ECA Sustainable Cities:

Improving Energy Efficiency in BANJA LUKA

Bosnia and Herzegovina

Republika Srpska

TRACE Study





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The TRACE diagnostic is part of the toolkit of the ECA SCI, which aims to promote sustainable development in ECA cities. Work on the report was done under the guidance of Stephen Karam (ECA Urban Sector Leader) and Vesna Francic (Senior Operations Officer), with a team comprised of Ranjan Bose (Senior Energy Specialist), Marcel Ionescu-Heroiu (Extended Term Consultant), Adnan Papovic (Short Term Consultant), and Senad Sacic (Program Assistant). Throughout the process of collecting data and writing the report, the team has enjoyed an excellent collaboration with local authorities in Banja Luka.

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Executive Summary

Cities in the Western Balkans in Southeastern Europe are uniquely positioned to manage the region's growing challenges of rapidly increasing energy demand and greenhouse gas (GHG) emissions. Many cities in this region are currently at a turning point in their development as potentially energy intensive infrastructure and urban design becomes hard-wired into the city fabric, e.g., the growing popularity of private vehicles and corresponding low density development. These developments point to the urgency for city administrations to act decisively with progressive policies and actions that will put these cities in a strong position for the future, by addressing rising energy demand, mitigating GHG emissions and improving energy security.

Banja Luka with 258,000 people in 2011 is one of the growing cities in the Western Balkans. The City of Banja Luka is the administrative capital of the Republika Srpska, the second largest city in Bosnia and Herzegovina and by far the largest city in the northwest part of the country. After a period of population and economic decline and infrastructure depreciation in the 1990s, the economic recovery began after the 1995 Dayton Peace Agreement. The structure of the economy has moved from agricultural and industrial production to being service-based. The authorities believe that the energy sector, and within it, the electricity sector is one of the stronger sectors of the economy with the potential to contribute to economic development in the short and medium-term. With more resources made available locally by economic growth, energy efficiency (EE) is a factor considered by the Banja Luka City Authorities in capital investments such as investments in the replacement of inefficient light bulbs in street lighting systems, newly constructed energy efficient water treatment facility, on-going audits of the district heating system to improve overall EE in the system, etc.

Strategic development commitments in Banja Luka will not come without their share of challenges. First, the combination of relatively low energy prices and a degree of continuing electricity price subsidies are suppressing some energy initiatives. Second, Banja Luka has been rapidly sprawling outwards, with more and more people choosing individual detached housing over apartments in high-rise buildings. Car ownership has increased as incomes have risen with in-city car commuting has also increased as people from surrounding suburban areas seek each opportunities in Banja Luka; waste generation has grown hand in hand with increased consumption; and existing age old infrastructure networks (e.g. water and wastewater, and district heating) have often been left to deteriorate as local authorities have focused on providing basic services to the new and underserviced parts of the city.

Despite these challenges, Baja Luka gives the impression of a vibrant center that is poised to become an EE capital in the region. By signing of the *Covenant of Mayors* in February 2009, Banja Luka became the first city in BiH that voluntarily committed to increasing EE and use of renewable energy sources in the city and to meet and exceed the European Union 20% CO_2 reduction objective by 2020. To achieve this objective, in November 2010, the City prepared a Sustainable *Energy Action Plan (SEAP)* containing clear set of activities in targeting both private and public sectors. The following report, drawing on the results of the SEAP and implementation of a city diagnostic tool called TRACE (developed by the World Bank's Energy Sector Management Assistance Program (ESMAP)), hopes to offer some answers to how that can be achieved.

TRACE (Tool for Rapid Assessment of City Energy)[1] is a software platform for quickly assessing EE efficiency performance in six municipal sectors or service areas: urban passenger transport, municipal buildings, water and waste water, public lighting, solid waste, and power and heat. TRACE consists of three principal components: an energy benchmarking tool which compares key performance indicators among peer cities, a prioritizing process which identifies sectors that offer the greatest potential with respect to energy efficiency improvement, and a "playbook" of tried-and-tested EE measures which helps select the appropriate interventions. It is a simple, low-cost, and practical tool to assist city governments in developing locally appropriate EE strategies.

The TRACE analysis was carried out under the umbrella of the Europe and Central Asia Sustainable Cities Initiative (ECA SCI)[2], and is just

[1] More information on the TRACE can be found at: http://www.esmap.org/esmap/TRACE

[2] More information on the ECA SCI can be found at: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,contentMDK:23050220~pagePK:146736~piPK:146830~theSitePK:258599,00.html

one of the components used to assess the potential of promoting sustainable development in ECA. As such, the analysis and recommendations made in this report do not only focus on EE per se, but on sustainability in general. For our purposes, sustainable cities can be understood as resilient cities that can more readily adapt to, mitigate, and promote economic, social, and environmental sustain. The focus is on triple-bottom line outcomes, with an eye to how urban development can address economic/fiscal, social, and environmental issues.

To complete data collection and to get a more rounded understanding of issues in the city, a World Bank mission was organized during February 7-10, 2012. Work in Banja Luka was carried out in close collaboration with local authorities, who were consulted on all the critical steps in the process. At the end of this quantitative and qualitative analysis, seven major municipal service areas were identified as being critical in improving the City's overall energy performance and rising reduce energy costs: district heating, potable water, municipal buildings, public transport, private vehicles, street lighting, and solid waste management. The report offers 15 recommendations for these service areas and they are briefly discussed below.

District Heating Network Maintenance and Upgrade

For the second biggest district heating (DH) plant in the country, Toplana – Banja Luka, one of the main challenges is to maintain and upgrade the primary and secondary heat energy distribution network which is generally in a deteriorated condition and requires considerable modernization and investments. Over time, the 155 km pipe network in the district heating system has deteriorated, leading to around 40% heat and hot water losses in the system that are among the highest of any city with relevant data in the TRACE database. Revamping this network is one of the key priorities of local authorities since over 75% of the DH plant's annual operational expenditure is on fuel oil for water heating. A system-wide survey is necessary to identify spots in the DH distribution network with highest heat and water loses.

District Cogeneration Thermal Plant

The DH plant in Banja Luka is the largest single consumer of mazut or heavy fuel oil in the city. However, all of the used fuel oil goes to heat generation, leaving a huge untapped potential of generating both power and heat, and reducing pollution. The local government should examine options for the possibilities of high-efficiency, combined heat and power (CHP) plants to generate energy efficiently and in an environmental-friendly manner. The conversion of DH plants to CHP systems are capital intensive and should be preceded by a rise in electricity tariffs, which are now among the lowest in Europe in order to assure cost recovery. Without proper market pricing of electricity, it is difficult to push for CHP technology, as the unit cost of producing energy would be higher than centrally imposed subsidized electricity tariff.

Active Leak Detection and Pressure Management

In 2011, around 35% of the potable water produced in Banja Luka was lost in the system due to technical loses. The overall share of non-revenue water was 45%. Vodovod Banja Luka (the city's Water and Waste Water Utility Company) has introduced a Supervisory Control and Data Acquisition (SCADA) system. The SCADA system can remotely monitor and control the adjustment of system pressure so that water leaks are limited. To improve the efficiency of the overall water piping network further, Vodovod should start a more extensive leakage detection program and determine investment needs for replacing old piping infrastructure.

Educational Measures for Water Conservation

Considering relatively high daily water consumption in the city (191 l/capita), water conservation awareness measures is a critical area where action is recommended. The methods of organizing this may include promotional leaflets sent with monthly bills, adverts, information on water company websites etc. A deeper understanding of the implications of water wastage, both in terms of energy used for pumping treatment and resource availability in the long term, will encourage consumers to use less water, hence lowering the energy that is required to treat and pump the flow at source.

