TOOL FOR RAPID ASSESSMENT OF CITY ENERGY – PUEBLA, 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.

Executive Summary

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 Puebla, 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 León, 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 Leon 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.

Puebla, Puebla

The capital of the state with the same name, the city of Puebla is approximately 2,100 meters above sea level, at the foot of the Popocatepetl volcano, and is located 130 miles southwest of México City. The local economy is based primarily on industry, and has the second-largest Volkswagen factory in the world and the largest plant in the Americas, located in the neighboring municipality of Cuautlancingo. Many of the city residents are employed in automotive sector and other industrial branches, and the area has a relatively low unemployment rate (4.5 percent).

In consultation with local authorities in Puebla 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 Puebla with the highest saving potential, and for which the local administration has a significant degree of control are: street lighting, municipal buildings, and solid waste. A summary of all six sectors that were evaluated are discussed below along with the principal recommendations.

Overview of energy use in Puebla

More than 54 percent of total energy use in the city is consumed by the transport sector. Residential, commercial, and public sectors account for 23.8 percent of total consumption, with industry consuming 21.6 percent. Total energy consumption by the six TRACE sectors amounts to some 27.6 billion MJ, of which 62 percent goes to urban transport, while a little over a third goes to the power sector.

STREET LIGHTING - The street lighting sector in Puebla is under-performing. The coverage is sub-standard, with only two-thirds of the streets in the city lit. While there is one lamp every 30 meters on primary and secondary roads, the overall coverage cannot reach all areas in the city, thus some of the neighborhoods are poorly lit. Although 80 percent of the lamps use medium efficient high-pressure sodium bulbs, only 15 percent of the consumption is metered. The amount of electricity used per kilometer of lit road (23,146 kWh) is similar to the average of other cities in the TRACE database. However, the annual related expenditure for the nearly 100,000 lamps spread across the city exceeds US$12 million. In recent years, the municipality has taken steps to improve the system, such as introducing a pilot light dimming program on one of the main avenues. There are plans to further improve the street lighting system by expanding the network coverage and switching to LED technologies. As the sector has a significant potential energy savings (US$3 million), Puebla could reduce energy consumption and improve the quality of street lighting in the city. Among the steps that the local government can take to move forward on improving street lighting are:

- *Procurement Guide for New Street Lights* - The city should set strict, clear rules for the provision of street lighting to encourage the adoption of energy efficient technology.
- *Street Lighting Retrofit* – Energy efficient street lamps can deliver the same lighting for significantly lower energy consumption levels, reducing associated carbon emissions and operational costs. The cost of LED technology has fallen to the point that it is the optimal choice today for street lighting.
- *Engage with an Energy Service Company (ESCO)* – A third party ESCO could pay for lighting and other upgrade costs and finance the investments from a share of the energy savings.

MUNICIPAL BUILDINGS - Most of the 134 municipal buildings in Puebla are public offices, as all schools and most of the hospitals are managed by state and federal authorities. Puebla presents a particular case since many of the government buildings in the large downtown area are historic, with the area declared a World Cultural Heritage by UNESCO in 1987. Accordingly, it is both difficult and costly to restore and renovate historic buildings. Most energy use in buildings in Puebla is for lighting and IT, since the pleasant climate minimizes the use of space heating or air conditioning. As a result, overall energy use in the building sector is among the lowest of cities in the TRACE database (14 kWh per square meter). Nonetheless, Puebla lacks reliable and consistent information on the overall floor area and energy consumption in buildings under municipality's management. With small investments, local authorities could improve the management of municipal buildings in the city, and save on energy and other utility expenditures. Some of the energy efficiency measures that could be considered include:

- *Municipal Building Database and Benchmarking Program* - A municipal building database could be developed to identify the buildings and end-uses with the largest energy saving potential. Publishing and updating the database on a regular basis would enable competition among building managers and the exchange of data and best practices.
- *Municipal Buildings Audit and Retrofit* – Such a program would identify and prioritize energy efficiency upgrades for city managers.
- *Mandatory Energy Efficiency Codes for New Buildings* – Codes and guidelines for energy efficiency for new buildings would establish best-practice standards based on new or existing international codes.

SOLID WASTE - The solid waste sector in Puebla is managed by both public and private operators. Some of the solid waste parameters compare favorably with international peers, such as the low level of waste generated per capita per day (0.89 kg), as well as per capita per year (324 kg), and the high percentage of solid waste that goes to the landfill. The landfill, located 6 kilometers far from the city, is operated by a private concessionaire, and is well equipped, including with a modern leachate plant that treats the wastewater collected from the landfill. However, like other cities in Mexico, Puebla does not have a well-developed solid waste collection system to separate recyclables from organic waste. Although recyclables handled by informal collectors has increased in the last few years, the rate of recycling is still very low (less than 3 percent). The city does not keep track of fuel consumption and related expenditure associated with waste collection and transfer by private concessionaires, nor does it promote energy efficiency measures by concessionaires. Both public and private operators have recently stepped-up efforts to

modernize the waste collection system by purchasing new waste trucks. A new program promoting waste recycling allows business entities to buy items from private informal collectors, with the money collected going into a fund to improve safety in the city. In the short and medium term, the energy efficiency of the solid waste sector in Puebla can be improved by implementing measures such as:

- *Transfer Stations* – Such facilities will help reduce the number of trips to the landfill and the distance travelled per ton of waste, thus lowering energy use.
- *Solid Waste Auditing and Planning* – The city can increase the efficiency of the solid waste sector by evaluating infrastructure and identifying opportunities for energy savings in the collection, transport, and disposal of solid waste.
- *Public Awareness Campaigns* – Such campaigns can increase the level of recycling by teaching people to separate organic from recyclables, and organizing selective collection by the city.

POWER SECTOR - Per capital electricity consumption in the city is low (1,786 kWh), although consumption per unit of GDP is average compared to other cities internationally (0.204 kWh). There is 98 percent power coverage in Puebla, with more than 660,000 households connected to the grid. Overall losses in the transmission and distribution network as well as commercial losses account for approximately 11 percent. Currently, there are four private energy producers in Puebla, with a total installed capacity of 7 MW, none of which are using renewable resources. Almost two-thirds of the overall energy consumption in the city is used in industrial facilities, and only 25 percent for the residential sector. Like all cities in México, the local government does not have significant influence over the power sector, which is operated by the state-owned electricity provider, CFE.

TRANSPORT - The transport system in Puebla is managed by state and federal authorities, with oversight from the local municipality. Almost half of the city residents in Puebla use public transport, while more than a third use non-motorized transport (NMT) modes. Only 21 percent use their own cars for their daily commutes. Compared to other cities in the TRACE database, the public transport sector in Puebla is very energy efficient. The public transport network includes a Bus Rapid Transit system and a number of feeders and auxiliary routes. At present, only one BRT route is in operation, providing for 108,000 daily trips, and one more route is under construction. Aside from the BRT buses, other public transport vehicles operating in the city are fairly old. About one quarter of the city's residents use their cars for the daily commute, which raises energy use per trip, i.e., 3 MJ per passenger-kilometer, one the highest figures in the TRACE database. During rush hour, it is estimated that drivers can spend up to one-third of their travel time waiting in traffic. A large number of people in Puebla bike or walk, particularly in the historic district, where there is a good pedestrian network. The city is expanding the number of bike lanes and is also promoting bike share programs with docking stations where people can rent bicycles.

WATER SECTOR - Operated by a decentralized institution owned by the state government, the water sector in Puebla is facing a number of challenges. Water coverage is not universal, as the network cannot reach all neighborhoods, and parts of the old historic district receive their water by tanker truck. Although Puebla uses a fairly low amount of water per capita (172 liters) the losses in the network are high (nearly 40 percent) partially as a result of old pipes and challenges of rehabilitation of the large historical part of the city. The system requires a fairly high amount of energy to treat potable water (0.5 kWh per cubic meter of water). Although there are five wastewater treatment facilities, some of the large industrial users discharge their wastewater directly into adjacent rivers, thus polluting surface waters and the environment. The wastewater treatment process uses a relatively small amount of energy, and none of the current wastewater facilities has the capacity to generate energy.

The matrix below presents the public utility sectors in Puebla identified by TRACE with the highest energy saving potential and the interventions local authorities might consider to reduce consumption and improve energy and resource efficiency of the city. These interventions can be implemented over one or two years, on average, and 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**	
	$12,890,000		$3,200,000	
	Responsible Institution	**Cost**	**Energy savings potential**	**Time of implementation**
1. Street Lighting Audit and Retrofit	City	$	**	1-2 years
2. Procurement Guide for New Street Lights	City	$	**	< 1 year
PRIORITY 2 Municipal Buildings	**Energy spending in the sector**		**Potential savings**	
	$1,615,000		$79,000	
	Responsible Institution	**Cost**	**Energy savings potential**	**Time of implementation**
3. Municipal Buildings Benchmarking	City	$	**	1-2 years
4. Municipal Buildings Audit and Retrofit	City	$$$	***	1-2 years
5. Mandatory Energy Efficiency Codes for New Buildings	City	$	***	> 2 years
PRIORITY 3 Solid Waste	**Energy spending in the sector**		**Potential savings**	
	$300,000		$16,000	
	Responsible Institution	**Cost**	**Energy savings potential**	**Time of implementation**
6. Intermediate Transfer Stations	City	$$$	***	> 2 years
7. Waste Infrastructure Planning	City	$	**	< 1 year
PRIORITY 4 City Authority Management	**Energy spending in the sector**		**Potential savings**	
	N/A			
	Responsible Institution	**Cost**	**Energy savings potential**	**Time of implementation**
8. Awareness Raising Campaign	City	$	**	< 1 year

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 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 city 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 that 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 in 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 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.

The municipality of Puebla is the capital of the state. Founded in 1531, the city is approximately 2,100 meters above sea level, located in Central México. It is located at the foot of Popocatepetl, one of the highest volcanoes in the country, and is around 130 miles southwest of México City and west of Veracruz, the country's main port to the Atlantic Ocean. Located in the Valley of Puebla (known as the Valley of Cuetlaxcoapan) in the west-central part of the state of Puebla, the city borders the municipalities of Santo Domingo Huehutlán, San Andrés Cholula, Teopantlán, Amozoc, Cuauthinchán, Tzicatlacoyan, Cuautlancingo, and Ocoyucan, as well as the state of Tlaxcala.

Because of its proximity to the Popocatepetl, Puebla is exposed to the ash and dust that sometimes emanates from the volcano. Puebla has a subtropical highland climate, with warm summers, and cool temperatures at night year-round. The city experiences a dry season from November through April and a rainy season between May and October. The average annual temperature in Puebla is 16.6 º C.

Popocatepetl Volcano

The city of Puebla comprises 480 communities, with a total area of 534 square kilometers. According to the 2010 census, the municipality0s population is 1,539,819, of which more than 94 percent live in urban areas.

The local economy relies primarily on industry, which is based on basic metals, chemicals, electrical items, and textiles. The steel company Hylsa and the Volkswagen automotive plant are the two largest industries and major employers in the city. The second-largest Volkswagen factory in the world and largest plant in the Americas is located in the nearby municipality of Cuautlancingo.

Most industry is located in several industrial parks located in the periphery of the city, such as the Cinco de Mayo Industrial Park, the *Resurrección* Industrial Zone, and the Puebla 2000 Industrial Park. As the city has grown, agriculture has become a small share of Puebla's economy. Most agricultural activities take place in small plots located in the outskirts of the city, and include the production of corn, beans, wheat, oats, avocados, apples, peaches, nuts, choke cherries, and Mexican hawthorns. The unemployment rate in Puebla currently stands are 4.5 percent.

Puebla is an important academic center with a number of public and private universities, with the largest number of higher education institutions after México City. Puebla has a storied history and today Puebla is home to 5,000 historical buildings in Renaissance, Baroque, and Classic styles. The historical center, which is filled with a large number of churches, monasteries, and mansions, was declared a World Heritage Site by UNESCO in 1987.

Downtown Puebla

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,[1] 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.[2] 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.

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):[3]

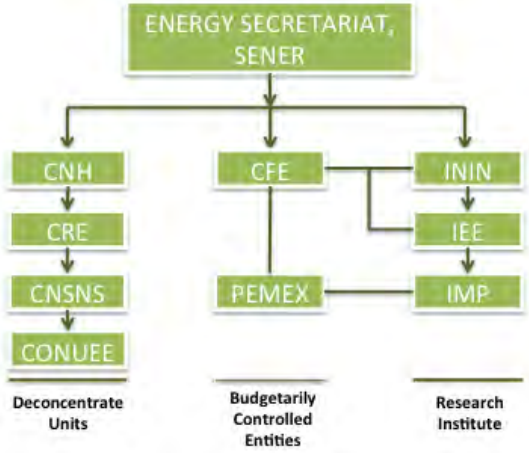
a) *Co-generation*: Electricity produced from co-generation is intended for individuals or private entities who own the facilities;
b) *Independent Production Energy* or *PIE*: This is the generation of electricity from a plant with an installed capacity greater than 30 MW, and aimed exclusively for 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.

[1] Electricity Sector Prospect 2012-2026, México, SENER 2012 (p. 63)
[2] Legal and regulatory framework of the energy sector in México available at: http://www.cre.gob.mx/articulo.aspx?id=12
[3] Official Site of the Energy Regulatory Commission, available at: http://www.cre.gob.mx/pagina_a.aspx?id=23

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.[4]

The ***National Energy Strategy 2013-2027*** (ENE) supports social inclusion in the use of energy, and the reduction of greenhouse gas emissions and other negative impacts on health and the environment associated with energy production and consumption.[5] 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 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).[6] 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.

[4] The Sixth Working Report - SENER 2012 (p. 8-13)
[5] National Energy Strategy 2013-2027. SENER 2013 (p. 63 – 64)
[6] National Energy Balance 2011 – México - SENER 2012 (p.39 -49)

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.

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 or local tax bill. The fee, which varies from state to state, is collected for municipalities by CFE.

Local energy efficiency and environment initiatives in Puebla

The state of Puebla has developed a number of initiatives aimed at improving energy efficiency and mitigating climate change effects. **The Puebla State Climate Change Law** developed public policies to enable the state and local governments to efficiently address climate change. The law enables relevant authorities to establish a dedicated fund to finance a series of interventions, such as awareness raising campaigns, promotion of capital investments and guidelines for climate change mitigation (e.g., reduction of GHG emissions in the industrial sector) and urban planning (like settlement of urban communities in low risk areas and the restoration of eco-systems). **The Strategy for Mitigation of Climate Change in Puebla** established a commission and a council at the state level to develop climate change related policies.

The air quality in Puebla is of a medium grade according to the Mexican Metropolitan Index of Air Quality (IMECA) which rates the city's air quality on average at 42 points out of 100. A study prepared by the Federal Commission on Health Risks COFREPIS in 2010 showed that medical treatment for pollution related illnesses in the city (such as respiratory issues, asthma) can be as high as 813 million pesos (over US$61 million). In order to address health issues associated with pollution, the **Air Quality Program Management "Proaire 2012 - 2020"** was established by the state of Puebla to improve air quality in the region. The document seeks to reverse air quality deterioration and reduce emissions. The economic growth in recent years has led to an increasing energy demand and use of more fossil fuels, a fact that resulted in increasing pollution and related emissions. The program brings together a number of stakeholders, such as the local government, academia, and civil society to identify the most adequate solutions to fight pollution in the city. In addition to enforcing environmental standards in the industrial sector, under the program the city requires vehicles to undergo mandatory emission control testing and to incorporate emission control devices in vehicles.

The Puebla Municipal Climate Action Plan (PACMUN) is a local tool to establish public policies by employing innovative solutions to reduce GHG emissions and respond to climate change. The initiative calls for use of efficient technologies, such as electromagnetic induction in public lighting, the promotion of the bus rapid transit systems (BRT), and the expansion of pedestrian networks and bike lanes in the city. The plan aims to attract funds to develop activities to reduce GHG, and promote research and new technologies related to climate change mitigation. The plan set a goal of reducing CO2 emissions in Puebla by 2 percent in the next five years. This program also plans to update the database on GHG emissions, review the emissions inventory in different sectors, execute at least five climate change related initiatives until 2014, and monitor the results in the short, medium, and long run**. The Energy Security and Sustainability Program for the State of Puebla** promotes energy efficiency and the use of clean energy technologies. One of the city's latest initiatives sets a target of 200 square meters of green area per person. According to this scheme, 20 percent of the city area should be converted to green spaces.

