits	Walk through a variety of office buildings to identify specific energy efficiency opportunities across the following end-uses and activities: • lighting systems • air conditioning systems

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum

First Cost
> US$1,000,000

Speed of Implementation
1-2 years

Co-Benefits
Reduced carbon emissions
Improved air quality
Enhanced public health & safety
Increased employment opportunities
Financial savings

	• heating systems • computers • server rooms and cooling of servers • appliances (water cooler, fridge, vending machines) The Municipal Offices EE Spreadsheet includes estimation methods for energy efficiency potential for offices which includes equipment retrofits, behavioral changes (turning lights off, heating set points, time of operation, etc.) and procurement guidelines.
Set Budget and Requirements	Allocate budgets for energy efficiency upgrades in municipal office buildings. Combining upgrades with natural building renovations tends to be the best use of limited financing. For example if a new roof is required due to leaks, this is a good time to add insulation and white roof; or if new windows are being installed they could be upgraded to highly insulated windows using Office Building Energy Efficiency Program funds. Alternatively contracts may be set up with Energy Service Companies (ESCOs) who will pay for the first cost of the upgrades and will share in the savings from the retrofits.
Design Retrofits / Upgrades	Considering the benchmarking data, detailed energy audits and budgetary constraints, design retrofits, equipment replacement and renovation upgrades specifically for each building.
Hire Contractor to Implement Retrofits	Prepare an RFP for mechanical or electrical contractors to bid on the retrofit projects. Combining a large number of similar retrofits across dozens of office buildings will allow the CA to obtain economies of scale and quality assurance with lower overheads. Alternatively prepare a RFP and award an energy service contract to a private company (ESCO) who will guarantee energy savings, put forward the initial investment, and share future savings with the CA.
Verify Retrofit and Performance	Walk through and verify each construction project has been performed per the specifications in the energy efficiency retrofit RFP. Continue to collect electricity and heating bills for each building with improved systems and compare to historical data.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.
Some suggested measures that relate specifically to this recommendation are as follows:

- $/m2 - Benchmark annual energy cost on a per-square-meter basis for all municipal office buildings;
- kWhe/m2 - Benchmark annual electrical energy consumption on a per-square-meter basis for all municipal office buildings;
- kWht/m2 - Benchmark annual heating energy consumption on a per-square-meter basis for all municipal office buildings;
- $/yr saved - aggregate total energy savings generated through the life of the program.

CASE STUDIES

Model for Improving Energy Efficiency in Buildings, Berlin, Germany http://www.c40cities.org/bestpractices/buildings/berlin_efficiency.jsp The City of Berlin in partnership with Berlin Energy Agency (BEA) has pioneered an excellent model for improving energy efficiency in buildings. They project manage the retrofit of public and private buildings, preparing tenders for work that will guarantee reductions in emissions. CO_2 reductions of an average 26 percent are written into the public retrofit tenders so that winning Energy Systems Companies (ESCOs) must deliver sustainable energy solutions. 1,400 buildings have so far been upgraded, delivering CO_2 reductions of more than 60,400 tonnes per year - these retrofits cost the building owners nothing - and the buildings make immediate savings.
Internal Contracting, Stuttgart, Germany http://www.c40cities.org/bestpractices/buildings/stuttgart_efficiency.jsp Stuttgart saves around 7200 tons of CO_2 each year through an innovative form of internal contracting, making use of a revolving fund to finance energy and water-saving measures. The city is able to reinvest savings directly into new activities, creating a virtuous circle of environmental improvements and emissions reductions.
EU and Display Campaign Case Studies http://www.display-campaign.org/page_162.html The European Display Campaign is a voluntary scheme designed by energy experts from European towns and cities. When started in 2003 it was initially aimed at encouraging local authorities to publicly display the energy and environmental performances of their public buildings using the same energy label that is used for household appliances. Since 2008 private companies are also encouraged to use Display for their corporate social responsibility CSR activities.
Energy Management System, Frankfurt, Germany http://www.managenergy.net/download/r164.pdf In 1996 the City of Frankfurt (Building department) entered into a contract with a private company to install and operate an energy-management system (EMS) for the City (Romer), Paulskirche and Museum "Schirn". The goal of the project is to reduce the costs for energy- and water as well as the CO_2-

emissions.
Based on the annual costs of 2.6 Million DM in 1992/1993 the potential cost reductions were estimated to be approximately 320,000 DM per year. To reach these cost savings an investment of 1 Million DM for control equipment was necessary. Repayment of the invested capital will be provided from the energy savings (54 percent) over a period of 8 years. The remaining 46 percent will reduce the operating costs for the buildings.