Municipal Offices Audit and Retrofit Program

Banja Luka owns and manages a number of buildings, including administrative buildings, educational facilities, sports and cultural facilities. For most of these buildings there is a significant energy savings potential through measures such as thermal insulation of roofs, exterior

walls, floors, better sealing, replacement of windows, and improvement of HVAC (heating, ventilation and air conditioning) systems. Local authorities could start by performing a full audit of the existing stock and craft a plan for how resources can be allocated to improve energy performance in these buildings. The City should strengthen its support for the refurbishment of the existing municipal building stock in order to raise awareness amongst other consumers, investors and key market players.

Municipal Buildings Benchmarking

The local authorities should consider developing a building 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). 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). The goal of the program is to identify the highest energy intensive buildings in the city authority portfolio so as to focus on the best energy efficiency opportunities. The benefits of the program are to use EE program resources most effectively and to spend time and money on the easy wins first.

Mandatory Building Energy Efficiency Codes for New Buildings

Focusing on EE measures in municipal offices can have a very powerful demonstration effect (particularly if they are properly advertised), and they would offer local authorities the moral high-ground for pushing more stringent EE guidelines and standards for new buildings. Such measures should not only focus on EE, 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 several forms such as: voluntary guidelines, minimum building standards, and an incentive program for private developers. The benefit of this program is to advance higher quality building design and construction and promote EE for all of the buildings in the city, saving money, saving water, and making better buildings to live and work.

Public Transport Development

A well crafted public transport development plan cannot only lead to better city-wide energy performance by offering alternatives to private vehicle use, but it can also improve energy performance by guiding city growth in a sustainable way. Public transport planning should therefore go hand in hand with city planning, as they are mutually beneficial. For example, an integrated land use and transport plan should allow for higher densities around public transit hubs. As Banja Luka's public transport system is run by four private operators, the city should build its strategy on organizational measures. Such measures need to focus on implementing an integrated city development plan with continuous expansion of the bus network to provide better access to people and increase bus ridership. In addition, local authorities must encourage private bus operators to renew their older buses by investing in modern buses that run on cleaner technology and betters fuels and make the city bus operation attractive and improve city's air quality.

Non Motorized Transport Modes

Non-motorized transport (NMT) modes have zero operational fuel consumption and require low capital costs for implementation. In addition to improving the health of users, their use reduces noise pollution and improves air quality. Clearly, walking dominates for shorter trips in Banja Luka given the city size. But, even in terms of distances traveled, walking accounts for a majority of all trips. Right now the city does not have the basic infrastructure to separate motor traffic from other NMT modes (e.g. bicycles). To the extent possible, local authorities need to ensure that the public transportation infrastructure is seamlessly integrated with the NMT infrastructure (e.g. walk and bike paths), to make it much easier for people to leave their cars behind.

Traffic Restraint Measures

Rising incomes, combined with demand for greater personal mobility and inadequate public transport will inevitably result in continuing increase in personal vehicle use and ownership, especially cars in Banja Luka. By 2011, the city had 211 cars for every thousand inhabitants, a rate much higher than most cities with similar levels of per capita income (US$ 4,970). The shift from mass transit to personal vehicles will have a large effect on energy use – as well as traffic congestion, pollution and

greenhouse gas emissions. A range of traffic restraint instruments need to be planned as part of a comprehensive transport strategy by the local authorities. For example, increased parking charges, as practiced in many cities, is an approach that Banja Luka city needs to seriously consider to discourage use of private vehicles. Similarly, city authorities can introduce sale of special central area permits or licenses, or a complete ban on automobiles on selected streets for reducing the use of cars in downtown areas.

Street Lighting Audit and Retrofit

Banja Luka has a well developed street lighting system in the city downtown area, although coverage in the city periphery and sub-urban areas are inadequate. Light audit and retrofit programs are recognized as being among the surest sustainable development investments cities can make. The retrofit costs are usually amortized within a year of two, and operation and maintenance costs are reduced significantly. Consequently, local authorities can chose to either finance such project directly, or they can engage an Energy Services Company (ESCO). Within Banja Luka there has been a push to replace mercury vapour street lights with high pressure sodium lamps, which is very good. Nonetheless, more needs to be done. For one, the street lighting system needs to be expanded to cover the entire city (including new and/or underserviced neighbourhoods). Also, there are a number of better lighting technologies (like, LEDs) available that also need to be considered for inefficient bulb replacement and for extending the network coverage.

Street Lighting Timing

Local authorities have already started replacing light bulbs with more efficient ones mainly high pressure sodium lamps. They should, in addition, consider integrated solutions to reducing energy consumption by introducing street lighting timing programs (e.g. with light intensity decreasing after mid-night on week-days, or with a central control system that allows the adjustment of light intensity based on how busy a particular area is). A program with strategic timing and/or dimming tailored to the specific needs for lighting in specific areas can significantly reduce energy consumption whilst still delivering appropriate levels of lighting for e.g. providing safety and sense of security in public areas. An intelligent monitoring system can be used to adapt the levels of lighting according to varying weather and activity levels.

Waste Sorting and Recycling

In Banja Luka, the recyclables separated from the mixed municipal waste amount to less than 3%. Banja Luka has established recycling arrangements with private recycling factories for paper, plastic, metal, and tires. DEP-OT, the solid waste management (SWM) company in the city, has undertaken a series of measures to reduce the negative environmental impact of municipal waste disposal: separating municipal waste and, to the extent possible, recycling municipal waste, such as paper, glass, aluminum and organic waste, and industrial waste; separating and incinerating medical waste; composting organic waste; ensuring biological treatment of municipal waste.

Land Fill Gas Capture

Landfill gas, or biogas, is a natural by-product of the decomposition of organic waste (such as food waste, green waste and paper) in landfills. If captured, it can be used as a source of energy through the generation of electricity and/or heat or by being processed for gas supply. Recognising this potential, currently, DEP-OT is doing a feasibility study to monitor and evaluate the quantity and quality of methane gas that can be produced annually to generate electricity and heat. This analysis will help the operator develop an appropriate energy generation plan.

Waste to Energy

Energy production from waste should be considered as a longer-term measure. Attention needs to be given to reducing waste generation at the source and to introducing life-cycle analysis of goods, with particular reference to those that could be recycled (e.g. beverage containers, cars, tires, and batteries). The objective of this recommendation is to capitalize on the energy generation potential of municipal solid waste by introducing new forms of waste treatment. In order to implement this recommendation, Banja Luka city must first meet essential waste collection and transportation requirements that enable sorting of solid waste for incineration, gas capture, and heat and/or power generation.

Introduction

Banja Luka, the biggest city of the Republic of Srpska and the second biggest city in Bosnia and Herzegovina, underwent extensive urban redevelopment after a devastating earthquake in October 1969. During the 1992-95 war that accompanied the breakup of the former Yugoslavia, the social transition caused the collapse of most of Banja Luka's economic base. In the post war period Banja Luka has started to put its economy back on track, working towards the development of trade, tourism, agriculture and the food industry.

While cities worldwide continue to grow, a majority of countries in Southeastern Europe have already reached high urbanization levels, including BiH with 60% of its population living in cities. However, the cities in the region face multiple challenges, which may be attributed to their transition from centrally planned to market-based economies. Local government officials are ill-equipped to fulfill their expanded responsibilities under decentralization frameworks and find it difficult to meet performance standards for utility services and investment projects, aligned with European Union (EU) pre-accession requirements, which they are striving for. Local authorities in Banja Luka are interested in seeing the recent growth translate into sustainable development.