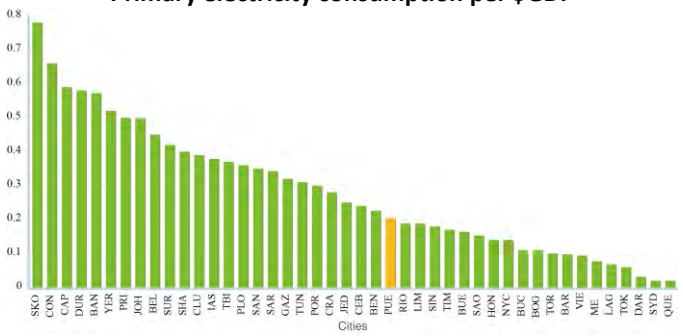
Sector Diagnostics

Puebla Sector Diagnostics

Power Sector Primary electricity consumption in Puebla is 1,786 kWh per capita per year. This figure places the city on the low side of the TRACE database compared to cities with a similar climate. Puebla uses more electricity per capita than México City, Casablanca or Tunis, but less than Bucharest, Budapest, and Vienna. The primary electricity consumption per $GDP is 0.204 kWh, a figure that puts Puebla in the middle of the database compared to cities with a similar Human Development Index. Thus, Puebla is performing better than Porto, Santiago, and some Eastern European cities like Cluj-Napoca or Belgrade but is behind others, such as Timisoara or Barcelona.

According to CFE, there are 665,236 households connected to the grid in Puebla, reaching a level of 98 percent coverage. In 2011, overall electricity use amounted to 3,798,882,436 kWh. The losses in the transmission and distribution network amount to nearly 8 percent, while commercial losses are around 3 percent.

Primary electricity consumption per $GDP

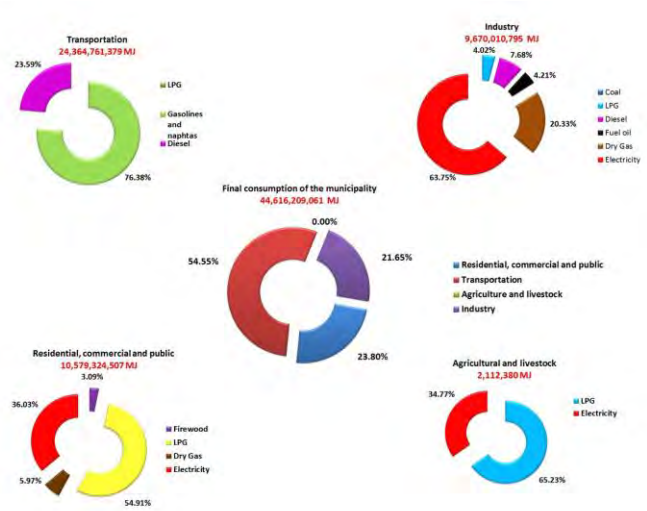


Electricity tariffs in Mexico depend on several parameters, including consumption, category of users, times of the day, voltage, average maximum temperature, and region. Tariffs are updated according to inflation and the cost of fuels used to produce electricity. Tariffs doubled between 2002 and 2012, paralleling the increase in the global price of petroleum. Currently, residential customers pay on average 1.1403 pesos (8.9 US cents) per kWh of electricity. Those under the basic plan (up to 75 kWh) end up paying 0.774 pesos (6 US cents) per kWh of electricity. Consumption between 76 to 140 kWh of electricity would increase the tariff to 0.945 pesos (7.4 US cents) per kWh. Finally, those who use more than 140 kWh will pay the highest tariff, i.e., 2.763 pesos (21.6 US cents) per kWh of electricity. Commercial clients pay the highest tariff, i.e., 2.9835 pesos (23.2 US cents) per kWh of electricity, while industrial consumers pay half this amount, i.e., 1.5330 pesos (12 US cents) per kWh.

Of the six private companies that have been given a license in 2005 to produce electricity in Puebla, only four are still operational today, with an installed capacity of 7 MW. None of them use renewable energy sources, with all relying on diesel.

Overall, the total energy consumption in Puebla in 2013 was estimated at 46,090,916,882.94 MJ. More than half is consumed by transport, while 21.6 percent by the residential, commercial, and public sectors.

Energy Balance in Puebla



Source: CEEA 2013, Municipal Energy Balance

The main fuel used by the transport sector was gasoline (i.e., 76 percent of the total consumption), while Liquefied Petroleum Gas (LPG) was the primary fuel for 54.9 percent of users in the residential, commercial, and public sectors. Electricity accounts for 63 percent of the total energy used by local industry.

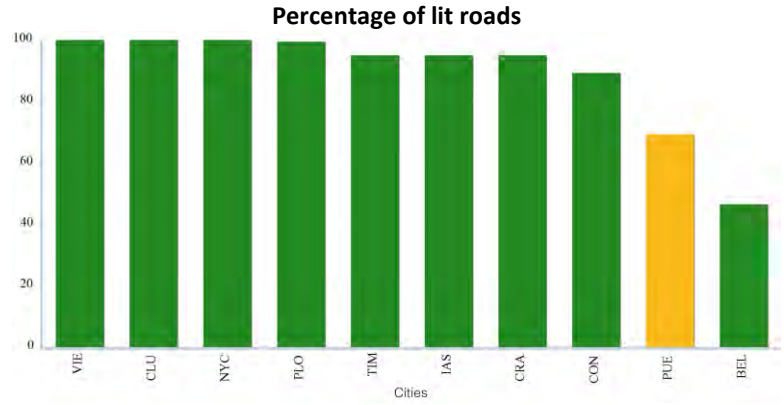
Even though Puebla is not a hub for renewable energy, solar energy investments have picked up in the last decade. According to local estimates, there are 2,884 solar panels installed in the city. According to the municipal energy balance, 3.2 percent of residential users (primarily low-income households) rely on solar water heaters. Solar heaters generate 14.6 million kWh of electricity annually, which would represent 0.7 percent of the total energy consumption. A number of solar energy projects have been developed in Puebla in recent years. For instance, US$6.2 million was invested to install solar panels in parks. In addition, solar energy is used for some street lighting. The Energy and Environmental Studies Center has built a photovoltaic system that generates energy for its own use. As the city has a good solar potential, solar energy could be a viable and low-cost alternative for both electricity generation and water heating. According to the city's solar potential, Puebla could generate 962 million MJ per year, the equivalent of 267,310,015 kWh, which would account for more than 7 percent of total electricity consumption.

The city has good potential of wind energy as well. Usable wind resources were estimated at around 160,370,799 MJ annually (the equivalent of 44,547,444 kWh), which would account for nearly 1.2 percent of total energy needs in Puebla. The 2011-2014 strategy on renewable energy is looking into several options for maximizing the use of renewable energy in the city.

Street Lighting

The public lighting sector in Puebla is coordinated by the local Ministry of Environment and Public Services through its Public Lighting Department. The Puebla City Hall is responsible for the maintenance of the public lighting infrastructure through a private concessionaire, Citelum. Currently, there are around 98,000 lamps spread across the city; nearly 80 percent of them are sodium vapor bulbs, 10 percent are induction lamps, and 2.4 percent are metal halide. Only 15 percent of the consumption is metered.

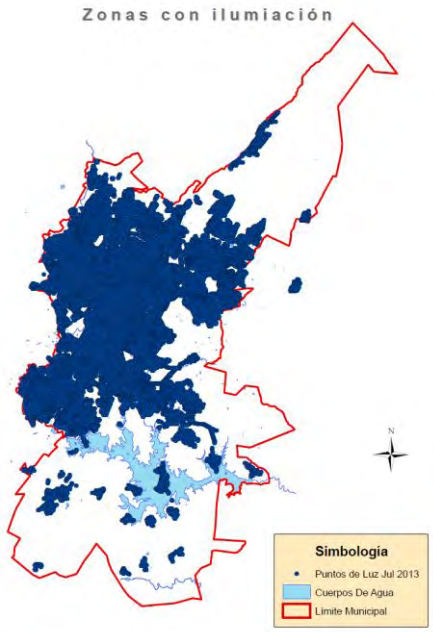
The street lighting coverage is fairly poor, as only 69 percent of the 3,588 kilometers of roads in the city are lit. This is the second lowest figure in the TRACE database, after Belgrade, in comparison to cities with a similar Human Development index.



According to city estimates, 15 percent of the lamps are located on primary and secondary roads, while the rest are located in residential neighborhoods. There is one lamp every 30 meters on primary and secondary roads.

In 2012, the overall energy used for street lighting in Puebla amounted to 65,647,291 kWh, or 23,146 kWh of electricity per kilometer of road lit.

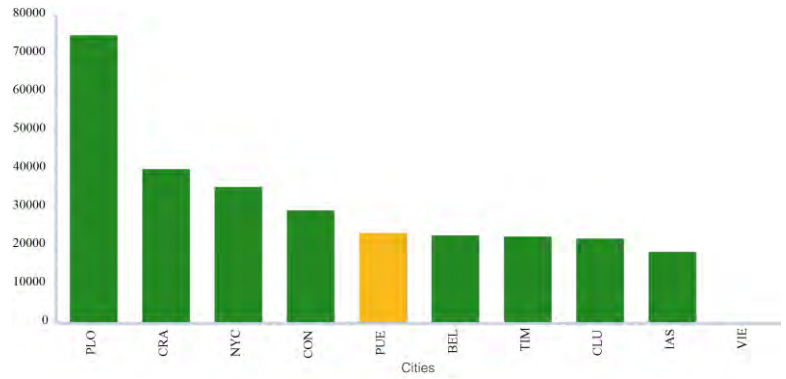
Street lighting coverage in Puebla



Source: SMAS[7]

This figure places the municipality within the medium range of the TRACE database for comparable cities. The energy consumption in Puebla (per kilometer of lit road) is comparable to Belgrade; it is lower than in some Eastern European cities such as Constanta or Timisoara in Romania, but higher than in Vienna or Cluj-Napoca.

Energy consumption per km of lit road – kWh/km of road



The related expenditure on energy for street lighting amounts to more than 167 million pesos or US$12.5 million.[8] Around 75 to 85 percent of this amount is covered through the *Derecho sobre Alumbrado Publico* (DAP), under which each electricity user pays a levy to cover the street lighting services.

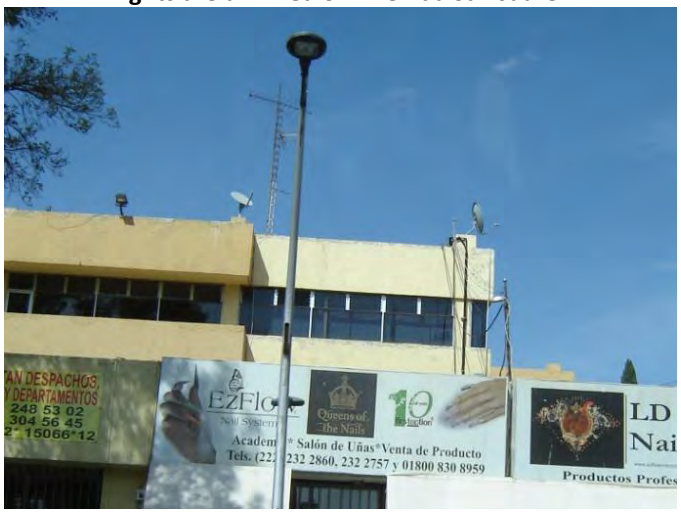
Citelum has a concession agreement that expires in 2014, during which it must execute the street lighting maintenance plan approved each year by the city government. The maintenance service costs 1,970 pesos per light pole for a period of 30 months (approximately US$150). People can report problems via a call center; subsequently, Citelum must fix the problem within 24 hours. The company also has to determine the life span of the lamps, and replace bulbs before they reach the end of their life. At the same time, under the "Colonies 100% Illuminated" program (Colonias 100% iluminadas), Citelum must make sure that at least 95 percent of the lamps in the city work at any time. One of the main issues for public lighting in Puebla is the light fixture. Many existing fixtures do not allow the incorporation of newer technologies, therefore hampering the city's plans to increase or replace existing lamps with more efficient technologies.

[7] Sistema Angelopolitano del Medio Ambiente y Servicios 2013, *Segundo Informe SAMAS 2012. P*uebla: Gobierno Municipal de Puebla

[8] Exchange rate USD 1 = 13.2 pesos

Sodium vapor bulbs lighting in the city center

Lights are dimmed on Avenida San Juarez



In recent years, local authorities have made some efforts to upgrade the system and purchase efficient equipment, such as magnetic induction and metal halide lamps. Some of the ornamental and seasonal lighting use LED bulbs. A pilot street light dimming program is carried out on Avenida Juárez, one the main roads in the city. The street lamps are dimmed between 8 PM and 3AM, depending on traffic. In the near future, the municipality also plans to expand street lighting coverage by 10,000 lamps in those areas which are currently not lit or where the service is deficient.

The city also has plans to replace sodium vapor bulbs with LED lamps, with money from the city budget and a credit line from the federal government. This program is helping municipalities to upgrade/improve their lighting systems through the use of clean, efficient technologies, which would result in significant reductions in electricity consumption.

A prefeasibility study is under way to assess the potential energy saving if LED lamps are installed. Some of the technical issues that may pose challenges for a widespread switch to LEDs include: fluctuations in electricity voltage, lack of metering, and the incompatibility of existing technologies and fixtures.

Municipal Buildings

The municipal building stock under the city government comprises 134 facilities, with a total area of 434,446 square meters. Most of the buildings are public offices and markets, in addition to four municipal health centers. Public hospitals and schools are managed by state and federal authorities.

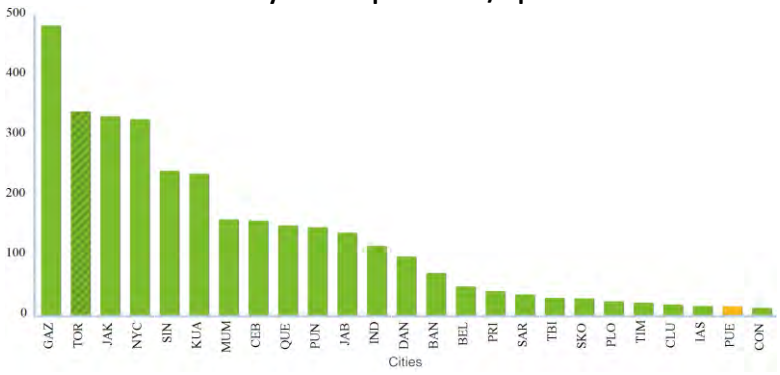
The bulk of the municipal offices are old stately historic buildings. The average age of the municipal building stock is a little over 60 years. The Puebla City Hall sits in a large, beautiful building (*Palacio Municipal*) completed at the beginning of the 20th century, in Spanish renaissance architecture style, with neo-classical and Italian influences. The building is located in the historic center, where a number of impressive old, imposing monuments are located. In 1977, city was designated a Zone of Historic

Monuments by the federal government. Ten years later the downtown area of Puebla became a UNESCO World Cultural Heritage Site.

The Municipal Palace of Puebla

The city does not operate any heating systems in municipal offices, and only a few buildings are equipped with A/C due to the pleasant climate. Accordingly, Puebla has the second lowest electricity consumption within the TRACE database, after Constanta, Romania, with only 14 kWh per square meter.

Electricity consumption kWh/square meter



In 2012, according to the local government, municipal buildings in the city consumed 6,133,335 kWh of electricity, for which the City paid 19.3 million pesos (US$1.46 million), accounting for 0.54 percent of the local budget. However, Puebla does not have an accurate and updated database for keeping track of energy consumption, including usage per square meter.

Some municipal buildings are not in good shape. Because many are historic monuments, renovation and restoration is difficult. Local, state, and federal administrations have joined efforts to restore and renovate some of the buildings in the city.[9] The authorities have drafted strategies to address a number of concerns regarding preservation of the historic downtown to the year 2031. UNESCO's World Heritage Committee is encouraging local and national authorities to finalize the restoration and preservation plan.[10] Currently, a university consortium is working on updating the Partial Program for the Historic Centre as well as designing a specific plan for achieving the goals set for the next fifteen years.