Energy Efficient Office of the Future (EoF), Garston, UK
http://projects.bre.co.uk/envbuild/index.html
The new Environmental Building at Garston was built as a demonstration building for the Energy Efficient Office of the Future (EoF) performance specifications, drawn up by a number of companies representing the manufacturers, designers and installers of building components and the fuel utilities, as part of the EoF project run by BRECSU.
A key part of this specification is the need to reduce energy consumption and CO_2 emissions by 30 percent from current best practice. Air conditioning is not used in the new building - the major energy consumer in many existing office buildings. Other savings will be made by making better use of day-lighting and by using the building's 'thermal mass' to moderate temperatures.

TOOLS & GUIDANCE

Tools & Guidance
EU LOCAL ENERGY ACTION Good practices 2005 - Brochure of good practice examples from energy agencies across Europe. http://www.managenergy.net/download/gp2005.pdf
ESMAP Public Procurement of Energy Efficiency Services - Guide of good procurement practice from around the world. http://www.esmap.org/Public_Procurement_of_Energy_Efficiency_Services.pdf
Energy Conservation Buildings Code provides minimum requirements for the energy efficient design and construction of buildings and their systems. http://www.emt-india.net/ECBC/ECBC-UserGuide/ECBC-UserGuide.pdf

ANNEX 6: MUNICIPAL VEHICLE FLEET EFFICIENCY PROGRAM

DESCRIPTION

The objective of this recommendation is to improve the energy efficiency of municipal vehicles. This is achieved by ensuring that municipal vehicles meet set standards in terms of their fuel type and consumption, as well as engine maintenance.

Reductions in fuel use, reductions in air emissions resulting in improved air quality, and reduced carbon footprint.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Engine performance standards	The City Authority produces a procurement requirement linked to international engine performance standards, e.g. EURO series (others include US EPA or Japan's Heisei Standards), adopted by a number of countries outside the European Union, such as India and China. Whilst the standards relate to air emissions, the more stringent they are, the more efficient the engine technology is likely to be. Standards are introduced through City Authority procurement contracts as minimum requirements for all new vehicle purchases including government cars, police cars, buses, waste-collection vehicles and emergency vehicles. A feasibility study is required to determine the appropriate engine performance standard to be implemented. See http://ec.europa.eu/environment/air/transport/road.htm for further details.
Maintenance standards	

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum

First Cost
< US$100,000

Speed of Implementation
< 1 year

Co-Benefits
Reduced carbon emissions
Improved air quality
Financial savings

	See the New York and Stockholm case studies for further details. The City Authority transportation departments define regular preventative maintenance standards for owned vehicles and contracted parties, for example: Once a week or at each fill-up • Check your oil, water, wiper fluid, engine coolant/antifreeze level, and tire condition and pressure. Monthly check • Inspect transmission fluid and brake fluid, windshield wiper blades, and power steering fluid. Review condition of belts, hoses, and battery cables. Every six months or 6,000 miles Check the brake system and inspect and/or rotate tires. Review condition of clutch system (manual transmissions) and chassis lubrication. Once a year • Have underbody flushing performed and service engine cooling system (which should include inspecting the radiator, water pump, fan belt, thermostat(s), radiator cap, and antifreeze). Check accelerator control system, and lubricate doors, locks, hinges, and parking brake. 15,000 miles • Inspect automatic transmission. Change auto transmission fluid and filter. 30,000 miles • Change spark plugs and fuel filter, inspect spark plug wire, check engine timing. (source: http://www.gmfleet.com/government/maintenance-info/maintenanceSchedule.jsp) City Authorities should define a maintenance program that suits their fleet profile and to ensure that owned vehicles are operating at desired performance levels. Maintenance requirements can be extended to taxis and buses, although these can be voluntary where the vehicles are not owned by the city authority. Municipal