The work included in this report is part of the efforts undertaken under the World Bank's European and Central Asia Sustainable Cities Initiative (ECA SCI). ECA SCI started in May 2010, with a knowledge exchange event in Copenhagen and Stockholm, from the premise that city-level sustainable development actions can set the stage for world-wide sustainable development. Home to over 50% of the world's population, and accounting for a lion's share of global GDP, employment, and innovation, cities are engines of economic growth. They are at the forefront of economic, social, and environmental change, and as such serve as ideal "laboratories" for generating, testing, and spreading new ideas and innovation. Ultimately, more sustainable cities will lead to a more sustainable world.

Sustainable development is understood to encompass all aspects that have to do with a city's healthy development, focusing not just on environmental issues, but on the triple bottom line – economic/fiscal, social, and environmental sustainability. It is also understood that successful sustainable development cannot happen without a series of key elements in place: strong city leadership; a clear vision and strategy; enabling national policy environment; implementation, enforcement, and good governance.

Focusing on sustainable development issues in ECA cities is particularly poignant, because they face a number of critical economic, social, and environmental challenges. ECA, for example, has some of the most polluted cities in the world. In fact, it has the highest share of pollution per unit of GDP of any other region in the world, accounting for 7.1% of the world population, 3.1% of global GDP, and 11.8% of global CO_2 emissions from fuel combustion. In economic terms, while ECA countries have registered some of the fastest growth rates in the past decades, they have also registered some of the sharpest economic declines in 2009 – underlining that much of the previous growth was not sustainable.

Sustainable energy is a critical element for economic development and process of European integrations. An approach advocated in the World Bank's Europe and Central Asia Sustainable Cities Initiative (ECA SCI) is to identify the main drivers of energy consumption and carbon emissions and take policy and institutional measures, alongside critical investments, to proactively deal with these sustainability challenges into the future. To address some of the sustainable development issues ECA cities are facing, ECA SCI framework uses a four stage process:

i. *Awareness-Raising and Orientation*, which can include general orientation workshops, learning materials and case studies, knowledge exchange and learning tours, profiling global best practice, peer learning, innovative applications.
ii. *Diagnostic Assessment (Tools)* – e.g. baseline surveys and benchmarking, urban planning audit, carbon footprint calculation, energy efficiency (EE) diagnostics, shadow bond rating, life-cycle costing, traffic system management studies.
iii. *Policy Reforms and Investment Strategies* – e.g. updating master plans, updating urban planning regulations, setting emission targets, sustainable city investment strategies.
iv. *Financing* – e.g. specific investment financing, results-based financing, private sector finance (e.g. Energy Service Companies), carbon financing, output-based aid, donor co-financing.

Within the scope of the Energy Sector Development Strategy of the RS that was adopted in May 2005, EE has been recognized as a top priority area in the production, distribution and utilization of energy by end consumers of energy related services. One of the major components of ECA SCI is to help city mayors and the municipal governments in the ECA region begin formulating sustainable urban energy developing strategies, in the context of cities' overall development plans. By ensuring that urban energy supply is secure, reliable, and affordable, and by ensuring demand is efficiently managed, cities can optimize operating costs, improve air quality, and improve quality of infrastructure services, while at the same time supporting economic development and climate change mitigation objectives. This requires investigating beyond the energy sector, to all sectors (notably urban transport and water supply/sanitation) using energy in their production of urban services.

A Note on Methodology

This city report on Banja Luka builds on a city EE diagnostic assessment tool 'TRACE (Tool for Rapid Assessment of City Energy)' referred to above as "stage two" of the ECA SCI framework. Developed by the World Bank's Energy Sector Management Assistance Program (ESMAP)[3], TRACE offers cities a quick, first-cut, sectoral analysis on city energy use. The TRACE is a 3-month long assessment process that includes several weeks of upfront data gathering and benchmarking, sector meetings and the preparation of a final report. This assessment tool prioritizes six municipal sectors or services, which are under direct municipal government control, with significant energy savings potential, and identifies appropriate EE interventions. The municipal sectors include: urban passenger transport, municipal buildings, water and waste water, public lighting, solid waste, and power and heat. TRACE does not cover industry, residential and commercial establishments. The tool uses a software platform and consists of three principal components: an energy benchmarking tool which compares key performance indicators among peer cities, a prioritizing process which identifies sectors that offer the greatest potential with respect to energy efficiency improvement, and a "playbook" of tried-and-tested energy efficiency measures which helps select the appropriate interventions. It is a simple, low-cost, and practical tool to assist city governments in developing locally appropriate EE strategies.

[3]For further details please visit http://www.esmap.org/esmap/node/235

TRACE Home Page

Work on this report started with a scoping mission in Banja Luka in October 2011, data collection by a locally hired consultant in December 2011-January 2012, and the implementation of the TRACE in the city from February 7 to 10, 2012. The TRACE diagnostic tool was selected because EE is often considered to be a "low hanging fruit" in sustainable development, with outcomes and benefits that are fairly easy to measure and monitor. This activity is expected to yield important dividends in helping Banja Luka identify investments necessary to develop as a sustainable city.

During the TRACE implementation mission, interviews were held with a range of Banja Luka City Administration (BLCA) departmental staff and representatives from a range of city/state agencies. The field mission also involved site visits at the city's main district heating plant, water treatment facility, and at the landfill site. Information gathered during

this period enabled a classification of each municipal sector based upon the degree of influence directly or indirectly exerted by the BLCA the potential for energy savings in the sector and relative spending on energy in each sector or service area. These enabled a detailed systematic filtering of all of the EE recommendations contained within TRACE, to examine their suitability in Banja Luka City. This process demonstrated that a large number of recommendations were:

- either likely to be technically and/or financially unviable;
- outside of the direct control of the BLCA; or
- already being implemented or in a trial phase.

Background

Bosnia and Herzegovina, native name Bosna i Hercegovina (BiH), sometimes called Bosnia-Herzegovina or simply Bosnia, is almost a landlocked country, except for 26 kilometers (16 miles) coastline on the Adriatic Sea, and is located in Southeastern Europe on the Balkan Peninsula. In terms of its geography, the country in the central and southern interior is mountainous, in the northwest it is moderately hilly, and the northeast is predominantly flatland. The country borders Croatia to the north, west and south, Serbia to the east, and Montenegro to the southeast. The country has a moderate-continental climate with hot summers and cold and snowy winters. The southern tip of the country has a Mediterranean climate and plain topography.

The population of BiH is comprised of three major ethnic groups: Bosniaks, Serbs and Croats. According to the last official census data from 1991, BiH had 4.37 million inhabitants, equivalent to an average population density of 85.5 inhabitants per square km. While the 1996 UNHCR census showed a decline in population to 3.92 million.[4] The Yugoslav wars in 1990s caused demographic shifts in the country as a result of large population migrations. No census was carried out since 1991/96 because of political disagreements which made it impossible to organize one. Nevertheless, a census has been planned in 2012. Current estimates of population vary depending on the source but are generally around 3.84 million indicating a decrease of about half million people since 1991. However, the level of urbanization has increased in the last decade.