Historic buildings in downtown Puebla

[9] World Heritage Convention UNESCO available at: http://whc.unesco.org/en/list/416

[10] *Plan de Regeneración y/o Redensificación Urbana de la Zona de Monumentos y su entorno Cuidad de Puebla*

A state initiative to help government offices in Puebla become more efficient was approved in 2011. The program supports a number of measures with regard to energy, water and solid waste sectors, including building maintenance and refurbishing plans. So far, the program has been able to lower energy consumption in three buildings.[11]

Local public authorities are encouraging the city residents and building owners to develop solar energy facilities, since the region has great solar potential. Moreover, solar energy investments are becoming increasingly attractive in Mexico as technology costs drop and electricity tariffs rise.

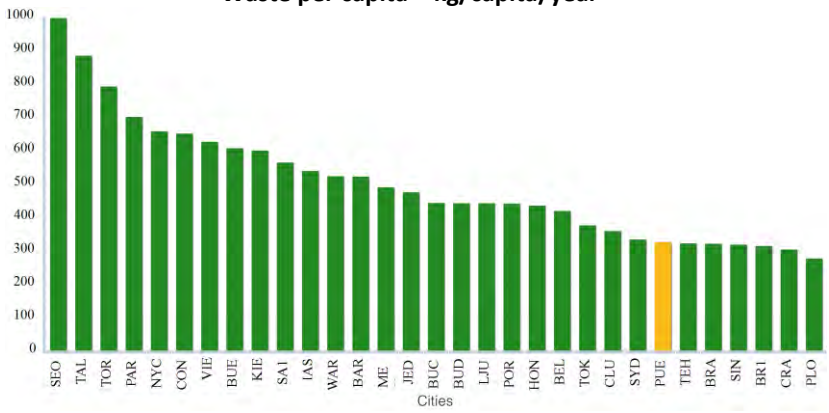
Solid Waste

The urban solid waste system in Puebla is operated by both private and public sector entities, under the coordination of the *Organismo Operador del Servicio de Limpia* or OOSL, a decentralized public body under the municipality. There are three solid waste collection companies in Puebla. There are three solid waste collection companies in Puebla. In addition to OOSL (which owns 23 vehicles), two private sector concessionaires provide the waste collection service in Puebla, namely Promotora Ambiental (PASA, which owns 41 vechicles) and Servicios Urbanos de PUEBLA (SUP, which operates 39 vehicles). The landfill is managed by a private concessionaire, *Rellenos Sanitarios* SA. As per national country regulations, the federal government deals with hazardous waste, while special management waste (such as construction/demolition waste and electronics) is handled by state authorities.

Waste truck in collecting garbage in the city center

According to the Ministry of Environment, in 2008 Puebla generated 324 kilograms of waste per capita, one of the lowest figures in the TRACE database compared to cities with a similar Human Development.

Waste per capita – kg/capita/year



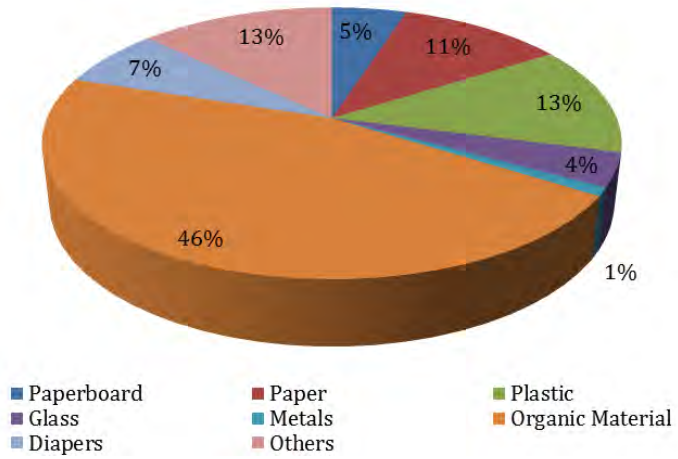
By 2013, the amount of solid waste had risen to 348 kg per capita, with a total production of 5 million tons. According to a study commissioned by the City, in 2008 Puebla produced 0.89 kg of waste per capita per day. Almost half of the municipal solid waste is organic, 13 percent plastic, 11 percent paper, and 5 percent metal. According to the State Agency for

[11]Programa de Excelencia Ambiental - Ecoeficiencias, Secretaria de Desarrollo Rural, Sustentabilidad y Ordenamiento Territorial, SDRSOT, 2013.

Environmental Sustainability, approximately 405 tons of hazardous waste and 27 tons of special management waste are generated daily.

The collection of solid waste in residential areas is free. However, depending on the location and value of the property, people are charged for handling services. The fees vary from 216 pesos (US$16) per year in low income neighborhoods to 528 pesos (US$40) per year in upper-middle income areas, and it can go as high as 708 pesos (US$53) in the highest income zones.

Generation of solid waste in Puebla



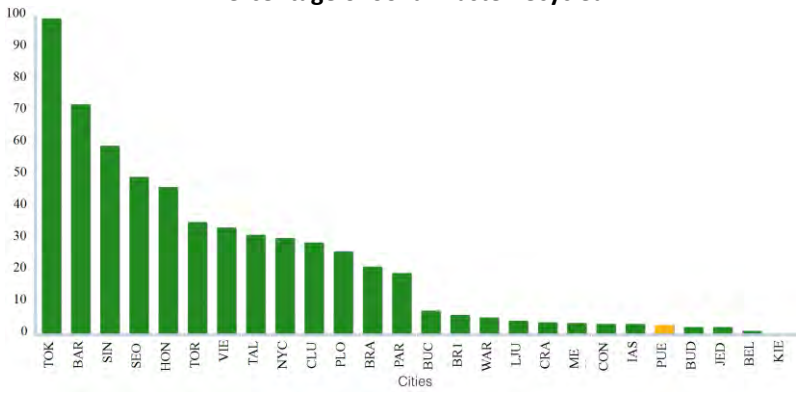
Source: Municipality of Puebla, 2008

Entities from the commercial sector pay 63 pesos for 200-liter containers of waste, and 317 pesos per cubic meter of waste. Industrial customers are charged 99 pesos for every 200 kg of waste and 494 pesos per cubic meter of solid waste. The municipality pays solid waste operators according to the amount of waste dumped at the landfill. The tipping fee is 72.3 pesos per ton of waste.

As with other cities in Mexico, the percentage of recycling waste in Puebla is very low. Only 2.7 percent of the urban waste in Puebla is recycled, one of the lowest figures in the TRACE database compared to cities with a similar Human Development index. For comparison, the figure is three times lower than in Bucharest, seven times lower than in Bratislava, and ten times lower than in Tallinn.

Puebla does not have a proper selective collection system to separate organic waste from paper, plastic, bottles and other recyclable items. Thus, the small amount of recycling that takes place is done by informal collectors directly from trash containers placed throughout commercial areas, parks, and public institutions. In 2011, the local authorities established the Volunteer Waste Collectors Program, aimed at promoting selective collection and to raise the level of recycling. In 2011, 57 communities were involved in this selective collection program; by 2012, the number doubled to more than 118. As a consequence, the amount of recycling went up from 14,000 kg per day to over 35,000 kg per day. Assuming that the amount of recycled solid waste in 2010 amounted to 227,000 kg, by 2012 it had increased by 60 times to 13.8 million kg. Similarly, the amount of recyclable waste collected by informal collectors rose from 14 tons to 33 tons per day. There are nine collection centers for recyclable waste in the city, in addition to a recycling center for construction and building materials and for batteries. 97 percent of the recycling activities are handled by voluntary collectors, while the remaining three percent is managed by OOSL and the landfill.

Percentage of Solid Waste Recycled



97 percent of the waste generated in Puebla goes to the landfill in Chiltepeque, which is located about 6 kilometers away from the city in the outskirts of Santo Tomas Chautla. The facility was built in 1994, and is spread over 67 hectares. From 1994 to 2011 the facility received approximately 7 million tons of solid waste. In 2012, a large cell with a capacity of 4.1 million cubic meters was built. The new cell should reach its full capacity by 2045. The landfill stopped handling special management waste in 2012, when it reached its capacity for this kind of waste. There are currently no transfer stations in Puebla. 80 percent of the waste dumped at the landfill is generated by residential customers and 12 percent by the industrial and commercial sectors.

Waste composition at the Chiltepeque Landfill

Source: OOSL, 2012

An 8.5 million pesos (US$650,000) leachate treatment plant was built in 2012 at the landfill. The facility is able to treat 100 cubic meters of wastewater from solid waste. The treated water is used for industrial purposes or to irrigate the green spaces in Puebla.

Leachate treatment plant at the landfill near Puebla

The two private operators have made efforts to improve their waste collection and transportation infrastructure. For example, two companies (PASA and SUP) spent 22 million pesos (US$1.6 million) to purchase 24 waste trucks. In 2012, the public operator, OOSL also spent 12 million pesos (approximately US$1 million) from the city budget to buy 41 pick-up trucks that are used to perform regular inspections at the landfill. Currently, most of the solid waste trucks in Puebla are new; less than 3 years old. According to city authorities, the energy expenditure for all collection and transportation of solid waste in Puebla for all thee operators amounted to US$300,000, a figure that looks to be quite small compared to other cities for similar activities. The low figure may also reflect the general lack of information on energy use in the sector.

The local government of Puebla is taking steps to implement an integrated solid waste management system. In the last three years, city authorities have begun a number of initiatives to improve the solid waste system. Such initiatives include the program *Al piso no!* (Not on the floor) that seeks to increase the number of trash bins per capita, to come closer to international standard of 1 container per 100 people. In 2011, more than 8,000 trash bins were installed in Puebla. As a result, the ratio improved from 1 container per 400 people to 1 trash bin per 140 people.

Trash bins in Puebla

Recently, a joint program called *Basura por Seguridad* (Trash for Safety) was launched by the City and the private sector to increase the amount of recycling in the city. Private entities buy the plastic, paper, and metal items collected by city residents, and the money collected goes into a security fund managed by the local government with the objective of increasing public safety in the city.

The increase in amount of waste at the landfill is a growing concern for city managers. Initially, it was proposed to install a waste treatment plant to convert solid waste into energy, however, this plan was dropped due to legislation that reduced the economic attractiveness of waste-to-energy schemes by independent energy producers. The city government is currently looking into the option of producing biofuel through thermal treatment, with the product slated to be sold to the local petrochemical industry.

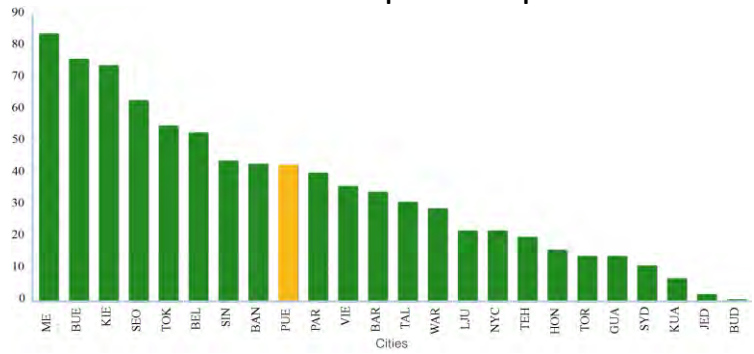
Urban Transport

Public Transport

As in most cities in México, the public transport sector in Puebla is coordinated mainly by state authorities. The local government typically engages with state and federal entities to support transport related initiatives, such as expanding bike lanes and pedestrian networks, or building new infrastructure.

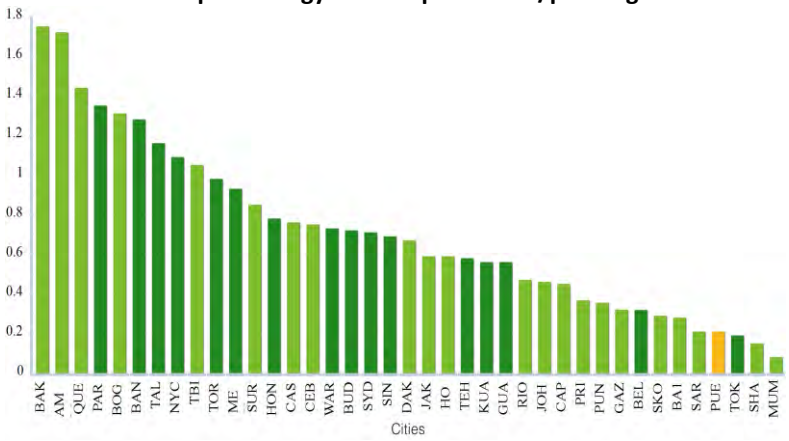
42.6 percent of city residents use public transport; 21 percent use their own cars, and 36.3 percent walk or bike. Public transport use in Puebla is close to other peer cities in the TRACE database with a similar Human Development Index, including Paris and Bangkok. According to INEGI 2010, city residents travel 3.5 million trips per day by all means of transportation. The length of a trip made by public transport is 25 kilometers on average, five kilometers shorter that the journey made by private car.

Public Transport Mode Split



Public transport in Puebla is one of the most energy efficient in the TRACE database, with a consumption of 0.21 MJ per passenger kilometer.

Public Transport Energy Consumption – MJ/passenger kilometer



The public transport subsector is organized under 284 routes, including the Bus Rapid Transit system and a number of feeders and auxiliary routes, most of them serving the downtown area.

Public transport network in Puebla

The BRT system was launched in 2013 under a project called *Red Urbana de Transporte Articulado* (RUTA). The project includes six BRT routes that will cover more than 1.1 million trips per day upon completion. Currently, one BRT route is operational, which covers 18.5 kilometers from the Diagonal Defensores de la República to Boulevard Atlixco in the southern part of city. The BRT route is operating on dedicated bus lanes, with 38 stops and 40 articulated buses. Puebla has 22 kilometers of high capacity transit per 1,000 people, a figure much lower than most of the cities in the TRACE database with similar Human Development Index. The figure is almost four times smaller than in Bucharest and almost seven times lower than Paris. BRT is operated by private companies under concession agreements with the State of Puebla. Currently, the BRT route provides for 108,000 trips per day. The tariff is 7 pesos (55 US cents) per trip for BRT buses, and 6 pesos (47 US cents) for the routes operated by feeders or auxiliaries. Transfer between the BRT system and the other routes is not free.

BRT bus operating in Puebla

Source: skyscraperlife.com

The vehicles in the BRT system meet high environmental standards. However, with the exception of BRT buses that employ Euro 5 emission standards, all other public transport vehicles in Puebla are old and operating on Euro 3 (or lower) standards. There is a traffic center managed by the City that monitors transport in the city.

The map of the only BRT route operational in Puebla

The public transport system has not followed the growth of the municipality. Thus, commuting can often be challenging due to traffic congestion and poor bus service. However, the situation should improve once the integrated public transport system is fully implemented. The construction of the second BRT route is 50 percent completed, while the tender for the third route has already been launched.

There are roughly 12,000 taxis in Puebla. On average, taxis charge 30 pesos per trip (US$2.2). According to the *Benemérita Universidad Autónoma de Puebla* and the national oil company PEMEX, in 2010, fuel consumption for public transport in the city amounted to 3,592,625,991 MJ, which is the equivalent of approximately 103 million liters of gasoline. At a tariff of 11.3 pesos per liter of gasoline (US$3.34 per gallon), the overall fuel cost for the public transport fleet in the city is around 1.16 billion pesos (approximately US$ 90 million).

Taxi in Puebla

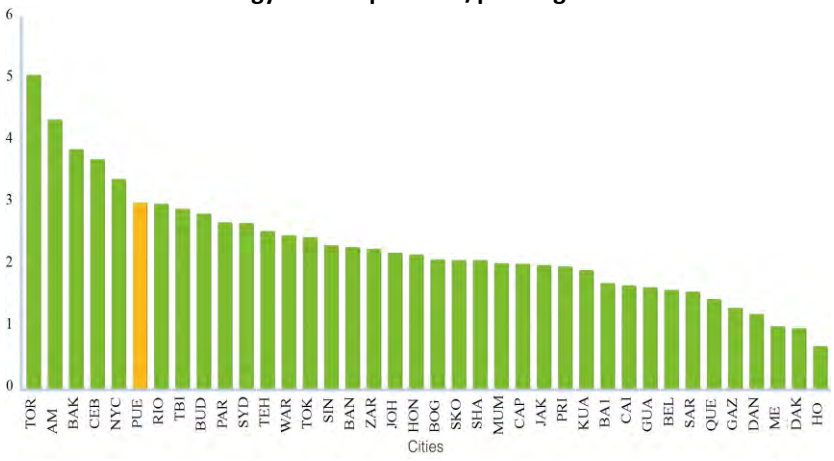
The state Transport Ministry requires that all public transport vehicles fulfill mechanical verifications on a regular basis ("*Revista Vehicular*") in order to renew their licenses. Vehicle licensing and related matters are done by the State of Puebla and its Ministry of Finance. The state government enforces vehicle emissions standards through a mandatory program to reduce air pollution. The federal government designs specific norms and procedures related to environmental standards, and sets limits for vehicle emissions.