	compliance with the objective should be made public to demonstrate leadership by example. See Jakarta case study for further details.
Contingent contracts	If the municipal fleet is subcontracted to different operators, contracts can be made contingent upon the use of vehicle standards with specific minimum fuel use and performance levels set by the City Authority. See Copenhagen case study for further details.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- Determine KPIs: Vehicle fleet fuel consumption records, emission test records, numbers of maintenance checks undertaken.
- Survey baseline performance (fuel consumption).
- Survey ongoing performance on fuel consumed per vehicle mile.

CASE STUDIES

NYPD hybrid vehicle program, New York, USA NYPD press release 2009-14 http://www.nyc.gov/html/nypd/html/pr/pr_2009_014.shtml The Mayor has introduced hybrid cars for use as police patrol cars. Each vehicle produces 25-30 percent lower CO2e compared to conventional fuel-powered models from fuel savings, and averages twice the distance per gallon for city driving. At a cost of $ 25,391 per vehicle, the payback period for the capital investment was just over one year. Notably their deployment has been concentrated in areas which maximize their economic and environmental benefits, i.e. in precincts with large coverage areas and those which are prone to heavy stop-and-go traffic.
Clean Vehicles Program, Stockholm, Sweden

http://www.c40cities.org/bestpractices/transport/stockholm_vehicles.jsp
http://www.managenergy.net/products/R1375.htm
All municipal cars, buses and heavy trucks will operate on biofuels or at a high emission standard by the end of 2010. Run through a fleet replacement program, critical factors for success have been a common procurement of electric vehicles by Stockholm City and other cities, in order to significantly reduce prices, as well as the active encouragement of local production of biogas.

Bus inspection and maintenance program, Jakarta, Indonesia
http://www.unep.org/pcfv/pcfvnewsletter/2009Issue2/Retrofit.pdf
As part of an initiative to reduce pollutant emissions from the city bus fleet, nine bus companies developed their own internal inspection and maintenance program. The program checked the vehicles for engine malfunctions and excessive smoke and measured exhaust opacity. The program's success rested on an extensive education program which aimed at raising awareness among technicians and drivers about the environment and technical training on how to conduct a proper inspection and maintenance program. The education also included instruction on safe and fuel saving driving practices.
In total over 13,000 buses were tested in 2001 and 2002, with 89 technicians and 1372 drivers trained. Measures identified through the inspection program that could be easily fixed were cleaning air filters, adjusting fuel injection timing and injection nozzle pressure and calibrating the fuel injection pump. In some cases, air filters and fuel injection nozzles had to be replaced.
This program achieved a 30 percent reduction of diesel soot and a 5 percent decrease in fuel consumption through improved, regular maintenance practices. Another 10 percent decrease in fuel consumption was attained through improved driving methods. Approximately a third of the vehicles failed the inspection but over 80 percent of these vehicles could be repaired with only minor additional cost. The inspection test method used in Jakarta, a free acceleration emissions test to measures smoke opacity, is a simple procedure to implement that provides an indication of a gross engine malfunction. The Jakarta program started out with just two bus companies on a voluntary basis but, by the end of the program, grew to nine bus companies as the economic benefits of inspection and maintenance became more apparent.

Contracted bus fleet, Copenhagen, Denmark
http://www.kk.dk/sitecore/content/Subsites/Klima/SubsiteFrontpage/
As part of the Copenhagen Climate Plan, the Copenhagen City Authority (CCA) has made contracts with bus companies operating within the municipality contingent in the on a reduction in 25 percent less CO2 emissions. The CCA does not require a particular technological solution, for example, procurement of hybrid busses. Instead, it taps into national government funding available until 2012 for pilot testing of various energy efficient transport solutions, of which increased energy efficiency of the bus fleet is one. At the time of publication of the Klimaplan (August 2009), CCA was looking to cooperate with neighboring municipalities to initiate a trial project in relation to energy efficient bus fleets.