BiH is recovering from a devastating three-year war which accompanied the break-up of Yugoslavia in the early 1990s. The 1992-95 conflict was centered on whether Bosnia should stay in the Yugoslav Federation, or whether it should become independent. BiH was made into a decentralized independent state in 1995, but under international administration, backed at first by NATO forces and later by a smaller European Union-led peacekeeping force to help country consolidate stability. BiH is currently a potential candidate country for future EU accession as its citizens generally feel that EU accession with increase political stability, trade, competition, foreign investment, and regard for social policies, as well as provide a better quality of life to citizens, concerning safety, employment, health, education, and information.

The 1995 Dayton peace accord, which ended the Bosnian war, established BiH as a state with limited central power, and assigned competency for social, educational, health care and fiscal policies to many levels of government and administration. Most important of these levels is the division of the country into two entities: Bosniak-Croat Federation of BiH (FBiH), and the Bosnian Serb Republic (or Republica Srpska - RS), each with its own president, government, parliament, police and other bodies. The FBiH covers 51% of BiH's total area, while the RS covers 49%. Overarching these entities is a central Bosnian government and rotating presidency. In addition there exists the district of Brcko which is a self-governing administrative unit, established as a neutral area placed under joint Serb, Croat and Bosniak authority. The third level of BiH's political subdivision is manifested in cantons. They are unique to the FBiH entity, which consists of 10 Cantons. All of them have their own cantonal government, which is under the law of the Federation as a whole. The fourth level of political division in BiH is the municipalities. The FBiH is divided in 79 municipalities, and RS in 63. Municipalities have their own local government. Besides entities, cantons, and municipalities, BiH also has four "official" cities. These are Sarajevo, East Sarajevo, Banja Luka and Mostar. The territory and government of the cities of Sarajevo and East Sarajevo officially consist of several municipalities, while the cities of Banja Luka and Mostar correspond to the municipalities of the same name. Cities have their own city government whose power is in between that of the municipalities and

[4] http://en.wikipedia.org/wiki/Bosnia_and_Herzegovina

cantons (or the entity in the case of RS). The largest city is the capital Sarajevo Canton (population 436,572); next in size are cities of Banja Luka (226,805), Mostar (140,000), and Zenica (135,000).

Before the war BiH had an economic structure that was strongly product and commodity based. The war had a devastating impact on the country's infrastructure. Approximately 45% of the country's industry, including 75% of its oil refineries, was either damaged or destroyed. Transport infrastructure suffered greatly; about 35% of the main roads and 40% of bridges were damaged or destroyed. The economic recovery began after the 1995 Dayton Peace agreement and following several years of strong growth, economic activity in BiH started to decline in late 2008. Driven by very good export performance, GDP in BiH grew 0.9% in 2010, which was above consensus expectations of 0.5%.

Population dynamic in the ten largest cities in BiH

	City	Population		Compounded annual growth
		census 1991	calculation 2012	
1	Sarajevo	527,049	436,572*	-0.94%
2	**Banja Luka**	**196,500**	**226,805***	**0.72%**
3	Tuzla	90,539	99,543	0.43%
4	Zenica	98,750	135,000*	1.58%
5	Bijeljina	37,216	78,960	3.48%
6	Mostar	75,612	140,000*	3.13%
7	Prijedor	37,568	43,307	0.65%
8	Brcko	40,921	38,968	-0.22%
8	Bihac	45,995	37,511	-0.92%
9	Doboj	27,579	31,794	0.65%
10	Kasindo	6,905	28,443	6.65%

* 2010 data.

Source: World Gazetteer and authors' calculations.

In 2011 the country's human development index, measured by the UNDP, was 0.733 (on the scale of 0.0 to 1.0). BiH ranked 74th out of 187 countries reviewed.

The highly decentralized state structure carefully balances political/ethnic interests. The national government remains weak and most power is vested in two entities: the FBiH and the RS, plus the special district of Brcko. The different layers of authority from entity (FBiH or RS) to municipality, is capable of causing overlapping, confusion, and a lack of systematic organization or interaction between decentralized actors and different levels of government. Communication between the government and non-governmental sector or even between the canton and municipalities is very weak. Within the RS, municipalities are the key providers of essential public services. These services include heating, local roads, sewage, solid waste disposal and water. Municipalities may adopt rules on operational procedures, regulate fees, and take management decisions; they provide administrative services and regulate business, which affects local economic development.

National Energy Efficiency Strategy

While energy and EE policy is within the competence of the two Entities of BiH there is as yet, no fully articulated set of energy policies, or EE Master Plan at any authority level (State, Entity). However, in 2001, BiH ratified the Energy Charter Treaty and the Protocol on EE and Related Environmental Aspects (PEERA). By ratifying the Protocol, BiH committed to formulate and implement policies for improving EE and reducing the negative environmental impact of the energy use. The guiding principle of the PEERA is that contracting parties shall cooperate and, as appropriate, assist each other in developing and implementing EE policies, laws and regulations.

The country review process is a core activity in monitoring and facilitating the implementation of the Protocol. The in-depth EE reviews, implemented under the PEERA, have proven to be an important tool in assessing the progress of BiH in fulfilling its commitments under the Protocol. They also provide peer guidance to governments in developing and implementing EE policies.

In 2011, the Energy Charter Secretariat conducted an in-depth review of EE policies in BiH, following a regular review report submitted by the BiH authorities in 2008. The following elements are reflected in this EE country policy review document brought out in 2012[5]:

- EU accession is a strategic priority for BiH to market reforms. Energy sector reform is being pursued in accordance with the listed priorities of the EU partnership approach.

[5]Energy Charter Secretariat 2012. In-depth Review of Energy Efficiency Policies and Programmes: Bosnia and Herzengovina, Belgium: Brussels.

- Like other countries of the Western Balkans, BiH has chosen a way forward in the framework of the 2005 Energy Community Treaty (EnC) which expresses a shared commitment to market reforms and the development of a regional market.
- The State of BiH has entered into agreements entailing commitments to the delivery of energy policy reforms with the EU and with other Western Balkan countries.
- BiH has established the necessary institutions at State and Entity level to effect and oversee energy market reforms. Regulatory authorities exist at State and Entity levels and certain Entity powers and responsibilities for tariff setting and EE have been assigned to the Entity energy regulators and cross subsidies are being phased out.
- The combination of relatively low energy prices and a degree of continuing electricity price subsidy is suppressing some economically efficient EE activity.
- Promoting EE is evidently an important strategy considering the large capital investments such as repowering of power stations.
- There are EE and renewable energy champions but in general they lack the resources and the legislative mandate to really make a difference.
- Useful progress in raising awareness through the demonstration of practical solutions at local and enterprise level has been made possible through the joint effort of donors, International Financial Institutions and EE actors in BiH at National, Entity and Municipal levels.
- The National EE Action Plan (NEEAP), like the necessary underpinning energy policy, is much delayed and there have been many calls for its finalization and implementation. Resource constraints and other barriers have been cited as reasons for the delay.
- The systematic diffusion of EE considerations as an integral part of policy, regulation and control is yet to begin in BiH. This could be addressed in the completion of the NEEAP and the creation of links that appeal to willing donors and so consolidate the desire to make practical progress that is evident on all sides.

BiH is endowed with basic energy resources, especially solid fuels, other fossil fuels and hydropower, as well as natural forest biomass and other renewable energies. Indigenous coal, lignite and hydropower are still predominating sources of primary energy consumption. The energy sector in BiH is responsible for between 66% and 72% of CO_2 emissions and much of this is from coal fired power plants. BiH is currently exporting electricity with potential for producing more and becoming a key exporter in the region.