Private Transport

There are approximately 527,000 private cars in Puebla. Almost half of them are fairly new vehicles, manufactured between 2001 and 2011. Nearly a third of the vehicles are from the 1990s, 16 percent from the 1980s, and 6 percent from before the 1980s.

Private transport in Puebla is very energy intensive. With an energy consumption of 3 MJ per passenger kilometer, the figure places the city in the higher side of the TRACE database. Puebla is performing similarly to Tbilisi and Rio de Janeiro, but uses more energy per passenger kilometer than Paris, Warsaw or Skopje.

Private energy consumption MJ/passenger kilometer

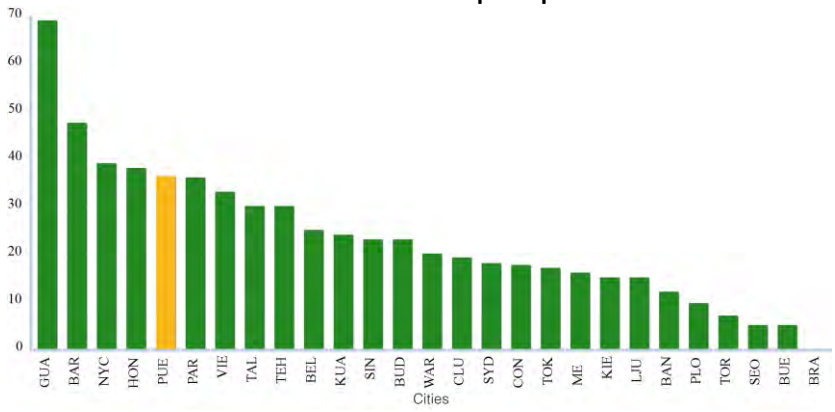


According to estimates made by the *Benemérita Universidad Autónoma de Puebla* and PEMEX, the total fuel consumed by private cars in Puebla exceeds 13.6 billion MJ, the equivalent of almost 400 million liters of gasoline, at a cost of 4.4 billion pesos (approximately US$ 343 million).

The road network is spread over nearly 3,600 kilometers, including primary and secondary roads. Primary roads include long arteries with high capacity transit, connecting the city and the national highways. Primary roads are divided into access roads, main roads, and streets which are used primarily for public transport. The secondary road system carries a lower volume of traffic and is used for short trips. It comprises collective roads (with intense car transit), local streets (providing access to private properties), and bike routes.

36 percent of daily commutes in Puebla are done through non-motorized transportation, similar to Paris. This figure places Puebla in the higher end of the TRACE database compared to cities with similar climate. More people walk and bike in Puebla than in Singapore, Belgrade, or Vienna, but fewer than in Barcelona or Hong-Kong.

Non-motorized transport split



The city has a large number of pedestrians paths, most of them located in the historic center. Such networks are the most attractive areas in the city, as they are built around leisure and entertainment venues, including shops, restaurants, hotels, and terraces. However, the city does not have a good bike network.

Pedestrian network in downtown Puebla

The first bike route of 1.21 kilometer was built in 2009 along the Cinco de Mayo Avenue. Overall, there are nearly 5 kilometers of bike lanes in the city, most of them in the downtown area.

Bike lanes in downtown Puebla

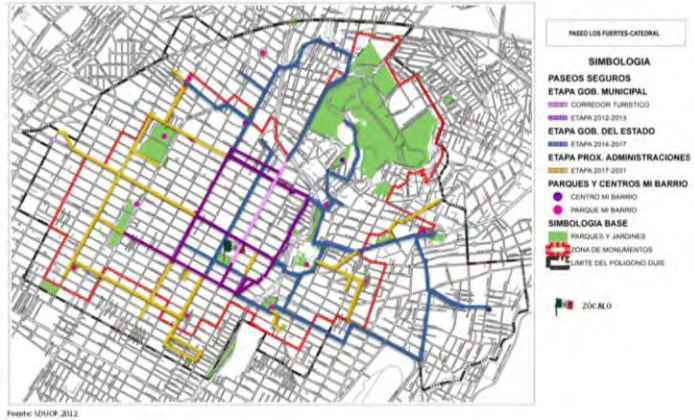
The state authorities and the city government have recently installed several docking stations in the main plaza of the historic center, where people can rent bikes for 3 pesos per hour.

Docking station in the city center in Puebla

Both state and city authorities are dedicated to getting more people to bike and walk, in part to decrease energy consumption and related GHG emissions. Under a program aimed at reviving the historic center and its surroundings, the City plans to develop an additional 6.5 kilometers of bike lanes in the downtown area. This local initiative resonates with the federal government's plan to expand non-motorized transport in several cities in México, including in Puebla. In addition, the state government of Puebla is planning to build bike terminals and integrate the cycling network with the BRT system.

Studies show that traffic congestion and bottlenecks in Puebla are common during morning rush hours and in the afternoon, especially between 2 and 3 PM. Drivers can spend up to one third of their travel time waiting at red lights or trying to pass congested intersections. Due to traffic congestion, the average driving speed does not exceed 23 kilometers per hour.

Bike network - existing lanes (pink); upcoming lanes (yellow & blue)



Recent studies commissioned by the Puebla Agency for Planning and Sustainability show that air emission limits have been exceeded on some 20 avenues in the city. Most of the streets in the city center, especially around *Zócalo*, are very narrow, and often traffic is severe and restricting both drivers and pedestrians.

Traffic congestion in Puebla

As part of the urban development plan, the local government is coordinating with state authorities to enforce a new 30 kilometers per hour speed limit in the city center. Local authorities also plan to improve traffic management in the city by using a fiber optic based technology that would allow for better monitoring and supervision of traffic.

Water Sector

Potable Water

The water sector in Puebla is operated by a decentralized public entity, (*Sistema Operador de los Servicios de Agua Potable y Alcantarillado de Puebla* or SOAPAP). The company serves 441,838 households in the city. SOAPAP provides water services to 33.9 percent of the municipal area. Due to the lack of water infrastructure, the company cannot reach all neighborhoods in Puebla. A number of private water systems are incorporated into the SOAPAP network, serving some of the districts in the city.

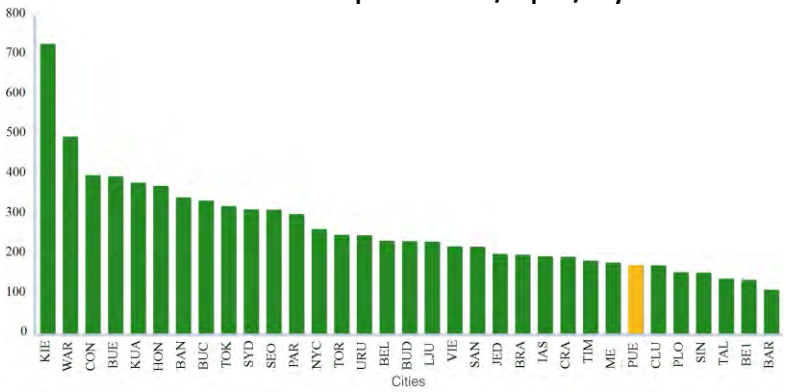
Puebla uses groundwater sources from two rivers (Atoyac and Alseca), and most of the water comes from the Alto Atoyac aquifer (spread over 1,470 square kilometers). The aquifer can supply 352 million cubic meters of water annually. Water is supplied to Puebla via a mix of pumping and gravitational networks. The water is pumped from deep-water wells to overhead storage tanks of high capacity, where it is further distributed to end users.

Water tank truck in Puebla

The water distribution network covers 3,136 kilometers. There are 171 public deep-water wells with an overall capacity of nearly 4,000 liters per second and a number of water tanks spread across the city. In addition, there are 25 private wells with an installed capacity of 357 liters per second that serve the industrial sector. Some of the water sources have high levels of salt and sulfur and require treatment. There are four water treatment plants with an installed capacity of 715 liters per second located near Puebla. The sulfur treatment plant can treat 190 liters of water per second. The water distribution in Puebla is divided into two main areas. One area is split into three regions, while the other is divided between eight sectors. These eight sectors are split into 33 neighborhoods, each of them located in proximity to a large water tank.

People in Puebla use 172 liters per capita per day, similar to México City. This is among the lowest levels in the TRACE database amongst cities with similar Human Development levels. Puebla needs more water than Tallinn or Barcelona, but much less than Ljubljana, Vienna or Budapest.

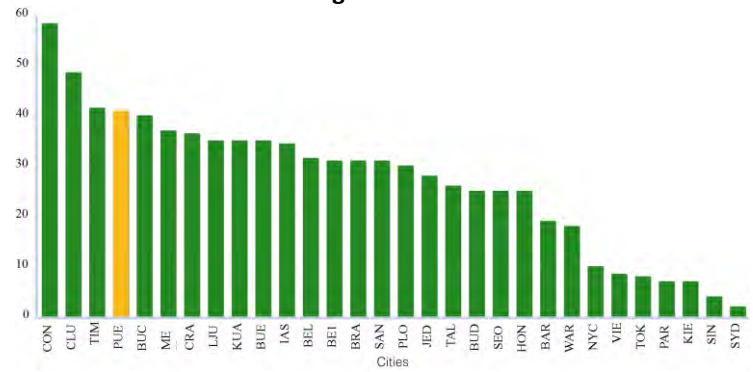
Water consumption – liters/capita/day



Puebla has a daily 712 liters per second water deficit, which affects mostly the residential sector. The gap between the demand and supply varies between 4 percent and 34 percent. This results in 87 percent of the water users in Puebla (commercial, residential, and industrial), not having continuous water services.

One of the culprits for the water deficit is the losses in the distribution network, which are among the highest in the TRACE database. 40.8 percent of the water produced in Puebla is lost, a figure that is twice as high as in Barcelona or Warsaw, and 50 percent larger than Belo Horizonte and Belgrade.

Percentage of water losses

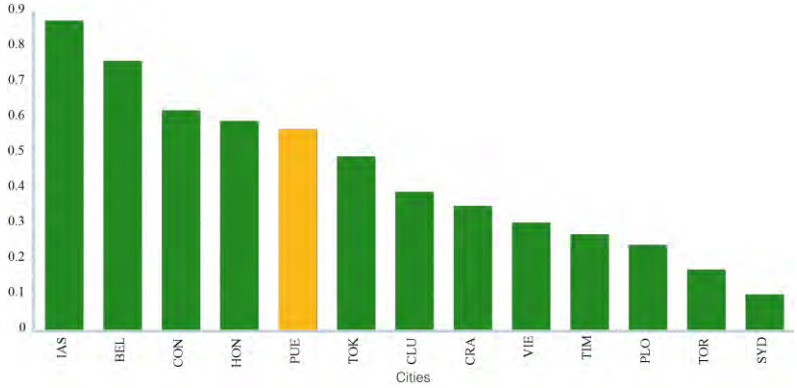


At the same time, not all water networks are in good shape. Even though half of the water pipes are fairly new (less than 10 years old), the other half are old. Nearly a quarter of the network is between 25 and 50 years old, 20 percent of the pipes are between 15 and 25 years old, while 8 percent were built and installed in the 1950s. Although old pipes produce the highest water losses, there are issues with the new pipes as well, due to poor design and installation.

There is a poor balance between the water demand and production in Puebla. Although the water demand has risen with the population, water production has not kept up. According to SOAPAP, water consumption is on the rise, and if this trend continues, water scarcity in Puebla is predicted by 2023. Currently, the water demand in Puebla amounts to 900 liters per second, and is expected to increase by more than 20 percent, up to nearly 1,100 liters per second in less than a decade.

The overall production, treatment, and water process supply in Puebla requires 0.56 kWh of electricity per cubic meter, a figure that places the city in the upper side of the TRACE database as compared to cities with a similar Human Development Index. Energy consumption in Puebla is similar to Hong-Kong and Constanta in Romania, but is twice as high as in Vienna and almost four times higher than in Toronto.

Energy consumption of Potable Water Production – kWh/cubic meter



In 2012, SOAPAP used 66.2 million kWh of electricity to process 116.8 million cubic meters of water. Approximately 25 percent of energy was used for pumping. About 12 percent (7.7 million kWh) was necessary for water treatment. Thus, total energy expenditures for the water system in Puebla amount to 161.7 million pesos (US$12.2 million). Energy used for potable and wastewater represented 15.3 percent of the overall expenditures of the utility.

Water tariffs are directly linked to consumption. Residential clients pay 6.67 pesos (US$0.52) per cubic meter if they use less than 30 cubic meters per month. The price goes up to 10.6 pesos (US$0.83) per cubic meter for a monthly consumption between 30 cubic meters and 50 cubic meters. Anything above 50 cubic meters should is charged at 10.7 pesos per cubic meter. Commercial and industrial clients pay 9.99 pesos (US$0.78) per cubic meter for less than 20 cubic meters per month; 10.26 pesos (US$0.80) per cubic meter for consumption between 20.1 cubic meters and 40 cubic meters; and 13.54 pesos (US$1.06) per cubic meter between 40.1 and 60 cubic meters. The price could go as high as 25.5 pesos (US$1.99) per cubic meter of water for any consumption exceeding 200 cubic meters.

State authorities are working to solve the water scarcity problem in Puebla. Under the Water Sanitation Program, the City has started to replace old pipes and assess the water network in residential areas. They also promoting the re-use of wastewater, clean buffer zones in ravines, and building rainwater collection and processing equipment. State authorities are also considering expanding water sources for Puebla by bringing water from rivers located near *La Malinche* Mountain. However, the 40 kilometers distance between the water source and the treatment plants could be a problem. The other main interventions that the State is pursuing in the water sector include the development of an integrated water infrastructure maintenance system, improving water treatment processes, cleaning up the rivers, establishing an integrated wastewater management system in the industrial sector, and installing water meters for all users.

Wastewater

There are five wastewater treatment plants serving Puebla, and located in Parque Ecologico, Alseseca Sur, Atoyac Sur, Barranca del Conde, and San Francisco, with a total installed capacity of 3,680 liters of water per second.

Four water treatment plants catering to Puebla

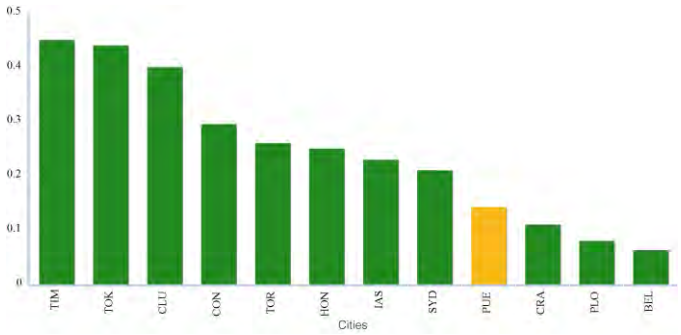
The largest treatment plant is located in Alseseca Sur, with an installed capacity of 1,500 liters per second. None of the wastewater treatment facilities capture wastes for the projection of electricity.

The sewage system in the city is gravitational, and includes a number of pools and sewers that collect both wastewater and rain. The drainage canals collect and transport contaminated waters from the industrial and commercial users to the treatment plants. However, not all wastewater goes to treatment facilities, and the result is that the Atoyac and the Alseca rivers are receiving wastewater from local industries. Some industrial clients discharge their wastewaters directly into the rivers, without any treatment, thus increasing water pollution, including 33 laundry and textile manufacturers.

In 2012, 54.6 million cubic meters of wastewater were treated, which required 7,784,263 kWh of electricity. With an energy consumption of 0.142 kWh per cubic meter of wastewater, the city is placed in the lower

end of the TRACE database within cities with similar Human Development index.

Energy consumption for Wastewater –kWh/cubic meter



Hence, Puebla is performing better than cities such as Toronto and Sydney, but uses more energy to treat one cubic meter of wastewater than some East European cities such as Belgrade, Serbia, and Timisoara and Constanta, Romania.