TOOLS & GUIDANCE

Tools & Guidance
UNEP (2009). "UNEP/TNT Toolkit for Clean Fleet Strategy Development", A step-by-step toolkit with guidelines and calculators to develop a strategy for reducing the environmental impacts of a fleet. This includes measures which improve fuel and performance efficiency of the fleet. http://www.unep.org/tnt-unep/toolkit/index.html

Tools & Guidance
Energy Trust (2009). "Grey Fleet guidance", A guidance document which provides an overview for reducing the impact of a City Authority's grey fleet (privately owned vehicles used by employees on CA business). http://www.energysavingtrust.org.uk/business/Global-Data/Publications/Transport-Advice-E-bulletin-October-09-Focus-on-grey-fleet

ANNEX 7: ENERGY EFFICIENCY STRATEGY AND ACTION PLAN

DESCRIPTION

Develop a comprehensive energy efficiency strategy and action plan for the municipality. The strategy should have measurable and realistic targets, set out timeframes and assign responsibilities. It should be developed collaboratively by representatives from across the municipality and other groups who will be affected by the strategy. A municipal energy efficiency strategy will help bring together a diverse range of initiatives into a coherent plan for city-wide energy efficiency. By presenting a single action plan, the strategy will also make it easier to monitor progress.

The strategy can also be used as an internal and external publicity tool for the municipality to promote and build support for their work on energy efficiency.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Mayoral decree	The mayor issues a mayoral decree for an interdepartmental energy efficiency review and strategy.
Regulation (Annual EE Reports)	The city authority introduces regulations requiring that the public organizations report on total energy usage, measures taken to improve energy efficiency and the impact of efficiency measures on an annual basis.

ATTRIBUTES

Energy Savings Potential
100,000-200,000 kWh/annum
First Cost
US$100,000-1,000,000
Speed of Implementation
< 1 year
Co-Benefits
Reduced carbon emissions
Improved air quality
Enhanced public health & safety
Increased employment opportunities
Financial savings
Security of supply

Appoint EE officer	The city authority appoints a senior officer to monitor energy usage and efficiency within city authority departments and public organizations. Incorporate the collection and management of data into the job descriptions of those municipal employees with responsibility for energy efficiency initiatives.

MONITORING

Monitoring the progression and effectiveness of recommendations, once implemented, is fundamental to an accurate understanding of their value over the longer term. Where the CA implements a recommendation a target (or set of targets) should be defined that indicates the level of expected progress over a given timescale. At the same time a monitoring plan should be designed. The monitoring plan does not need to be complicated or time consuming but should, as a minimum, cover the following aspects: identification of information sources, identification of performance indicators, a means of measurement and validating measuring equipment or processes, record keeping protocols, a schedule for measurement activity (daily, weekly, monthly etc.), assignment of responsibilities for each aspect of the process, a means of auditing and reviewing performance and finally, establishment of reporting and review cycles.

Some suggested measures that relate specifically to this recommendation are as follows:

- Total city authority energy use, total efficiency savings achieved from energy efficiency initiatives, percentage of energy efficiency initiatives for which data is collected every year;
- Total city authority energy use;
- Total efficiency savings achieved from energy efficiency initiatives;
- Percentage of energy efficiency initiatives for which data is collected every year;
- Set targets for the city authority for each KPI, for example, improve KPI performance by 20 percent in 5 years. Produce annual reports on progress towards set targets. Monitor and update the action plan on a regular basis.

CASE STUDIES

Municipal Initiatives to address Climate Change, Bridgeport, Connecticut, USA

Connecticut General Assembly "Municipal Initiatives to address Climate Change" http://www.cga.ct.gov/2010/rpt/2010-R-0300.htm
Regional Plan Association, Copy of Mayor's Executive Order http://www.rpa.org/bgreen/BGreen_2020_Executive_Order.pdf
Regional Plan Association "BGreen 2020: A Sustainability Plan for Bridgeport, Connecticut" http://www.rpa.org/bgreen/BGreen-2020.pdf
In 2008, the mayor issued an executive order that established a goal for the city government to reduce its annual GHG emissions from a 1990 baseline by 7 percent by 2012 and 20 percent by 2020, in accordance with the city's Plan of Conservation and Development. In order to meet this goal, the executive order required the city to obtain at least 25 percent of its electricity from renewable resources by 2012 and for all new major city construction and major renovation projects to earn at least a silver rating under the Leadership in Energy and Environmental Design (LEED) program, or its equivalent under similar rating systems.
The order established a Sustainability Community Advisory Committee, which is charged with:

- overseeing the completion of a city-wide and municipal government GHG inventory,
- making recommendations to the mayor and the city on how to meet the city's sustainability goals,

- preparing educational materials for households and businesses describing climate change and actions they can take to promote sustainability, and
- identifying economic and workforce development opportunities associated with green jobs.

The city, in collaboration with the Bridgeport Regional Business Council, has developed a program to promote sustainability. The program includes specific measures around auditing energy use, reducing total building footprint within the city, using advanced waste treatment techniques, and analyzing the feasibility of installing renewable energy systems on public and private buildings.

Since the order was issued, the city and the Regional Business Council have also developed a comprehensive sustainability plan, BGreen2020. The plan was developed following an 18-month planning process with a Community Advisory Committee and five technical subcommittees. The process involved over 200 participants from city, state, and federal governments, businesses, and civic and neighborhood groups. The plan is a comprehensive strategy to improve the quality of life, social equity, and economic competitiveness while reducing GHG emissions and increasing the community's resilience to the impacts of climate change.

Energy Efficiency Strategy, Spain

European Commission - Saving & Energy Efficiency Strategy in Spain http://ec.europa.eu/energy/demand/legislation/doc/neeap/es_neeap_en.pdf

Evaluate Energy Savings http://www.evaluate-energy-savings.eu/emeees/en/countries/Spain/index.php

Spain's Energy Saving and Energy Efficiency Strategy 2008-2012 (E4), which constitutes its National Energy Efficiency Action Plan (NEEAP), aims to achieve security of supply in terms of quantity and price with some basic levels of self-sufficiency, taking into consideration the environmental impact and economic competitiveness.

The plan identifies 7 sectors including: agriculture, buildings, domestic and office equipment, industry, public services, transport, and energy transformation. Within each of these sectors, it sets out sets out strategic objectives as well as the route that energy policy should take to achieve these objectives. The Plan establishes a primary energy saving of 24,776 ktoe in 2012 as quantified energy objective in opposition to the scenario which was used as the base for the initial Plan 2004-2012, involving 13.7 percent. The plan also monitors progress against previous action plans, identifies investment and the potential for improvement in each sector, and sets targets for the immediate future.

The financing of the Plan is via investments in the private sector and in public services, and are therefore passed on to the end-users (consumers) and employers, who make investments which improve the processes or equipment that they bring to the market, so the services that they provide are carried out with less consumption of energy.

Energy and resource saving program, Brisbane, Australia

Good Practices in City Energy Efficiency: Eco^2 Cities: Energy and Resource Saving Program in Brisbane, available online http://www.esmap.org/esmap/node/1225

Brisbane's population is expected to continue to grow over the next two decades. In 2007, the Brisbane City Council issued Brisbane's Plan for Action on Climate Change and Energy, which delineates the selected actions to be achieved in the short term (about 18 months) and the long term (more than five years). Brisbane has three major challenges: climate change, high peak oil demand, and greenhouse gas emissions. Analysts suggest that, if Brisbane responds intelligently to these challenges, the city may generate significant economic benefits by developing sustainable industries, while saving resources. Brisbane is actively introducing various approaches to sustainable development. In addition, in the city's "Our Shared Vision: Living in Brisbane 2026" policy document, authorities have committed to cutting greenhouse gas emissions in half, reusing all wastewater, and restoring 40 percent of the natural habitat by 2026.

Integrated resource planning and management, Stockholm, Sweden

Good Practices in City Energy Efficiency: Eco^2 Cities - Integrated Resource Management in Stockholm, available online http://www.esmap.org/esmap/node/1228

The City of Stockholm, the capital of Sweden, has pursued integrated city planning and management to become a sustainable city. The city has a comprehensive urban vision, environmental programs, and concrete action plans to reduce greenhouse gas emissions and tackle climate change. It implements integrated urban planning approaches that consider ecological benefits and efficient resource use.