According to the same EE policy review document, in the early 1990's the energy intensity of GDP was exceptionally high. It was more than twice that of its nearest comparator Serbia. From about 1996 onwards the energy intensity of GDP in BiH has decreased, being close to the average of Albania and Croatia and well below that of Serbia. However, the energy intensity of the economy of BiH is high when compared with that of the EU. More than 20% of national GDP is spent on energy, a clear indicator that suggests more attention needs to be paid to EE.[6]

Power generation in BiH is carried out by three electricity companies: Elektropriveda (EP) BiH, Mixed Holding Company Electropriveda Republike Srpske (EP RS) and EP Hrvatske Zajednice Herceg Bosne d.d. Mostar (EPHZHB). All three companies are in majority owned by the entities of FBiH and RS. Out of total 3,834 MW installed capacity in BiH, more than 98% power generation comes from these three companies. In addition, there are other privately-owned companies and initiatives for construction of new generation capacities.

As regards to heat supply, district heating systems were and are still in place in major cities. Today most of these systems are in bad conditions, they are poorly maintained and obsolete, and require considerable modernization. All district heating systems in the territory of BiH are used only for space heating, in rare cases as industrial processing heat, and not for warm water heating.

There are no EE laws in place at the state or entity level in BiH. However, EE is indirectly covered in other legislation. Regulators, for example, have the responsibility of considering both environmental and EE issues in tariff setting as well as in investment approval regulations and decisions. There are no EE targets in place at State level. The

[6] http://www.munee.org/node/19

assumption here is that BiH will aim to comply with EU efficiency targets and applicable European Commission Directives.

At the local level, cities in BiH are already becoming aware of the global realities and city mayors have made a dedication to achieving the climate change goals by signing the Covenant of Mayors[7]. The goal of the action plan is to reduce CO_2 emissions by 2020 in all sectors by implementing EE measures, increasing the use of renewable energy, through demand management, training and other measures. Stimulated by the results of studies and informed by several energy audit programs, EU awareness raising activities such as the Covenant of Mayors, a number of local authorities have taken action to raise the profile of EE and renewable energy. The main areas of action have been: energy performance of public buildings, sustainability plans and demonstration actions such as retrofitting to insulation to building facades, upgrades to district heating and the regulation of new building energy performance. For example, plans for refurbishment of a district heating system in Banja Luka are understood to be proceeding and to be yielding worthwhile results for the local authority owned district heating company and its customers.

Despite the high energy costs that cities face, most municipal leaders have relatively little awareness of these problems, and the existing solutions. Often, cities are not aware of how much they spend on energy, have little experience in tracking energy costs, do not adequately plan for energy expenses in the future, and cannot identify the energy "*hot spots*" - the buildings with the most flagrant energy waste.

In terms of institutional setup, the key government institutions involved in policy making, managing and operating the energy sector are:

- At the State level: The key ministry is the Ministry of Foreign Trade and Economic Relations (MoFTER); in accordance with the Law, MoFTER's responsibility is "for activities and tasks within the jurisdictions of BiH and which are related to policy defining, basic principles, coordination of activities and harmonization of entities' authoritative bodies and institutions on the international level in the field of agriculture, energy, environment protection, development and usage of natural resources and tourism."

  The key institutions established by statute are: State Electricity Regulatory Commission responsible for regulating transmission, transmission-related activities and international trade. Commissioners rotate on an equal basis the position of Chairman each year. The SERC is financed by regulatory fees paid by regulated companies. SERC has its office in Tuzla.

  Transmission System Operator (TRANSCO) responsible for transmission, maintenance and construction was registered and started operating in February 2006. Independent System Operator (ISO) responsible for the management and control of the transmission network, directing, scheduling and coordinating maintenance, planning and development of the grid, development of the indicative generation plan with TRANSCO.

- At the Entity level: The key government ministries are - (a) Federal Ministry of Energy, Mining and Industry (FMEMI); it implements the policy and enforces the laws as determined by the legislative body, executes the administrative supervision of implementation of the laws and other regulations, proposes and gives recommendations in the field of legislation, answers to questions of the legislative authorities, and performs tasks of administrative and professional nature. (b) Ministry of Industry, Energy and Mining of RS (MEED); five sections within MEED have energy related responsibilities: section for energy and energy related power utilities, section for energy and fuels, section for development of energy and mining, thermo energetic inspection, and electric power inspection.

  The key institutions responsible for regulating generation, distribution and supply are: Federal Electricity Regulatory Commission – offices in Mostar; Regulatory Commission for Energy of RS – offices in Trebinje.

  A regulatory framework for sustainable energy exists only indirectly. EE and sustainable energy are covered in other legislation. Regulators, for example, have the responsibility of considering both

[7] The Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO_2 emissions reduction objective by 2020.

environmental and energy efficiency issues in their tariff making and investment approval regulations and decisions.

There is a wide range of international organizations active in BiH and co-ordination is reported to be increasing with a view to improved targeting and aid efficiency. The principal sources of funds and assistance in implementing reforms of the energy sector include global bodies, the EU and bi-lateral initiatives from many countries. Aid and other assistance are received from the EBRD, EU (CARDS, IPA), Federal German Agency GIZ, KfW Norway, Swedish SIDA, UNDP and USAID. Other valuable assistance comes by way of the panning, verification and peer review processes of treaties such as the Energy Charter and the Energy Community.

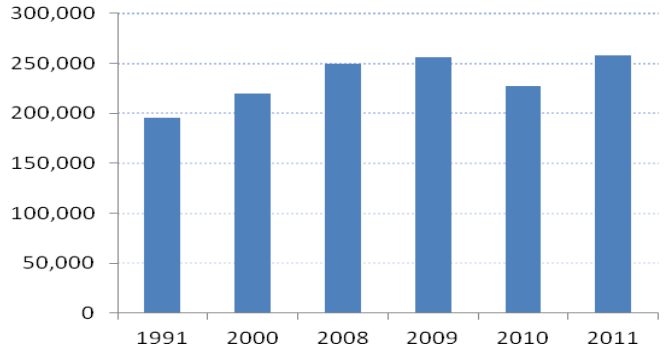
Urban Growth and Energy Challenges in Banja Luka

Banja Luka is the second largest city in the country BiH and the administrative capital of the RS entity. The city is located in the north-western part of the country on the Vrbas river and is well known for being full of tree-lined avenues, boulevards, gardens, and parks. The city is the seat of the National Assembly of Republika Srpska, and is home to the University of Banja Luka, as well as numerous state and entity institutions of BiH. Following a devastating earthquake in October 1969, the city underwent extensive urban redevelopment.

Although the city itself was not directly affected by the Bosnian war in the early 1990s, its population was. The population of the Banja Luka increased from 195,692 in 1991 (last official census data available) to 258,000 in 2011 as shown in figure below.

The city area is spread over 2 catchment areas – catchment area of the Vrbas River (the eastern part of the city – 891 km^2), and catchment area of the Sana River (the western part – 341 km^2).The city downtown area is at 163 meters above sea levels surrounded by rolling green hills. The area around Banja Luka is mostly woodland, although there are mountains a little further from the city. The city itself is built in the Banja Luka valley, which is located at the transition between high and low mountain areas. The most notable of these mountains are Manjaca (1,214 meters), Cemernica (1,338 meters) and Tisovac. These are all part of the Dinaric Alps mountain range. A large building called Titanik in the center of the town was razed to the ground, and the area was later turned into a central public square.