Energy Efficiency Recommendations

Following the estimation of the savings potential for each sector and indicator, a sector prioritization was done in TRACE. The three sectors that were identified as the most promising for energy savings in Puebla were: Street Lighting, Municipal Buildings, and Solid Waste. All of the priority sectors and actions identified by TRACE were presented and discussed with local public administration officials in Puebla. Together with city managers, eight principal recommendations were identified, which are discussed in detail below.

City Authority Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	Street Lighting	25.0	12,890,427	1.00	3,222,606
2	Municipal Buildings	4.9	1,615,384	1.00	79,153
3	Solid Waste	8.8	300,000	0.60	15,985

City Wide Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	Private Vehicles	32.9	400,343,377	0.15	19,800,854
2	Public Transportation	33.3	136,515,329	0.15	6,825,766
3	Potable Water	57.5	12,438,555	0.15	1,074,576
4	Wastewater	29.0	967,526	0.15	42,102
5	District Heating	0.0	0	0.01	0
6	Power	33.9	0	0.01	0

It should be mentioned 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 Puebla is to improve street lighting in the municipality. The sector has a high energy consumption, and based on the analysis has a significant potential for energy savings. With an upfront investment of up to US$ 1 million, and an implementation period of 6-18 months, the local government could conduct a thorough audit of the public lighting system and put together a retrofit program that could reduce energy consumption by around 200,000 kWh per year.

The city is currently exploring options to replace sodium vapor lights with more efficient LED bulbs, and the audit and retrofit program would provide support for such an intervention. Before going further, the local public administration should consider carrying out an audit of the lighting system in the city, and move to prepare a retrofit program.

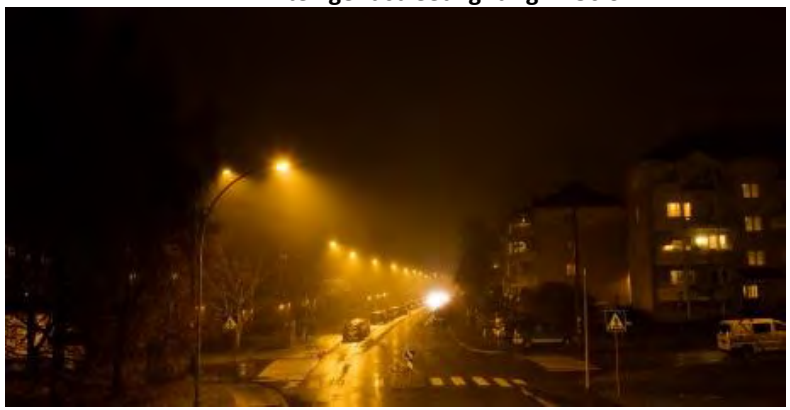
One of the main benefits of a retrofit program is the reduction in annual electricity consumption. Other advantages of energy efficient lighting include delivering the same lighting levels for lower energy consumption levels, and reducing associated carbon emissions and operational costs. It is important to note that maintenance costs of more efficient lighting will be lower, while the overall system will improve by reducing service interruptions.

Retrofitting can be implemented either by the city itself or with support from an Energy Service Company (ESCO). 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. 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.

The city of Oslo stands as a good example for street lighting retrofits. The municipality set up a joint-venture with Hafslund ASA, the largest electricity distributor in Norway to perform the work. Old PCB and mercury bulbs were replaced with high performance high pressure sodium lamps, and the use of 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 bulbs, reducing maintenance requirements. The street lighting system in Oslo is now fully equipped and is being calibrated to sort out some minor problems related to failure of communication units.

The authorities in Puebla plan to change the sodium vapor street lamps with high-efficiency LED bulbs using local and state/federal funds. Currently, a feasibility study is underway to outline the potential savings associated with the use of LED lamps. While LED lamps are more efficient and consume less energy than sodium-vapor bulbs, LED lighting is also costly, requiring large upfront investments. Therefore, local authorities need to undertake a rigorous cost-benefit analysis before expanding LEDs in Puebla.

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.

Procurement Guide for New Street Lights

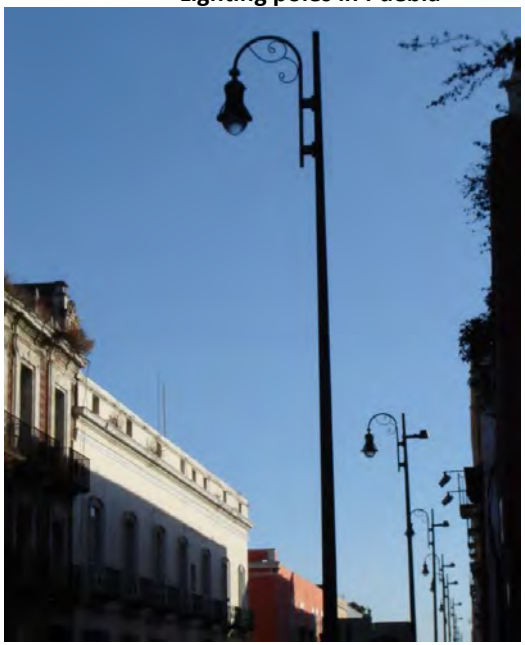
A second TRACE recommendation is for the municipality of Puebla to produce a specific procurement guide for street lighting. New procurement guidelines could help design a better, more efficient street lighting solution for Puebla. The city would prepare guidelines that set clear, strict rules about what the street lighting provider or the company responsible for maintenance service of the public lighting infrastructure would provide, so as to improve the overall efficiency of the system and reduce related costs.

The city government in Puebla could consider a manual for street lighting design similar to that prepared by IESNA (Illuminating Engineering Society of North America), which specify best practices for visibility and safety guidelines. This manual should establish parameters for illumination, pole spacing and lamp type, as well as dimming or illumination operations during nighttime for all types of street lights in the city.

Subsequently, when choosing the new concessionaire, the city managers could include specific requirements related to design, installation, maintenance, and operational costs. Future concession agreements are best given for a medium- to long-term period (for example, a minimum of five years), so as to give the concessionaire enough time to recover

investments. The contract should have requirements for illumination, and should entice competition among the private sector to provide the lowest costs possible.

Lighting poles in Puebla



The Midlands region in the United Kingdom provides a good example for improving energy efficiency through the use of procurement guidelines. Nine councils from Midlands partnered with the Midlands Highways Alliance to achieve energy efficiency savings for major and medium highways and professional civil engineering services, by sharing best practices in maintenance contracts and by joint procurement of new technologies for street lighting and signaling. The procurement guidelines outlined the minimum and desired specifications for street lighting technologies in order to achieve targets for reducing carbon emissions and costs. The project was estimated to save the region GBP 11 million (US$18.4 million) in highway maintenance and improvements by 2011.

Municipal Buildings

Municipal Buildings Benchmarking

Most of the cities where TRACE has been implemented do not have reliable and consistent information on energy consumption and related expenditures for municipal buildings. Although the local budget typically covers energy expenditures for municipal buildings, most cities do not keep proper records to track and monitor energy consumption. Commonly, the local public administration does not know the actual electricity consumption and related expenditures for a given floor area, so they cannot tell whether the consumption is efficient or not. In addition, with a database, it is not possible to know if completed energy efficiency investments are indeed effective.

Like many cities, Puebla does not have a proper database regarding the floor area of municipal buildings and related energy expenditures. Such a database would help the local public administration monitor energy consumption and expenditures in public buildings, and would also be important for implementing energy efficiency programs.

State authorities in Puebla are currently developing a project to help government offices become more efficient in terms of their consumption of electricity, water, and their generation of solid waste. The program is intended to engage public building managers to improve maintenance services and promote refurbishment. So far, the project has been able to lower energy consumption in three buildings. TRACE is encouraging the City of Puebla to continue with such initiatives, and to consequently develop a benchmarking program for municipal buildings. TRACE estimates that through the investment of approximately US$100,000, city managers could establish a public buildings benchmarking program that could reduce energy consumption by up to 200,000 kWh per year.

The building benchmarking could be done by a small team of one or two people from the City administration or by external consultants, with support from various departments within the municipality. 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.

Historical building in Puebla

Source: www.ovpm.org

The TRACE database has several good practice examples for a benchmarking program. The Ukrainian city of Lviv developed such a program that has achieved considerable energy savings. Lviv was able to reduce annual energy consumption in all 530 municipal public buildings by 10 percent and cut water consumption by 12 percent through a monitoring and targeting program to control energy and water use. In 2010, the program achieved savings of US$1.2 million with minimal costs. The program provided the city management with monthly consumption data for district heating, natural gas, electricity and water in all municipal buildings. This information was able to determine annual goals based on historical consumption and negotiations on an adjustment. The consumption was reviewed every month and all deviations and performances were communicated to the public through a public display campaign. Subsequently, the City established a new energy management unit and trained all personnel with responsibilities on building utility use in an administrative division, unit, or building.

Municipal Buildings Audit and Retrofit

In addition to the municipal building benchmarking program, another recommendation of TRACE is consideration of an audit and retrofit process to reduce energy expenditures and the carbon footprint of the city. The building audit should target specific end-users and activities, such as computers, lighting, air conditioning and heating systems, computer server rooms, and appliances (such as fridges and water coolers). Depending on the results, the city government may wish to allocate money for energy efficiency upgrades, the purchase of new equipment, and building repair or renovation.

Puebla has a large number of old and magnificent historic buildings. Not all are in good shape, and some could use renovation and rehabilitation work. Although renovation work can be difficult or nearly impossible in some cases, restoration can be done under strict specifications with supervision from the local and national authorities.

Government office in Puebla

Source: wikipedia.org

In recent years, the national and local administration has established an ambitious plan to renovate and preserve the core of the historical buildings and monuments in Puebla by 2031. Currently, several stakeholders came together to update the Partial Program of the Historical Centre, and prepared a plan establishing targets for the next fifteen years.

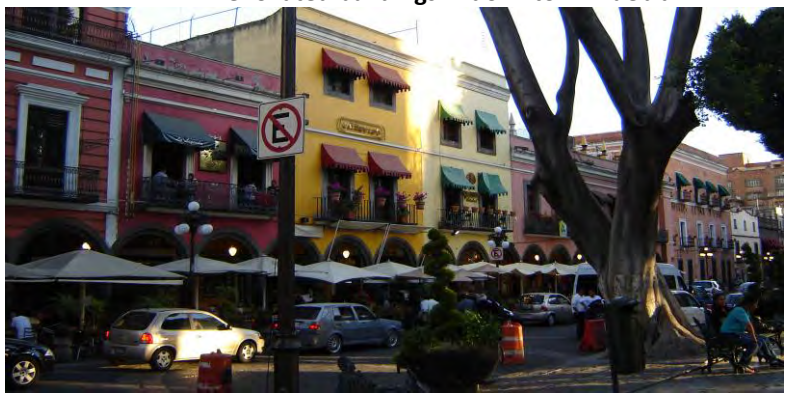
Any retrofitting activities should target first those buildings which are not historical monuments. The retrofit program can be executed in a cost-effective manner, through Energy Service Companies (ESCOs), who would pay for the first cost of the upgrades and will share in the savings from the retrofits. Prior to that, the local government should assign a person to be responsible for the execution of energy efficiency projects in municipal office buildings. The benchmarking process and the data collected on office buildings could be very useful in identifying preliminary opportunities for energy efficiency interventions, including new computers, lighting systems, and other energy-using equipment. After defining the requirements and the budget, city authorities should make a plan to design retrofits, equipment replacement and renovations specifically for each building, and subsequently hire an ESCO. Under a classic shared savings contract, the ESCO makes the initial investments, guarantee energy savings, and shares the savings with the city, which can be used to pay the ESCO.

Historical buildings decorated with tiles in Puebla

Source: wikipedia.org

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.

Renovated buildings in downtown Puebla



The government of Berlin, in partnership with the Berlin Energy Agency, managed the retrofit of public and private buildings by preparing tenders for work that would guarantee reductions in emissions. The tenders required an average of 26 percent reduction in greenhouse gas emissions. Under this program, 1,400 buildings have been upgraded by ESCOs at no cost to owners and reduced CO_2 emissions by more than 60,400 tons per year. 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.

Mandatory Energy Efficiency Codes for New Buildings

Puebla can encourage the energy efficiency of new buildings through the enforcement of energy efficiency guidelines or certification programs for

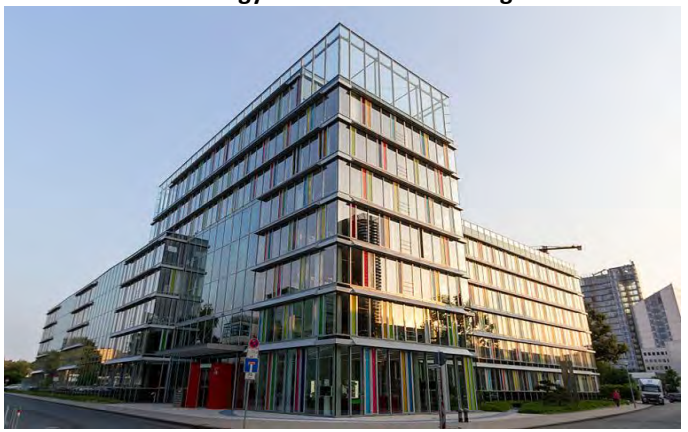
using green building technologies. Examples of similar programs that have established energy efficiency codes include LEED (used in the United States), BREEAM (in UK) and CASBEE (in Japan).

Although the guidelines should primarily focus on energy efficiency, they also typically cover water conservation, urban heat island effect (green roofs), indoor air quality, and other building-related issues. The energy efficiency code can take various forms -- voluntary guidelines, minimum building standards, or incentive programs for private developers -- and seeks to advance higher quality building design and construction. This TRACE recommendation could be implemented with an investment of US$100,000 over a two-year period, and could result in energy savings of 200,000 kWh, in addition to lower water consumption.

Before preparing such codes, city managers should evaluate green building opportunities by assessing climate, building types, the real estate market and construction sector, and examine existing and relevant codes and guidelines in the region and worldwide. A cost-benefit analysis can determine the relative merits of codes for the design of new construction versus strategies for green building design. Subsequently, the local authorities should draft design guidelines based on a voluntary approach. The guidelines can be distributed to the public to be used voluntarily by progressive developers, designers and building owners. The local government can also create a program to boost the construction of green buildings by providing incentives in the form of taxes, credits, zoning benefits, or quicker loan approvals to the development community. If a voluntary or incentive-based approach would not work, the local government can transform the guidelines into a mandatory code and include green building designs into the building code. In either event, the draft guidelines should be distributed for feedback to all interested parties for comment (e.g., real estate and construction companies, city residents).

Best practices to improve construction/energy efficiency standards for new buildings include the City of Münster, Germany, which incorporated low-energy building standards in sales contracts for city-owned land. This created a market transformation that led to an 80 percent adoption rate if the city's energy efficiency requirements in all new buildings constructed in 2010, including those constructed on privately owned land.

The energy efficient LVM building in Münster



Source: wikimedia.org

The municipality of Seattle developed a set of action plans and strategies to promote construction of efficient new buildings in the city. All new city buildings over 5,000 square feet were required to meet Leadership in Energy and Environmental Design (LEED) standards, with the city providing financial incentives for private projects to comply with such requirements. In parallel, the city implemented programs that offering incentives for newly built buildings, such as providing downtown commercial, residential developments greater height and/or floor area if a certain green building standard of LEED silver standard or higher is met, or providing subsidies for energy conservation and design & consulting fees for LEED projects. Between 2001 and 2005, US$4.3 million was offered for projects implementing LEED standards. Energy consumption went down by 35 percent on average and by 6.9 million KWh/annually for LEED municipal buildings. In addition, the emissions of LEED buildings fell by 1,067 CO2e tons per building, while the annual average energy savings amounted to US$43,000.

Solid Waste

Intermediate Transfer Stations

The municipality of Puebla can improve the solid waste system in the city and reduce energy expenditures by building transfer stations. By investing US$1 million, the city could build transfer stations that would result in savings of 200,000 kWh annually. Such facilities would not only reduce greenhouse gas emissions and enhance public safety and health in Puebla, but would also reduce traffic associated with waste vehicles and achieve budgetary savings. Transfer stations help reduce the number of trips to the landfill and decrease the distance travelled per ton of waste, which would translate into reducing the energy use associated with transfer of waste to the landfill. With fewer waste trucks traveling long distances to the landfill, there would be less noise and dust in residential areas, in addition to improved roads and better air quality.