The ongoing redevelopment in the city's southern district, Hammarby Sjöstad, is a good model for understanding integrated approaches to sustainable urban planning and redevelopment. The area aims to be twice as sustainable as Swedish best practice in 1995. The area implements integrated resource management (waste, energy, water, and sewage) through systematic stakeholder collaboration and has transformed the linear urban metabolism into a cyclical one known as the Hammarby Model.

According to Grontmij AB, a private consultancy firm in Stockholm, primary assessments of the initially developed districts of Hammarby Sjöstad show that the area has achieved, for example, 28 to 42 percent reductions in nonrenewable energy use and 29 to 37 percent reductions in global warming potential.

TOOLS & GUIDANCE

Tools & Guidance
N/A

ANNEX 8: LIST OF ABBREVIATIONS FOR CITIES IN THE TRACE DATABASE

	City	Country	City Abbreviation		City	Country	City Abbreviation
1	Addis Ababa	Ethiopia	ADD	38	Karachi	Pakistan	KAR
2	Amman	Jordan	AMM	39	Kathmandu	Nepal	KAT
3	Baku	Azerbaijan	BAK	40	Kiev	Ukraine	KIE
4	Bangkok	Thailand	BAN	41	Kuala Lumpur	Malaysia	KUA
5	Belgrade	Serbia	BE1	42	Lima	Peru	LIM
6	Belo Horizonte	Brazil	BEL	43	Ljubljana	Slovenia	LJU
7	Bengaluru	India	BEN	44	Mexico City	Mexico	MEX
8	Bhopal	India	BHO	45	Mumbai	India	MUM
9	Bratislava	Slovakia	BRA	46	Mysore	India	MYS
10	Brasov	Romania	BR1/BRA	47	New York	USA	NEW
11	Bucharest	Romania	BUC	48	Odessa	Ukraine	ODE
12	Budapest	Hungary	BUD	49	Paris	France	PAR
13	Cairo	Egypt	CAI	50	Patna	India	PAT
14	Cape Town	South Africa	CAP	51	Phnom Penh	Cambodia	PHN
15	Casablanca	Morocco	CAS	52	Ploiesti	Romania	PLO
16	Cebu	Philippines	CEB	53	Pokhara	Nepal	POK
17	Cluj-Napoca	Romania	CLU	54	Porto	Portugal	POR
18	Colombo	Sri Lanka	COL	55	Pune	India	PUN
19	Constanta	Romania	CON	56	Quezon City	Philippines	QUE
20	Craiova	Romania	CRA	57	Rio de Janeiro	Brazil	RIO
21	Dakar	Senegal	DAK	58	Sangli	India	SAN
22	Danang	Vietnam	DAN	59	Sarajevo	Bosnia and Herzegovina	SAR
23	Dhaka	Bangladesh	DHA	60	Seoul	South Korea	SEO
24	Gaziantep	Turkey	GAZ	61	Shanghai	China	SHA
25	Guangzhou	China	GUA	62	Singapore	Singapore	SIN

26	Guntur	India	GUN	63	Sofia	Bulgaria	SOF
27	Hanoi	Vietnam	HAN	64	Surabaya	Indonesia	SUR
28	Helsinki	Finland	HEL	65	Sydney	Australia	SYD
29	Ho Chi Minh	Vietnam	HO	66	Tallinn	Estonia	TAL
30	Hong Kong	China	HON	67	Tbilisi	Georgia	TBI
31	Iasi	Romania	IAS	68	Tehran	Iran	TEH
32	Indore	India	IND	69	Timisoara	Romania	TIM
33	Jabalpur	India	JAB	70	Tokyo	Japan	TOK
34	Jakarta	Indonesia	JAK	71	Toronto	Canada	TOR
35	Jeddah	Saudi Arabia	JED	72	Urumqi	China	URU
36	Johannesburg	South Africa	JOH	73	Vijaywada	India	VIJ
37	Kanpur	India	KAN	74	Yerevan	Armenia	YER