Demographic Profile in Banja Luka



Banja Luka has a continental climate, with harsh winters and warm summers. The warmest month of the year is July, with an average temperature of 21.3 ^{o}C (70.3 ^{o}F). The coldest month of the year is January, when temperatures average near freezing at 0.8 ^{o}C (33.4 ^{o}F). Annual precipitation for Banja Luka is about 988 mm. It snows in Banja Luka almost every year due to city's latitude.

The Banja Luka city municipality in RS and its administration comprise 11 sectors and services and 7 departments. The City Administration ensures that all the decisions enacted by the City Council and the City Mayor are executed. It also executes the laws and regulations of the RS and BiH, resolves administrative disputes, performs administrative tasks, prepares development projects and plans and programs proposed by the City Council and the Mayor, prepares regulations and other acts that the Mayor and the City Council with the working bodies may enact.

Urban planning and construction, housing and communal affairs, managing city-owned assets are the issues, among other, fall within the competence of the City Administration. The City Administration has invested in IT modernization process to ensure faster and efficient service delivery to citizens.

Banja Luka is the biggest industrial and business center of the northwestern part of BiH. There are 316 big and medium-sized

enterprises and 2,189 small-sized enterprises that operate in the city today. Some of the key enterprises and agents of economic development in the city include: brewery, city market, krajina, hemofarm, brick factory, timber industry. Like many other cities in Eastern Europe, Banja Luka underwent a process of economic restructuring, with industrial employment losing ground to the service sector.

Republic of Srpska – Municipalities

The future planning activities and investment decisions in the City of Banja Luka are governed by the following two strategic documents: (i) The Development Strategy of the RS Local Self-Government for 2009-2015, and (ii) The Development Strategy of the City of Banja Luka for 2007-2015. Rapid industrial development, uncontrolled urbanization and lack of care for basic infrastructure in rural areas and agriculture, led to sudden deagrarianization in BiH. The deagrarianized population is mostly not urbanized – i.e. they work but they do not live in the cities. Their construction of housing facilities has kept getting closer to the places in which people work, as people built their housing units at the outskirts of urban areas. This is a particular characteristic of the areas around bigger cities such as Sarajevo, Banja Luka, Zenica, Tuzla and Mostar. As a result densely inhabited areas were created, mostly around big towns, in the river valleys and in the lower parts of predominantly highland areas. Such a development pattern has created a significant pressure on the urban environment, particularly in cities, while the rural population decreased.

Urban mass plays a critical role in determining energy usage patterns in a city. Generally, the denser a city is, the more energy efficient it will be. A dense city makes travel by foot and by bicycle easier; it makes public transport more efficient and economical; it reduces the cost of delivering public services such as water, wastewater, and district heating; it limits the number of light poles required to light streets and public spaces; it lowers transport times and fuel expenditure for garbage trucks.

Promoting dense development patterns should be the norm for all city authorities. Unfortunately, cities the world over are becoming less dense. Even cities with a stagnating or declining population are witnessing some measure of sprawl. Many of the reasons for this occurrence are known, while others are less intuitive. An aging of the building stock in center cities, the advent of the private car, and rising incomes, have pushed more and more people to cities' peripheries.

The challenge for local authorities is to encourage dense development patterns, and discourage sprawl. Local authorities can play an important role in adjusting the scale of outward expansion, and improving the city's energy performance. In February 2009, the Mayor of Banja Luka is the first city in BiH that signed the "Covenant of Mayors", thereby making a formal commitment to concrete measures and projects that support EE and promotion of renewable energy technologies. By making this commitment, Banja Luka agrees to report and monitor the implementation of outlined Action Plans. The city also accepts termination of their involvement in the Covenant in case of non-compliance. In order to implement the commitment city has established

a Climate Change Council, as a voluntary advisory board to Mayor and City Assembly, tasked with developing, and later guiding and overseeing implementation of a Climate Change Action Plan for City of Banja Luka. EE and promotion of renewable energy sources are the basis for preparing a sustainable energy action plan, and City of Banja Luka with its plan keeps pace with the positive practices of countries in the EU. The City came out with their first published report titled 'Sustainable Energy Action Plan (SEAP)' for Banja Luka was published in November 2010.[8]

Banja Luka Urban Mass

[8]'Banja Luka City Sustainable Energy Action Plan (SEAP). City of Banja Luka with support of the United Nations Development Programme (UNDP) Bosnia and Herzegovina, November 2010.

Sustainable Banja Luka

Recognizing EE as a priority area for both the Sustainable Development Strategy of the RS and the National Economic Development Strategy, this city report focuses on how to improve EE in municipal sectors or services in Banja Luka. Although the report focuses on ways to improving EE and local public intervention that can contribute to making Banja Luka City more sustainable, the city EE diagnostic assessment tool (TRACE) also allows local authorities and policy makers to think about the city in a holistic manner. Focusing on EE is critical for city authorities as it helps controlling rising energy costs in the production and distribution of energy related services and reduces the city's energy budget and its environmental footprint. The overall and energy specific performance of the municipal sectors or service areas was evaluated for Banja Luka in comparison with a range of peer cities using both hard data (embedded in TRACE), as well as qualitative information collected during the field mission to Banja Luka.

The energy benchmarking component of TRACE enables the energy performance assessment of Banja Luka City compared to other peer cities. For each of the six municipal sectors, 3-6 Key Performance Indicators (KPIs) embedded in TRACE are derived from the city level data collected, and these KPIs are then compared with a range of peer cities graphically. The present version of TRACE contains a database of 28 KPIs collected from 65 cities geographically spread around the world. Each of the data points that make up these KPIs is collected from Banja Luka prior to the application of the tool in a city.

The prioritization process in TRACE is determined by the magnitude and intensity of energy use and cost savings potential in the city of Banja Luka across municipal sectors or service areas. The process is driven by three principal factors: (i) opportunities for improvements in EE (defined as the Relative Energy Intensity) through benchmarking process, (ii) sector energy spending, and (iii) the overall degree of control or influence of the city authority over the sector or energy use factors. On the basis of the energy cost savings potential, the list of priority sectors is drawn.

The priority sectors identified in Banja Luka then feeds into the EE recommendations component of TRACE to identify sector specific measures that are likely to have the biggest impact, for the lowest

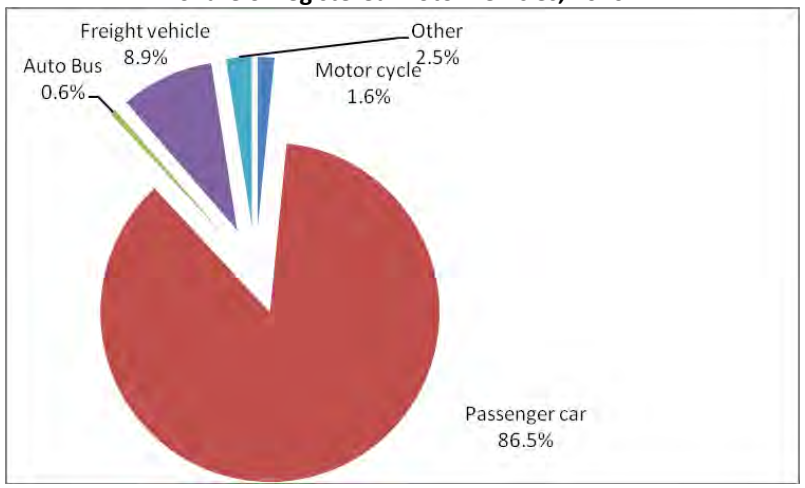
amount of effort and resources invested. During the EE recommendation appraisal the City Authority's "level of competency" and "capacity to act" is rated on five factors in TRACE: (i) Finance, (ii) Human Resources, (iii) Assets/Infrastructure, (iv) Policy/Regulation/ Enforcement, and (v) Data/Information. Finally, taking into consideration both on-site interviews and field visits, which helped with a more rounded picture of EE challenges in the Banja Luka City, and the EE recommendation appraisal process, EE measures are proposed in this city report for consideration by the BLCA.