Together with the private operators, the city managers of Puebla should prepare a plan to address the shortfalls in the waste collection system, and lay the ground to develop transfer stations. A map highlighting the issues in the waste management system should identify possible places to locate the waste transfer stations. The private operators should provide financial support for building the new waste facilities. The new facilities should be incorporated in the city's spatial planning strategy so that the City can allocate land for the new transfer stations. After the transfer stations are developed, local authorities should monitor fuel consumption associated with the quantity of solid waste collected.

In Victoria, British Colombia, the Ministry of Environment hired a private engineering consultancy firm to produce the guidelines for transfer stations to look into what would be the most appropriate methodology, design, and operational procedures to apply for the new facilities. The guidelines include cost models that compare direct haul in collection trucks with transfer haul to the landfill. These models allow city managers to assess the benefits of transfer stations under various conditions and identify and quantify operational and capital costs.

Transfer and sorting station

Source: comtechrom.ro

In Romania, integrated solid waste management plans at the county level are developed with financial support from the EU and with contributions from the local administrations that benefit from waste collection services. In addition to sorting and compost stations, the master plans include transfer stations to reduce the distance travelled by garbage trucks to the landfill and other storing facilities.

Solid Waste Auditing and Planning

Puebla can improve the solid waste sector by identifying opportunities to reduce energy consumption in the collection, transport, and disposal of solid waste. The City currently does not have reliable data about solid waste. By carrying out an audit of the waste sector, city managers can determine the amount of energy used for waste management and identify opportunities for energy savings. An annual environmental report would assess all solid waste infrastructures in the city -- e.g., solid waste trucks, trash bins, the landfill, the leachate plant. The report would monitor energy consumption per ton of waste collected, transported, and treated.

The solid waste operators should submit data annually on solid waste collected, fuel used for collection and transportation activities, and waste

management at the landfill. The city could also talk to informal collectors to obtain information on potential recycling activities. The report should lay out the foundations for a short- to medium-term waste management strategy, detailing the distribution and inventory of city-wide solid waste infrastructure. The document would target interventions to reduce energy associated with waste pre-treatment activities. Thus, it could target reductions in energy per ton or cubic meter of waste treated, as well as per ton of waste managed per year.

Waste truck operated by a private company in Puebla

Municipalities worldwide have employed different methods to improve the solid waste sector and to save energy. For example, in Italy waste services are delivered through public entities known as “ATO”, funded by local authorities. These bodies are responsible for defining the most appropriate services required to manage solid waste streams. Often, new solid waste infrastructure is funded from the city budget, although private finance is obtained through a form of public borrowing for large waste facilities. Italy put in place an eco-tax for waste disposal that is used to generate revenues for new infrastructure and waste monitoring activities. The Italian authorities raised US$324 million from an eco-tax on all packaging that is set aside for financing new waste infrastructure.

The City of London employed a strategy to achieve greater regional self-sufficiency by developing new infrastructure and focusing on new low-carbon technologies in waste management (e.g., transfer facilities to resource recovery parks). In partnership with private waste operators, the Greater London Authority (GLA) is developing a site-framework to collect data on current, planned and potential waste sites at the local and regional level in order to determine the type, number and location of the solid waste facilities needed in the future. The Solid Management Board allotted US$114 million to develop new facilities for collection, treatment and the disposal of waste, with some financial support from strategic partners (such as joint ventures, private investors, and European Union funds). One of the most important tools employed is the WasteDataFlow, an online web-based site that acts as a reporting system for all UK local authorities to inform on best practices and strategy. One of the local solid waste operators is building the Riverside Resource Recovery Facility, a large project with its own resources and loans from private banks. This riverside facility is one of the UK's most efficient waste-to-energy (WTE) plants with an annual capacity of 670,000 tons of waste, and that will help to reduce more than 100,000 heavy vehicle trips from the roads each year.

Awareness Raising Campaigns

The final TRACE recommendation for Puebla is related to helping citizens become more aware of the benefits of energy efficiency. This program is aimed at encouraging the city government to use public education and training campaigns to increase awareness and understanding of energy conservation, but also to change people’s attitude towards energy efficiency. The city government can provide citizens with easy, accessible information related to energy efficiency so as to influence behavior.

Energy efficiency can be promoted in various ways, from advertising campaigns, public events and features in the local media to dedicated websites, training programs in schools and community centers, and an energy efficiency champion program. In addition to changing the behavior of city residents, the benefits of such interventions would be lower electricity bills, reductions in greenhouse gas emissions, better air quality, and financial savings.

One way of increasing public awareness is through training programs. In partnership with an education and training provider, the City could develop training programs that could be rolled out in schools and offices. The programs could primarily target large energy users, such as public and

private offices, manufacturing plants, industrial facilities, schools, and hospitals. Other stakeholders, such as non-profit organizations and businesses, would also be welcome to join the programs.

Another way of promoting energy efficiency is through public education campaigns that could spread the word about the benefits related to lower energy consumption. The city of Puebla could join efforts with an advertising and marketing company to develop a strategy for providing information on energy efficiency issues. Such campaigns can rely on a number of communication tools, such as posters, billboards, leaflets spread throughout the city, in addition to articles and ads in the local media.

Promoting waste collection in Altamira in Mexico

Source: factreports.revues.org

One of the sectors that could be targeted in Puebla's communication strategies is solid waste. The City, the public waste company, OOSL, and the private operators can organize public campaigns to raise awareness about separating organic from recyclable wastes. Moreover, such public campaigns could also help promote the new recycling initiative "*Basura por seguridad*" (Waste for safety), a joint initiative between the city of Puebla and the private sector.

Public campaigns can target other sectors as well, such as water and transport. For example, the city managers of Puebla could encourage citizens to bike and walk, and rely less on their private cars.

Promoting solid waste recycling

Source: www.pcwastemgmt.com

Moreover, the city can continue to promote bike sharing programs at affordable rates. Also, the local government can take initiatives to increase awareness on the benefits of public transport. Such a campaign could focus on promoting public transport as a reliable, fast comfortable, cheap, and accessible means of transportation in comparison to private vehicles.

Promoting public transport

Source: www.irenesoo.wordpress.com; www.bangalore.citizenmatters.in

Another method of raising awareness is through the use of local energy efficient champions, who teach people about the importance and benefits of energy efficiency. The City could recruit and train, on a voluntary basis, a few well-known or famous individuals, including local authority figures

(e.g., government, businesses, or health) or music or film stars, to spread the word about the benefits of reducing energy consumption. The City could provide knowledge and logistical support to the energy efficiency champions, and monitor their progress. The local government can also monitor the number of people participating in training programs, hits on energy efficiency websites, relevant articles in the media, and the number of energy efficiency champions.

The County of Meath, Ireland is a good example of how public campaigns on energy efficiency can inform people the subject. The local authorities extended the Energy Awareness Week to all residents of the County by using a dynamic campaign to raise public awareness among consumers through several activities, such as visits to schools, information displays, widespread media coverage, a "Car Free Day," and offering CFL light bulbs.

Car free day in Brussels

Source: wikipedia.org

Not only did the campaign help significantly increase the interest in energy efficiency, but it also encouraged residents to use sustainable energy and transport options. The campaign's cost was less than US$5,000, not factoring in prizes and sponsorships provided by local companies and other energy related entities.

In 2000, Car Free Day was established by the European Commission as a European-wide initiative to encourage people to abandon their cars for one day. Many cities across Europe mark September 22nd as the day when they walk and bike and leave their private vehicles at home.

ANNEX TRACE PUEBLA RECOMMENDATIONS

Detailed Recommendations from TRACE

Improving Energy Efficiency in Puebla, 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.

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.

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

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 USD 120,000 and the retrofit was completed within a 3-month period. Annual energy savings of 56 percent were achieved, delivering the equivalent of USD 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 between Clinton Climate Initiative (CCI) and the city of Los Angeles, 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-privet 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 favorable 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
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: PROCUREMENT GUIDES FOR NEW STREET LIGHTS

DESCRIPTION

Traditionally used incandescent bulbs in street lights, are highly inefficient in that they produce little light and much heat energy from their significant power consumption. They are often also poorly designed, emitting light equally in all directions unnecessarily, including the sky above, which further increases their energy inefficiency. New bulb technologies can often significantly increase their efficiency as well as extending their design life. Traditionally used luminaires usually have short design lives of about five years, requiring frequent replacement. The aim of this recommendation is to produce a guide to inform the procurement of new bulbs when replacing faulty ones.

The replacement of lighting technology can deliver the same lighting levels for lower energy consumption, reducing associated carbon emissions as well as operational costs. The improved design life also reduces maintenance requirements and costs and further reduces interruptions to service, thereby improving public health and safety.

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
Financial savings

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Improved Street Lighting Design Manuals	Prepare a design manual for public street lighting which follows best practice IESNA public lighting for visibility and safety guidelines. The design manual should include parameters for illumination, pole spacing recommendations, luminaire and lamp type recommendations and dimming or time of night illumination operations for all types of streets in the city.
Energy Service Contracts for new street lighting installations	Prepare an RFP for energy service companies (ESCOs) to bid on providing street lighting illumination for the city. The requirement should include design, installation, maintenance and operational (energy) costs. The contracts should be for a long time period (more than 10 years) and include strict requirements for illumination (minimums and maximums). The goal of the contracts will be to entice competition in the private sector to provide the lowest operational cost possible.
Life Cycle Cost analysis component in	Require all procurement submissions for purchasing of new street lighting installations, lamp replacement purchases, or maintenance costs to provide a

procurement submissions	life cycle analysis of first cost, maintenance costs and energy costs over the span of 7 years.

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:

- Lumens / Watt - efficacy of illumination for the current design standards for lamp procurement
- Watts / km - averages for different street widths and types

CASE STUDIES

Midlands Highway Alliance (MHA), UK http://www.emcbe.com/Highways-general/idea%20case%20study.pdf Working under the East Midlands Improvement and Efficiency Partnership (EMIEP), the Midlands Highways Alliance (MHA) will save the region GBP11 million across highways maintenance and improvements by 2011. Supported by Constructing Excellence, the nine councils in the region and the Highways Agency have been making efficiency savings through a best practice procurement framework for major and medium sized highways schemes and professional civil engineering services, sharing best practice in maintenance contracts and by the joint procurement of new technologies such as street lighting and signage. The document outlines the minimum and desired specifications for street lighting technologies in order to achieve the carbon emissions and cost reductions required.
"Lighting the Way" Project, Australia http://www.iclei.org/fileadmin/user_upload/documents/ANZ/CCP/CCP-AU/EnergyToolbox/lightingtheway.pdf Australia is committed to reducing its growth in greenhouse emissions. Currently initiatives are underway at all levels of government to improve the efficiency of public lighting, including State and local government trials of more efficient public lighting. Public lighting of minor roads is a major source of greenhouse gas emissions for local government. There are many opportunities to improve the quality of the lighting while reducing both the costs and greenhouse emissions. The various stakeholders have produced a procurement guide, "Lighting the Way", which provides information to assist local governments in improving the public lighting of minor roads in their communities while reducing their greenhouse emissions, lowering their costs and decreasing their liability and

risk. These outcomes can be achieved through use of energy efficient solutions that provide better service in street lighting and comply with Australian Standards (AS/NZS 1158).
It outlines technical and other issues related to energy efficient lighting. It also provides some guidance for councils on techniques to improve their ability to negotiate public lighting issues with distribution businesses. A number of lamp types offer considerable advantages over the standard 80 watt mercury vapour lamps in terms of power consumption, lumen depreciation, light output, maintenance, life span, aesthetics and performance in various temperatures.

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
New York State Energy Research and Development Authority. "How to guide to Effective Energy-Efficient Street Lighting" Available online from http://www.rpi.edu/dept/lrc/nystreet/how-to-officials.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

ANNEX 3: MUNICIPAL BUILDING BENCHMARKING

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).

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

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

	• 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 fulfil these recommendations. The plan contains programmes 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 programme of energy management to ensure their operating efficiency is maintained throughout their life span. The BEEMP consists of the following programmes:

- 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 Labelling Programme, Singapore
http://www.e2singapore.gov.sg/buildings/energysmart-building-label.html
The Energy Smart Building Labelling 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 polluted 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
Energy Efficient City in Russia: Workshop Proceedings, June 2010. A guidance document for Preparing, Financing and Implementing Municipal Energy Efficiency Programs. http://www.esmap.org/esmap/sites/esmap.org/files/Russia%20EE%20Cities%20Proceedings%20ENG%20080210.pdf

ANNEX 4: 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 • 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 include equipment retrofits, behavioral

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

	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% 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 hall (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 5: MANDATORY BUILDING ENERGY EFFICIENCY CODES FOR NEW BUILDINGS

DESCRIPTION

This project is a city-specific green building guidelines or certification program to encourage the use of green building technologies. The guidelines can be based on previously established systems such as LEED (USA), BREEAM (UK), CASBEE (Japan), Green Mark (Singapore), Estidama (Abu Dhabi) or many others. It should focus on energy efficiency, but should also cover water conservation, urban heat island effect (green roofs), indoor air quality, and many other aspects of green buildings. The program can take many forms such as: voluntary guidelines, minimum building standards, an incentive program for private developers. The benefit of this program is to advance higher quality building design and construction and promote energy efficiency for all of the buildings in the city, saving money, saving water, and making better buildings to live and work.

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum
First Cost
< US$100,000
Speed of Implementation
> 2 years
Co-Benefits
Reduced carbon emissions
Efficient water use
Increased employment opportunities
Financial savings

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Assess opportunities	Assess the climate, building types, real estate market and construction industry for green building opportunities. Evaluate other green building guidelines in the region and globally and identify the most relevant strategies
Perform cost - benefit analysis	Assess the general costs of each of the green building strategies in the specific city in terms of new construction for code-based design versus green building design strategy. Provide ranges of additional cost as well as ranges of savings and co-benefits of the strategy beyond pure financial benefits.
Draft Guidelines (voluntary approach)	Create custom-green building design guidelines that are city-specific guidelines and respond to the conditions of the city as researched above (climate, construction practices, safety, financial, market, etc.). The design guidelines can be distributed to the public and encouraged to be used voluntarily by progressive developers, designers and building owners.
Draft Incentive Program (Incentivized approach)	Along with the design guidelines, create a program to incentivize the construction of exceptional green building design by providing tax credits, zoning benefits, quicker approvals or other tertiary benefits that the development

	community will respond to.
Draft Green Building Code (mandatory approach)	If a voluntary approach or an incentive-based approach does not seem likely to succeed, and the design and construction community responds better to mandatory requirements, then reform the guidelines into the form of a code and find ways to update the local building code to include requirements of green building design. See Seattle case study as an example of best practice.
Public outreach	Distribute the draft guidelines to the real estate community, construction community, design community, and residents and citizens of the city. Along with the guidelines produce.
Enact Green Building Ordinance	With public comments integrated, a full set of technical and financial analysis completed, and potentially a small number of demonstration projects to point to, enact a law, ordinance or executive order to implement the green building guideline/incentive program/code.

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 - benchmark electrical energy consumption on a per-square-meter basis.
- kWht/m2 - benchmark heating energy consumption on a per-square-meter basis.
- $/m2 - Benchmark energy cost on a per-square-meter basis for all buildings.
- Number of buildings certified under (new/other) codes.

Energy Efficiency Codes in Residential Buildings, Tianjin, China.

Source: ESMAP (2011). "Good Practices in City Energy Efficiency: Tianjin, China -Enforcement of Residential Building Energy Efficiency Codes", available online from http://www.esmap.org/esmap/node/1280

Tianjin is one of the most successful Chinese cities in compliance enforcement of building energy efficiency codes (BEECs). Results of recent annual national inspections organized by the Ministry of Housing and Urban and Rural Development (MoHURD) indicate that compliance of BEECs in new residential and commercial buildings in Tianjin is close to 100 percent, compared to the 80 percent average across nearly three dozen large cities inspected by MoHURD in 2008. More remarkable is the fact that, in terms of building envelope thermal integrity, the currently enforced residential BEEC in Tianjin (identified as DB29-1-2007) is 30 percent more stringent than what is required by the pertinent national BEEC (identified as JGJ 26-95).