Transport

In Banja Luka, transportation system in exclusively based on road transport. As the city is relatively small (the smallest in the TRACE database), it is relatively easy to walk to most places. Non-motorized travel (walking) and mass transit account for the vast majority of trips. One of the most useful indicators of overall transport orientation in a city is the level of motorization, usually measured by the number of private vehicles per 1,000 city inhabitants. In 2010, the total number of motor vehicles registered in Banja Luka was 55,273, and the city's car ownership rate of 211 cars for every 1,000 inhabitants is quite high. While the very strict land-use controls and high density housing policies under Communism strongly encouraged public transport use, the recent trend toward low-density commercial and residential development at the suburban periphery obviously reinforces the trend toward more auto ownership and use.

Growing personal incomes and rapidly changing markets are generating demand for a greater variety and higher quality of transport services than are currently available in most West Balkan countries. Although time trend motor vehicle registration data for Banja Luka are not available, it is likely that car ownership rates have grown strongly in recent years – a phenomenon observed virtually everywhere (see the figure given below). A higher ownership of passenger cars and its utilization (motorization level) has an impact on congestion, haphazard urban growth and land use, petroleum dependency, harmful vehicle emissions, and safety costs in terms of traffic fatalities and injuries.

Share of registered motor vehicles, 2010



Source: Statistical Yearbook of Republika Srpska 2011.

Recognizing the importance of moving people rather than motor vehicles, the city needs to attach a higher priority to public transportation to ensure greater safety in transport, while minimizing adverse effects on health due to adverse impacts on the environment. In Banja Luka, public buses use only one-eighth as much energy per passenger-kilometer as cars, and about one-third as much as motorized two-wheelers. Developing a strategic approach to motorization is therefore increasingly critical in Banja Luka. Two different, but potentially related, issues need to be addressed: (i) there is a need for introduction of economically efficient charges for road infrastructure; and (ii) there is a need to develop an attractive public transport system integrated with greater use of non-motorized transport.

The transport sector in Banja Luka is responsible for the majority of city-wide energy use. A quick and rough estimate based on the transport data collected from the city provides energy demand and expenditure on public transportation and private vehicles in 2010 (see table below).

Annual energy use and energy spent on mobility in Banja Luka, 2010

Mode	Energy Use (MJ)	Energy Spent (US$)	Energy Intensity (MJ/PKM)
Public transportation	145,481,790	5,496,652	0.28
Private vehicles	887,539,852	34,597,071	1.70

Note: (i) Diesel price is taken as $ 1.289/l and gasoline as $ 1.222/l. All public transport modes are assumed to run on diesel fuel and private cars on gasoline or petrol (65%) and diesel (35%).

Public Transport

Buses form the backbone of the public transportation system in Banja Luka. Generally, buses are the most economically and environmentally efficient means of providing transport services to the most people. This is because reasonably full buses are inherently efficient – in terms of both road space and fuel use per passenger kilometer. But transit shares of travel are declining in many cities around the world and conditions are worsening. Changing these trends and moving toward more sustainable transport is imperative.

In Banja Luka, buses constitute less than one percent of the vehicle fleet, but serve about half of all travel demand. A very quick and rough estimate shows that in 2010, the city's total passenger travel demand was around 1 billion passenger kilometer (PKM) with buses catering to 0.52 billion PKM.

Banja Luka is served by 113 city buses, which are organized in 23 transit lines, covering 178.67 km of road length. In addition, these buses are operated in 30 suburban transit lines that cover a road length of 768.90 km.[9]

The city bus operation is quite efficient and well connected and provides good access to people to the city centre. While the City Administration owns the infrastructure, all buses in the city are run by private operators. The city has four private operators: Autoprevoz, Bocacturs, Ventral Company, and Pavlovic. Each private operator is under a contract with the city government and they are provided with designated routes (or traffic lines) to operate their buses. There are two types of bus routes in the city: radial, which go from the periphery to downtown and back; and diametric, that connects two peripheries. In addition there are sub-urban lines which do not pass through the city center. The Banja Luka Bus Station is the main hub for buses. The oldest bus link in the city is No. 1. Nearly 60 thousand passengers travel daily by public buses in and around the city. Bus tickets are available in dedicated kiosks or on the bus itself. The cost of each bus ride is 1.40 KM one-way. Bus schedules and maps of bus routes are available at most of the bus stops. Moreover, monthly prepaid coupons have been introduced for rides on city buses with no route restrictions.

Buses in Banja Luka

As a result of rapid city development, the street network is continuously expanding and the number of motor vehicles is fast increasing in the city area. This has led to a number of negative externalities, such as air pollution, time loss in traffic congestion due to traffic jams, and traffic accidents. Private bus operators in the city need to ensure that they conform to progressively stringent standards (e.g. age of the bus, condition of the bus engine and its emissions characteristics, fuel efficiency etc.). As the image below highlights, buses

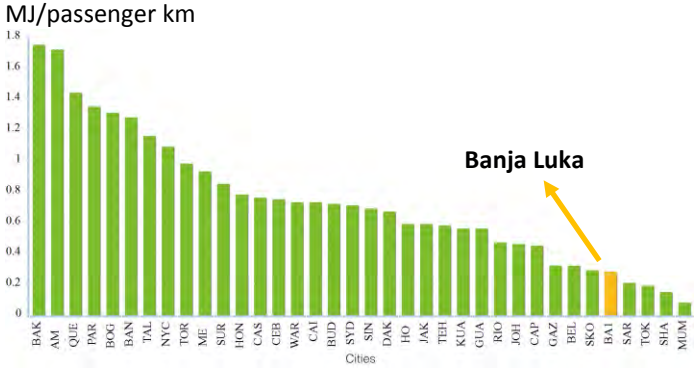
[9] Department of Housing, Communal Affairs and Traffic, Banja Luka City Administration.

in Banja Luka come in all shapes, colors and sizes. Some of these buses are new, some are older, and some are well past their prime. Local authorities need to ensure that the private operators renew their older buses on a continuous basis. According to the assessment results of interviewed commuters in the city, about 11.42% people rated the public transportation system in Banja Luka satisfactory, 28.34% good, 34.48% very good and 23.03% excellent.[10]

The critical task of bus operators is thus to renew the existent fleet with modern buses which are fuel efficient and environmental-friendly. Control of vehicle exhaust gases and adhering to technical safety features will make public transportation attractive and increase ridership levels. Apart from city public transport buses, the taxi service is also available and is provided by 9 operating private companies. There are 265 taxis with reliable service throughout the city, during the day and night. Some of the taxis are fairly old, with the average age of the taxi fleet being close to about 10 years.

Presently, energy consumption in the public transportation sector is relatively low in terms of the number of people carried, and therefore the overall city bus fleet is fuel efficient. In fact, Banja Luka had one of the lowest rates of all cities with pertinent data in the TRACE database (see figure below).

Public Transport Energy Consumption



[10]Mensur Hodzic, Natasa Kostic and Ener Covrk. "Public Urban Traffic in Banja Luka and Sarajevo". Paper presented at a Seminar on safe and sustainable mobility management in Mediterranean cities. Barcelona: 10-14 December 2007.