In 1997, Tianjin introduced its first mandatory residential BEEC (identified as DB29-1-97), which is equivalent to the requirements of the JGJ 26-95, the national model BEEC for cold climate regions enacted in 1995. DB29-1-97 was enforced from 1998 to 2004. Enforcement actually began on January 1, 2005; it was based on an earlier version which was updated and reenacted on June 1, 2007. This case study covered five years of enforcement of DB29-1-2007, from 2005 to 2009.

Tianjin's efforts to go beyond national BEEC requirements marked a departure from the mostly central government-driven BEEC regulation of the past in China. Tianjin began piloting residential BEEC in the late 1980s, despite the fact that it has taken about 15 years for Tianjin to achieve a high degree of compliance. Tianjin has demonstrated the importance of the following factors in achieving BEEC compliance: (i) a well-established building construction management system, (ii) standardized and structured procedures for compliance enforcement, (iii) broad-based capacity of the construction trades to meet compliance requirements, including technical skills and availability of parts and materials, (iv) consumers' ability and willingness to pay for the costs of BEEC compliance, and (v) local government resources, support, and commitment to implementing increasingly stringent BEECs.

Low-energy Building Standards, Münster, Germany

Source: ESMAP (2011). "Good Practices in City Energy Efficiency: Low-energy Building Standards through Sale of City-owned Land, Münster, Germany", available online from http://www.esmap.org/esmap/node/1170

By mandating low-energy building standards in sales contracts of city-owned land, the City of Münster (Germany) caused a market transformation that led to 80 percent of all new buildings constructed in 2010, even those not built on city-owned land, to follow the city's energy efficiency requirements.

Austin Energy Green Building (AE/GB), Austin, USA

http://www.austinenergy.com/energy%20efficiency/Programs/Green%20Building/index.htm

http://www.c40cities.org/bestpractices/buildings/austin_standards.jsp

In 1991, Austin Energy Green Building (AE/GB) developed the first city-wide tool for evaluating the sustainability of buildings in the U.S. It is made up of four programs, covering single family homes, commercial, multi-family and governmental or utilities buildings. As a market transformation program it provides technical support to homeowners, architects, designers and builders in the design and construction of sustainable buildings. Using green building rating tools specifically developed for Austin, along with the LEED and Green Globes national rating tools, Green Building's staff assist design teams to establish green building goals, review plans and specifications, make recommendations for improvements, and rate the final product on its impact to the environment and community.

AE/GB has produced $ 2.2 million in annual financial savings from reduced energy costs to consumers. The initial investment of $1.2 million for the project came from an annual budget (including a $50,000grant from the US Department of Energy). The AE/Gb has also reduced energy consumption by 142,427 megawatt hours and reduced demand on the utility's generation resources by 82.8 megawatts. These energy savings have resulted in the reduction of power plant CO2 emissions by 90,831 tons, NOx by 87.6 tons, and SOx by 17.4 tons.

Sustainable Building Action Plan, Seattle, USA

http://www.c40cities.org/docs/casestudies/buildings/seattle_green.pdf

Under the Sustainable Building Policy, Seattle requires that all new city buildings over 5,000 square feet meet new state LEED (Leadership in Energy and Environmental Design) building ratings, which measure the sustainability of buildings. The city provided financial, height and density bonuses for private projects meeting LEED.

Seattle implemented programs such as the Sustainable Building Action Plan (with key strategies to promote green buildings), the Density Bonus (offering downtown commercial, residential and mixed use developments greater height and/or floor area if a green building standard of LEED silver or higher is met), and the City LEED Incentive Program (providing financial incentives for energy conservation, natural drainage/water conservation, and design and consulting fees for LEED projects).

Between 2001 and 2005, the city provided incentives of over $4.3 million for projects implementing LEED standards. The standards have produced average reductions of 35 percent in energy use and 6.9 million KWh/annually for LEED Municipal buildings. Other benefits from the scheme included an average reduction of 1,067 CO2e tonnes per LEED building, along with an annual average financial saving of $43,000 per LEED building.

Green Building Guidelines, Cape Town, South Africa

http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Documents/DRAFT City of Cape Town Green Building Guidelines.pdf

The City of Cape Town plans to enact a bylaw by 2012 to call for environmentally-friendly building methods. The Draft Green Buildings Guidelines will form the core of the planned bylaw, actively promote resource efficient construction of new or renovated buildings in Cape Town to minimise the negative environmental impacts of the built environment, whilst maximising positive social and economic impacts. In the long-term the City will work towards design manuals and legislation to ensure the implementation of green buildings.

The Green Building Guidelines document is aligned with the Green Building Council of South Africa, which has incorporated the Green Star Rating system of the Green Building Council of Australia. It is envisaged that the City of Cape Town will also incorporate the Green Star Rating system in the future.

The guidelines for the implementation of green buildings are specific to Cape Town, including advice on site selection, design and construction phases, sustainable resource management, waste management, urban landscaping, human health and safety and visual mitigation measures.

TOOLS & GUIDANCE

Tools & Guidance
http://www.epa.gov/region4/recycle/green-building-toolkit.pdf

ANNEX 6: INTERMEDIATE TRANSFER STATIONS

DESCRIPTION

Use transfer stations for bulking of waste to help minimize the number of trips to treatment facilities by smaller city based waste collection vehicles. This recommendation has good synergies with the recommendation "waste vehicle operations fuel efficiency standards" and the city authority should consider implementing them together.

Reducing the distance travelled per ton of waste can reduce energy demand associated with transfer of waste to large treatment facilities (such as landfills). Co-benefits include a reduction in the number of waste vehicles travelling long distances, leading to reduced noise and dust in residential areas, improved road safety, and improved air quality.

ATTRIBUTES

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

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Provide transfer stations as part of the Solid Waste Management Plan	The city authority works with its planning department and waste management team to identify shortfalls in the city's waste collection system and improve the city's Solid Waste Management Plan. Create a flow map of waste that includes the existing waste catchment and planned city development, to highlight gaps and inefficiencies in the city's waste management system and identify opportunities to provide waste transfer stations. The city authority can also seek support from private waste management companies in return for procurement of city waste collection catchments. See New York and British Columbia case study for further details.
Planning regulations for waste management	The city authority planning department makes waste management an integral part of the city's spatial planning strategies, allocating land for waste transfer stations and other facilities in accordance with the Solid Waste Management Plan. Where appropriate, waste management regulations and guidelines should

	also be included within the city's development control documents, for example, requiring developments above a certain size to integrate waste transfer stations into master plans when certain densities are reached. In order to ensure a site's suitability, coordination is essential with the city's waste management strategy, urban development plans and environmental plans. See Kuala Lumpur and Birmingham case studies 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:

- Energy use per ton of waste for collection transportation and disposal (MWh)
- Total city energy use for waste transportation per ton of waste (MWh/t)
- Total annual waste mileage (km)
- Kilometers travelled per ton of waste (km/t)

Assess number and location of waste transfer stations and map against waste catchments in municipality. Waste catchments can be based on daily collection route extent, districts, or capability of waste collection fleet.

Track city development and establish mapping regime of existing and potential waste transfer stations against expanding municipality catchments.

Ensure distances from collection points to treatment facilities do not exceed recommended travel distances as supplied by vehicle manufacturers.

Compare fuel use per volume or mass of waste transferred pre- and post-transfer station implementation.

Solid Waste Management Plan, New York City, USA

http://www.plannyc.org/taxonomy/term/762

The mayor of New York initiated a Solid Waste Management Plan (SWMP) in 2006 as a framework for dramatically reducing the energy use associated with waste disposal in the city while implementing a cost-effective and environmentally sound system for managing the city's waste. The plan involved the assessment of existing transfer stations to maximize waste management efficiency and create a more equitable distribution of waste storage, transfer and disposal throughout the boroughs.

By exporting 90 percent of the city's residential waste by barge or rail (rather than by truck), the program will reduce waste truck miles by 2.7 million per year and reduce tractor-trailer travel by 3 million miles per year. This relies on updating transfer stations in every borough, re-opening eight disused transfer stations, and the building of seven new marine transfer stations within the city. The marine transfer stations, due for completion in 2013, are also expected to reduce waste truck travel by 3.5 million miles. However, some sources claim that the marine transfer stations will increase the cost of waste disposal from $77 per ton to $107.

The project has faced challenges with the construction of the new transfer stations, which has been held-up by lawsuits and community organizations concerned about increased truck traffic, air and noise pollution and water dredging that may harm nearby wildlife. Due to this, only two of the seven marine transfer stations were under construction by May 2010 and none of the barges are being utilized. In March 2009, the Mayor signed a 30-year contract with a private waste management company to oversee a program for transporting waste from Brooklyn's transfer stations to out-of-state landfills by train.

Municipal Solid Waste Guidelines, British Columbia, Canada

http://www.elp.gov.bc.ca/epd/epdpa/mpp/gfetsfms.html

The regional authority (Ministry of Environment) funded a project to prepare a report on guidelines for establishing transfer station facilities for municipal solid waste. The authority hired a private engineering consultancy in Victoria, BC to produce the report on transfer station methodologies, using examples to recommend siting, design and operational guidelines for establishing transfer stations. The guidelines also include cost models that compare direct haul in collection trucks with transfer haul to a landfill, and rural landfills with rural transfer stations. Such cost models can be used as an aid to decide whether a transfer station is justified under particular conditions, as they identify operational and capital costs in detail per relevant case study. The report covers potential issues for future implementation, and the detailed examples of transfer station operation/capital costs in the report make it applicable to municipalities during the implementation of their solid waste management plans.

Kuala Lumpur Waste Structure Plan 2020, Kuala Lumpur, Malaysia
http://www.dbkl.gov.my/pskl2020/english/infrastructure_and_utilities/index.htm

The Kuala Lumpur Structure Plan 2020 is the strategic spatial development plan for the capital, which includes guidelines on improving the quality of its infrastructure and utility services. Solid waste collection and disposal services are integrated into the Structure Plan where coordination of existing landfill sites and capacities are outlined, supported by the allocation of new transfer stations in the city. The Structure Plan identified the limited capacity of the Taman Beringin landfill site, leading to the transfer or waste to a private landfill site outside the city in Air Hitam. Plans for a new transfer station at Taman Beringin is to be built to support this waste transfer, by sorting waste for recovery of recyclables and compacting of the remaining waste before it is transported to the Air Hitam site for disposal by sanitary landfill. The distribution of existing solid waste disposal sites and transfer stations are planned and mapped out in the structure plan.

Veolia Environmental Services Waste Transfer, Birmingham, UK
http://www.veoliaenvironmentalservices.co.uk/Birmingham/

Veolia Environmental Services, a private waste management company, operates two major waste transfer stations in Birmingham, in the north and the south of the city. These play a key role in managing the waste arising of the city and act as focal points for recycling management.

The transfer stations accept kerbside collected waste from Birmingham City Council refuse vehicles. This waste is then bulked up and transported either to the recycling re-processor, the Energy Recovery Facility (ERF) at Tyseley or to landfill.

A normal refuse vehicle will hold about 8 tons of rubbish. Bulk vehicles will hold up to 25 tons, which means that vehicle movements are reduced by a third by the use of the transfer stations. It also means that refuse collection vehicles do not have to travel across the city to deposit their rubbish, but rather they run into the nearest transfer station. A considerable portion of the rubbish brought to the ERF is transported at night to reduce traffic congestion and improve the efficiency of the operation.

The transfer stations also act as bulking stations for the recyclable materials that are collected either from the kerbside or from the Household Recycling Centres, reducing vehicle movements, easing congestion and reducing the environmental impact of transporting Birmingham's recyclable materials.

TOOLS & GUIDANCE

Tools & Guidance
"Guidelines for Establishing Transfer Stations for Municipal Solid Waste" http://www.env.gov.bc.ca/epd/epdpa/mpp/gfetsfms.html
"Waste Transfer Stations: A manual for decision making" (US Environmental Protection Agency)

Tools & Guidance
http://www.epa.gov/osw/nonhaz/municipal/pubs/r02002.pdf

ANNEX 7: WASTE INFRASTRUCTURE PLANNING

DESCRIPTION

Waste treatment infrastructure design, allocation and distribution can directly or indirectly influence the use of energy. Measures that assess current waste infrastructure energy use and how it interacts with other aspects of the city's waste management strategy help ensure that waste treatment infrastructure is operating at its highest efficiency.

The objective of this recommendation is to enable the city authority to identify opportunities in waste treatment infrastructure that affect energy use.

Reduced fuel consumption and energy use as a result of good planning and allocation of suitable facilities.

More efficient and effective processes to treat more waste and/or more waste types.

Co-benefits include increased diversion of waste to recycling or reuse activities, reduced air emissions (odour) and reduced staffing requirements for the same tasks allowing wider coverage of waste services.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Set up program to audit energy used in waste management	The city authority sets up an auditing program for monitoring and collection of data, using either an in-house team or hiring a suitably qualified consultant where required. The audit program can be used to assess the city's performance and review the city's approach to waste management where necessary. This implementation lever can be easier for the city authority because much of the effort is centralized; however, close collaboration with waste authorities (if they are established) is essential to the success of this program. See Melbourne and London case studies for further details.
Planning regulations: Plan for new infrastructure	Ensure that city planning policy and strategies allocate land for new waste infrastructure that aligns with the city waste management strategy and wider urban plans. Allocating land on a city scale provides a framework

ATTRIBUTES

Energy Savings Potential
100,000-200,000 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
Operational efficiency
Security of supply
Time savings
Reduced waste vehicle traffic

	that can bring together disparate planning procedures to establish the most effective waste management strategy for the city. See Melbourne and London case studies for further details.
Enforcement: Annual Environmental Reports	Assess energy use for all waste infrastructure by monitoring how much fuel and energy is used per ton (or m3) of waste collected, transported and treated. Aim to require all operators and plants to submit yearly data on energy use in an Annual Environmental Report (AER). The AER is also an opportunity to capture waste tonnage data. See London case study for further details. This implementation activity works well with educating operators about the benefits of efficient operations.
Work with private waste collectors to seek energy savings in waste treatment infrastructure	Seek savings in energy by working with the private waste sector and community led waste collection schemes. Savings can be achieved by combining waste quantities and treating as a single bulk product. The private sector may be interested in filing infrastructure gaps via revised collection regimes, and a waste management strategy would identify such savings opportunities. See Dhaka, Melbourne and London case studies for further details
Subsidies: Encourage development of multi modal waste transfer systems	Offer land and or tax incentives to encourage movement of waste by rail or barge thereby reducing road traffic. National, regional or local funding streams should be tapped into to help finance more efficient waste treatment infrastructure. See London and Italy case studies 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:

- energy use per ton or cubic meter of waste treated city wide and for each plant
- percent reduction in energy use per ton of waste per year

Monitor fuel and energy use per ton or cubic meter of waste treated in the city - include energy used in collection, transportation and treatment and monitor separately where possible.

Require all plants to submit yearly data on energy use in an Annual Environmental Report (this is also an opportunity to capture waste tonnage data). Assess changes in energy use each year.

Create a city waste management strategy (or assess and improve the current strategy), detailing allocation of city-wide waste infrastructure. Aim to reduce energy associated with pre-treatment of waste. Create 5 year schedule for review of waste management strategy.

Assess any involvement on third party waste operators who are collecting commercial or community waste in the municipality. Seek synergies for mutual gains, for example, increasing waste volumes to maximize energy efficiency in plants.

CASE STUDIES

The Metropolitan Waste and Resource Recovery Strategic Plan, Melbourne, Australia

Metropolitan Waste Management Group "The Metropolitan Waste and Resource Recovery Strategic Plan" http://www.mwmg.vic.gov.au

BVSDE "Towards Zero Waste -A Material Efficiency Strategy for Victoria, Australia "http://www.bvsde.paho.org/bvsacd/iswa2005/zero.pdf The Metropolitan Waste Management Group (MWMG), a statutory body of the state government, produced the Metropolitan Infrastructure Schedule as part of the wider Metropolitan Waste and Resource Recovery Strategic Plan. The objective of the schedule is to give an overview and assessment of existing municipal waste infrastructure across Melbourne, with the aim of identifying improvements to enable MWMG to recover more waste in the future

In formulating the schedule, MWMG carried out studies on infrastructure needs, existing infrastructure, future recovery opportunities, future waste infrastructure considerations and upgrades or new infrastructure. Models to consider the merits of different improvement options were established to assess environmental, social and economic impacts. In addition, a private engineering consultancy was appointed to model and develop an analysis of

options for the Strategic Plan to identify opportunities for recovery of materials sent to landfill for disposal, including municipal waste clustering opportunities. This incorporated economic costs and benefits, life-cycle assessment (greenhouse gas emissions, energy and water consumption, air emissions and waste to landfill) and an assessment of transport options and impacts.

The studies identified existing composting facilities, transfer stations and MRFs as being the key areas of improvement. For example, the options which provided the best results for "energy from fossil fuel use" were two types of 3 bin systems, one which included separate bins for recyclables, garden and food (for anaerobic digestion) and residuals (for landfill) or alternatively a system with separate bins for recyclables, garden (for aerobic composting) and residuals (containing food, for thermal treatment). These options will be financed from household collection fees, ranging from US$ 137-158 per household per year.

The implementation of the schedule comes from US$ 9 million in State Government funding, set aside for the wider Strategic Plan. Additionally, a landfill levy of up to US$ 13.50 per ton helps to support the funding of waste infrastructure, innovation, development and other improvements in efficiencies for waste management in Melbourne.

London Municipal Waste Strategy, London, UK

"The Mayor's Draft Municipal Waste Management Strategy" http://legacy.london.gov.uk/

"Research and Information Plans 2006/07"www.londoncouncils.gov.uk/London%20Councils/ResearchandINformationPlans0607FINA.pdf (must be downloaded as a .pdf)

Cory Environmental http://www.coryenvironmental.co.uk/page/RRRcasestudy1.htm

Clinton Climate Change Initiative, C40 Cities http://www.c40cities.org/londonwasteworkshop/downloads/07%20-%20Shanks%20-%20ELWA%20Case%20Study.pdf

Freight On Rail http://www.freightonrail.org.uk/CaseStudyWasteByRail.htm

WasteDataFlow http://www.wastedataflow.org/home.aspx

The London Municipal Waste Strategy aims to achieve greater regional self-sufficiency by developing new infrastructure, keeping the value of London's waste in the capital and focusing on new low-carbon technologies in waste management (e.g. away from bulking and transfer facilities to resource recovery parks). The Greater London Authority (GLA) is developing a London-wide site framework in partnership with waste authorities to collect data on current, planned and potential waste sites at a local and regional level to help the London Waste and Recycling Board determine the type, number and location of the waste facilities needed over a set period. Financial assistance from the board (US$ 114 million) is dedicated to the development of new facilities for collection, treatment and the disposal of waste, supported by external funding from strategic partners (joint ventures, private investors, EU

match funding). The Mayor also works with waste authorities to promote more sustainable forms of transporting waste, by maximizing the potential use of rail and water transport.

The GLA works with national organizations, local authorities as well as private waste operators to deliver its strategy. For example:

o GLA works jointly with the national Department for Environment, Food and Rural Affairs (DEFRA), the Environmental Agency and London councils on the annual collection, validation dissemination of waste statistics for London. WasteDataFlow is an online web-based reporting system used by all UK local authorities, which provides information which can be used nationally, regionally and by boroughs to inform best practices and strategy.

o Cory Environmental (CE) has a 30 year waste management contract from four London boroughs from households and businesses. To support and safeguard its waste operations, CE is building the Riverside Resource Recovery Facility (RRR), claimed to be one of UK's most efficient energy-from-waste plants with an annual throughput of 670,000 ton. The new riverside operation will help remove more than 100,000 heavy good vehicle trips from the roads each year. The project is financed by a term facility of up to US$ 728 million from private banks, with US$ 124 million of equity finance provided by CE.

o The East London Waste Authority (EWLA) uses a private company to transport its solid household waste. The contract is via a Private Finance Initiative (PFI) Integrated Waste Management agreement, which provides $US 204million for the construction of the waste-by-rail transfer service from an upgraded railhead as well as innovative technologies to improve ELWA's waste treatment facilities.

Solid Waste Management Project, Dhaka, Bangladesh

Kitakyushu Initiative for a Clean Envrionment "Solid Waste Management in Dhaka City"
http://kitakyushu.iges.or.jp/docs/mtgs/seminars/theme/swm/presentation/3%20Dhaka%20%28Paper.pdf

Dhaka City Corporation (DCC), responsible for solid waste management in Dhaka, encouraged private and non--profit organizations to organize community waste management programs in line with the implementation strategies set out in the citywide Solid Waste Management Plan. The

Dhanmondi Solid Waste Management pilot project was the first DCC-approved solid waste management project. The project was carried out by SCPL, a local private consultancy, with assistance from DCC. The main objectives of the project were to upgrade waste infrastructure (household collection containers and municipal garbage containers) and to provide door-to-door garbage collection services. After an initial assessment, SCPL supplied 2 waste bins (one red and one blue) to every household for separating waste into inorganic and organic waste at the source. The collected waste was disposed of at central dumping sites within each block, where the containers were monitored by SCPL workers. The waste was subsequently transferred by DCC waste vehicles to the central dumping sites. SCPL collects a monthly charge from each household, which also covers the workers' salaries. The project has significantly reduced air, water and soil pollution in the area and the separation of wastes has made it easier for the authorities to sell inorganic materials to recycling companies. This has reduced the volume of waste as only organic materials are carried by DCC trucks to secondary dumping sites. The project has also helped generate positive behavioural changes within the community

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

CONAI Environmental http://www.pro-e.org/Financing_Italy.html

Waste services in Italy are delivered through public bodies known as 'ATOs', which are normally funded directly by local authorities and are responsible for defining the services required to manage local authority waste streams. New waste management infrastructure is often funded directly from the local authorities' own resources, although for large facilities some private finance is also obtained through a form of prudential borrowing. In some cases waste facilities or services are 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. For example, the CONAI packaging management scheme, which places an eco-tax on all packaging used for the sale of goods on the Italian market, generates annual revenue of US$ 324million, a proportion of which is used to finance new waste infrastructure.

ANNEX 8: AWARENESS-RAISING CAMPAIGN

DESCRIPTION

Public education and training campaigns will increase the public's awareness and understanding of the benefits of energy efficiency and can help change attitudes towards energy efficiency. Providing information on easy ways to be more energy efficient can help modify citizen behavior and contribute to overall energy-savings. This can be achieved through

- Advertising campaigns
- Public events
- Articles in the local press
- User-friendly website providing information about energy efficiency
- Training programs in schools, community centres and businesses
- An 'energy efficiency champion' program

Key benefits are more efficient energy behaviours by residents leading to reduced energy consumption within the city. Indirect benefits include reduced pressure on energy infrastructure, reduced carbon emissions and better air quality.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Targeted training programs	Working with an experienced education/training provider, the city authority develops training programs which can be rolled out in schools and offices. These programs should target big energy users, for example, offices. These programs can also be implemented through a partnership with other organizations, such as utility companies, businesses and NGOs.
Public education campaigns	Working with an advertising and marketing company experienced in public education campaigns, the city authority develops a strategy for providing information on energy efficiency to all residents. This can include posters, billboards and leaflets, as well as public media announcements and advertisements. A partnership can be created with a business or utility company to help finance this.

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
Financial savings
Security of supply

Energy efficiency champions	The city authority recruits local energy efficiency champions and trains them to teach people about the importance and benefits of energy efficiency. Champions can be anyone interested in spreading the message about energy efficiency, for example, local authorities, businesses, local community groups, NGOs, health trusts, school children and other individuals. This implementation activity can be carried out in a number of ways: • Ask champions to come to a 'train the trainer' course and provide them with support to run sessions within their own community. • Teach champions about simple ways to save energy, and then give them leaflets to distribute in their community. Ensure that champions inform people that they are the local contact for any energy efficiency questions. Since energy efficiency champions are often volunteers, an officer should be appointed to provide support and encouragement, conduct regular follow ups and monitor progress of each energy efficiency champion program.

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:

- Number of people participating in training programs annually
- Number of hits to city energy efficiency website monthly (if developed) or number of requests for energy efficiency measures
- Number of articles in the press about energy efficiency in the city.
- Number of energy efficiency champions trained (if this option is chosen)

PlaNYC, New York

PlaNYC http://www.nyc.gov/html/planyc2030/html/plan/energy.shtml ;
http://www.nyc.gov/html/planyc2030/downloads/pdf/planyc_energy_progress_2010.pdf

PlaNYC is a comprehensive sustainability plan for the city's future. The plan puts forth a strategy to reduce the city's greenhouse gas footprint, while also accommodating a population growth of nearly one million, and improving our infrastructure and environment. Recognizing the importance to reduce global carbon emissions, and the value of leading by example, New York has set the goal of reducing its citywide carbon emissions by 30 percent below 2005 levels.

Within the Energy sector of the plan, the city has an initiative to undertake extensive education, training, and quality control programs to promote energy efficiency. By 2010, the city launched an energy awareness campaign, and set up training, certification, and monitoring programs. The plan proposes that these measures will be delivered through a series of partnerships until an Energy Efficiency Authority is established.

Energy Efficiency Office, Toronto, Canada

City of Toronto http://www.toronto.ca/energy/saving_tips.htm

The Energy Efficiency Office in Toronto provides energy saving tips for households, businesses and developers on the city's website. As an example, the Energy Efficiency Office conducts the Employee Energy Efficiency at Work (E3@Work), an awareness program designed to save money and promote energy efficiency practices by managing office equipment power loads. Developed and implemented by the City of Toronto in 2002, the program is being promoted to business establishments and offices across the city. The goal is to reduce energy consumption and building operating costs, improve energy security and reliability and help preserve the environment.

Low Carbon Singapore, Singapore

Low Carbon Singapore http://www.lowcarbonsg.com

"Low Carbon Singapore" is an online community dedicated to help Singapore reduce its carbon emissions and move towards the goal of a low carbon economy. The project aims to educate individuals, communities, businesses and organizations on issues relating to climate change, global warming and clean energy, providing information, news, tips and resources on various ways to reduce carbon, including adoption of clean energy and energy efficient behaviors and technologies.

Low Carbon Singapore is published by Green Future Solutions, a Singapore-based business that promotes environmental awareness and action for a

green future through a network of green websites, events, presentations, publications and consultancy.

Carbon Management Energy Efficiency (CMEE) Programme, Walsall Council, UK

Walsall Council http://www.walsall.gov.uk/index/energy_awareness_staff_presentations.htm

Walsall Council has been rolling out energy awareness training by with the Carbon Trust under their funded Carbon Management Energy Efficiency (CMEE) programme, including:

- Energy surveys of the council's least energy efficient buildings
- Evaluating feasibility of combined heat and power (CHP) generation at the council's leisure centres
- Raising staff awareness through a number of energy presentations to senior managers, building managers, school caretakers and a number of the council's general staff. A total of 226 staff were trained in this round using presentations developed by the Carbon Trust and adapted, with the help of some of the environmental champions, to reflect Walsall Council's needs.

The aim of the CMEE programme is to identify and achieve significant carbon savings throughout the council and as a consequence financial savings too. By reducing their energy spent, the council will also reduce the number of carbon credits it has to buy under the Carbon Reduction Commitment, which comes into force in 2010.

Siemens Energy Efficiency Academy, Brisbane, Australia

Siemens http://aunz.siemens.com/EVENTS/ENERGYEACADEMY/Pages/IN_EnergyEfficiencyAcademy.aspx ; http://www.siemens.com/sustainability/report/09/pool/pdf/siemens_sr_2009.pdf

The Siemens Energy Efficiency Academy brings together some of the leading international and local experts to share their insights on government policy, emerging technologies, market drivers and best practice implementation.

Apart from adopting and showcasing its own energy efficient practices, it runs regular training programs for businesses across topics such as:

- Incentive schemes: Market mechanisms, grants and funding explained
- Building winning business cases for energy efficiency
- Energy Efficiency Policy in Australian Governments
- Next generation technology - What's next?
- Best practice implementation for variable speed drives and power quality
- Energy monitoring in Industrial and Commercial facilities

Energy Awareness Week, Meath, Ireland

ManagEnergy "EU LOCAL ENERGY ACTION: Good practices 2005" http://www.managenergy.net/download/gp2005.pdf

In 2004, the Meath Energy Management Agency's (MEMA) extended its Energy Awareness Week to everyone who lived or worked in the County of Meath, Ireland, using a concentrated burst of media campaigning to raise energy awareness among consumers. Visits to schools, information displays, widespread media coverage, competitions, a 'Car Free Day' and an offer of free CFL light bulbs encouraged participation at all levels. The campaign dramatically increased requests for information from the energy agency. The competitions and promotions also improved local knowledge of energy efficiency, and encouraged people to choose sustainable energy and transport options in the future.

Energy Awareness Week activities were coordinated and carried out by MEMA with the support of the Environment Department of Meath County Council. The direct costs for the campaign were US $ 4,470. This covered printing and copying of promotional materials, prizes, and provision of reflective jackets for walking bus participants. Additional prizes and sponsorship were provided by local companies and by Sustainable Energy Ireland (SEI).

TOOLS & GUIDANCE

Tools & Guidance
"EU LOCAL ENERGY ACTION: Good practices 2005" http://www.managenergy.net/download/gp2005.pdf

ANNEX 9: LIST OF ABBREVIATIONS FOR CITIES IN THE TRACE DATABASE

1	Addis Ababa	Ethiopia	ADD	40	Karachi	Pakistan	KAR
2	Amman	Jordan	AMM	41	Kathmandu	Nepal	KAT
3	Baku	Azerbaijan	BAK	42	Kiev	Ukraine	KIE
4	Bangkok	Thailand	BAN	43	Kuala Lumpur	Malaysia	KUA
5	Belgrade	Serbia	BE1	44	Lima	Peru	LIM
6	Belo Horizonte	Brazil	BEL	45	Ljubljana	Slovenia	LJU
7	Bengaluru	India	BEN	46	Mexico City	Mexico	MEX
8	Bogota	Colombia	BOG/BO1	47	Mumbai	India	MUM
9	Bhopal	India	BHO	48	Mysore	India	MYS
10	Bratislava	Slovakia	BRA	49	New York	USA	NEW
11	Brasov	Romania	BR1/BRA	50	Odessa	Ukraine	ODE
12	Bucharest	Romania	BUC	51	Paris	France	PAR
13	Budapest	Hungary	BUD	52	Patna	India	PAT
14	Cairo	Egypt	CAI	53	Phnom Penh	Cambodia	PHN
15	Cape Town	South Africa	CAP	54	Ploiesti	Romania	PLO
16	Casablanca	Morocco	CAS	55	Pokhara	Nepal	POK
17	Cebu	Philippines	CEB	56	Porto	Portugal	POR
18	Cluj-Napoca	Romania	CLU	57	Pune	India	PUN
19	Colombo	Sri Lanka	COL	58	Puebla	Mexico	PUE
20	Constanta	Romania	CON	59	Quezon City	Philippines	QUE
21	Craiova	Romania	CRA	60	Rio de Janeiro	Brazil	RIO
22	Dakar	Senegal	DAK	61	Sangli	India	SAN
23	Da Nang	Vietnam	DAN	62	Sarajevo	Bosnia and Herzegovina	SAR
24	Dhaka	Bangladesh	DHA	63	Seoul	South Korea	SEO
25	Gaziantep	Turkey	GAZ	64	Shanghai	China	SHA
26	Guangzhou	China	GUA	65	Singapore	Singapore	SIN

27	Guntur	India	GUN	66	Sofia	Bulgaria	SOF
28	Hanoi	Vietnam	HAN	67	Surabaya	Indonesia	SUR
29	Helsinki	Finland	HEL	68	Sydney	Australia	SYD
30	Ho Chi Minh	Vietnam	HO	69	Tallinn	Estonia	TAL
31	Hong Kong	China	HON	70	Tbilisi	Georgia	TBI
32	Iasi	Romania	IAS	71	Tehran	Iran	TEH
33	Indore	India	IND	72	Timisoara	Romania	TIM
34	Jabalpur	India	JAB	73	Tokyo	Japan	TOK
35	Jakarta	Indonesia	JAK	74	Toronto	Canada	TOR
36	Jeddah	Saudi Arabia	JED	75	Urumqi	China	URU
37	Johannesburg	South Africa	JOH	76	Vijayawada	India	VIJ
38	Kanpur	India	KAN	77	Yerevan	Armenia	YER
39	Leon	Mexico	LEO				