Private Vehicles

Motorized two- and four-wheelers represent nearly 90% of the total vehicle fleet in Banja Luka. The high level of auto ownership (211 cars per thousand inhabitants) is influenced by the economic status of the population and the availability of alternative modes of travel. This rate in most developed countries in the world (the United States and Canada, for example) is over 500 cars per 1,000 inhabitants. In most developed European Countries this ratio is between 400 and 470. In the countries in transition auto ownership varies from 34 to 424 cars per thousand inhabitants, like in Albania and Slovenia, respectively.[11] This rate in BiH before the war was 92 cars per 1,000 inhabitants. The sharp increase in vehicle registrations after the war and therefore auto ownership are the result of post-war free import policy and a good supply of pre-owned motor vehicles from Western European markets. This has had a negative impact on traffic safety and environmental issues in the city, as the average imported vehicle is over 10 years old.

With continued income growth, the motor vehicle population is expected to continue expanding at a high rate. The city municipality can play a very limited role to regulate in excess of what the National Government is doing in terms of controlling the growth of automobiles. Lower price of gasoline or petrol compare to diesel act as incentive to using private cars and there are no incentives (e.g. a national cash-for-clunkers program) or more stringent local control (e.g. congestion charges).

The local authorities have been hard pressed to create and provide appropriate parking spaces. Since the allotted parking spots are not enough to fulfill all the needs, many people simply park on sidewalks as shown in the image on next page.

As it stands now, intensity of energy consumption in the private transportation in Banja Luka is relatively higher when compared to peer cities like Belgade, Sarajevo, or Gaziantep. However, when the city's energy consumption is compared with all cities in the TRACE database, Banja Luka has a relatively low value (see figure on next page). Nonetheless, the rate at which private vehicle ownership is growing in the city indicates that pre-emptive measures would be ideal. In other

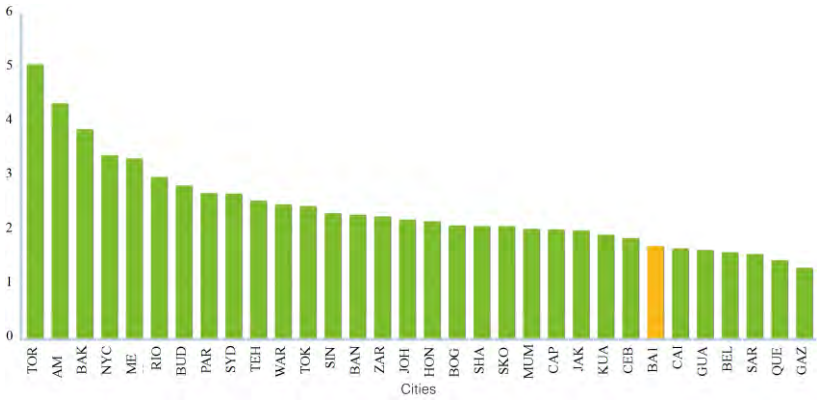
[11]Traffic, Technology International: December 2003/January 2004.

words, local authorities should think about ways of restraining use of private vehicles.

Cars parked on sidewalks in Banja Luka

Private Transport Energy Consumption

MJ/passenger km



Banja Luka is a good city to experience by foot, with a well planned urban space in the downtown area. Gospodska Ulica is the main pedestrian zone in the city center and the most popular pedestrian walkway. The street starts from the City Hall and is the main shopping mall in Banja Luka. This has not only helped encourage people walk more through the city center, but it has also discouraged car use. This has increased business activity in the area with numerous shops, cafes, banks, restaurants benefiting from higher pedestrian traffic. Moreover, pedestrian streets often become lively places where people meet and greet, or just spend more time away from their daily chores.

Gospodska Ulica the main Pedestrian Street in Banja Luka

Road safety is the focus of attention as the country has the highest number of fatalities when compared to other countries in the region. As a safe community, the City of Banja Luka's goal is to promote road safety through prevention of injuries and deaths, a serious social and public health issue in the country.

A number of measures are being undertaken on a regular basis by the City Administration to improve road safety. Some of these measures include: marking – renewal of horizontal traffic signalization, maintenance and full development of vertical traffic signal, lighting maintenance of traffic signals on local streets and roads and at some traffic lights, and sound signals to warn visually impaired and blind people to get across the street. In order to increase pedestrian safety several footbridges were made and underground passages to divide pedestrian flows from motor traffic.

Water and Waste Water

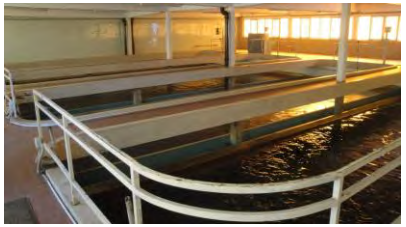
The public water distribution system is over 104 years old with the major water source being the Vrbas river. The first drinking water supply system in Banja Luka started with the Subotica Well, which was activated in 1908. VODOVOD ad Banja Luka is the local public company responsible for water treatment and the maintenance, repair and reconstruction of the water-supply system and sewer system in the city. It is also engaged in the maintenance of the connections, water gauges and hydrants, the control of water quality and the disinfection of the water-supply network. Through its regional water-supply network and the water treatment facility in Novoselija (6 km upstream in the outskirts of the Banja Luka city), the utility company supplies water in the City of Banja Luka, the municipality of Celinac and part of the municipality of Laktasi. As of December 1, 2011, the Company's parent entity was the City of Banja Luka, holding approximately a 65% stake in the capital with 318 employees. The basic primary network for the city of Banja Luka is approximately 270 km long. However, the water-supply network is regional, because it supplies water to the adjoining municipalities. Together with Banja Luka the primary water supply network for Celinac, Laktasi and the well Subotica are approximately 235 km long. The total length of the network, including the primary and secondary connecting network, is 610.50 km. The Banja Luka city's sewerage system was first introduced in 1912 and currently it possesses approximately 150 km of the main sewers. TRACE considers potable water and waste water as separate items, but in reality in many cities including Banja Luka operate these sectors under one company.

Potable Water

In 2011, the regional water treatment and supply company VODOVOD Banja Luka was serving a total population of 181,000 inhabitants. To ensure supply of high quality drinking water, the company analyses everyday water quality. The analysis of the unprocessed raw water and treated potable water are not only done in VODOVO's own laboratory but also in some other authorized institutions in the RS, Serbia and Croatia. According to VODOVOD, based on the laboratory test results the potable water produced daily complies with the standards issued in the Environmental Regulations.

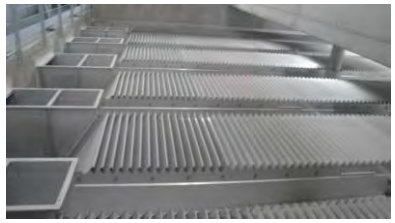
The reservoir space of Banja Luka's water treatment facility for water-supply is 18,450 m^3, and it is filled with the help of five pumping station. There are 31,565 water gauges installed in the system and divided as 25,505 for individual consumers; 2,299 are for the residential areas; 3,761 are for the industry, handicrafts and institutions. Three types of water sources are used for pumping water into the main water treatment plant for potable water production. In 2011, water intake from the river Vrbas produced water at 632 l/s; nine water wells together in operation produced water at 271 l/s; and the Subotica well produced water at 15 l/s. Together, the VODOVOD ad Banja Luka produced around 918 l/s of water for 24 hours with continuous operation of 5 pumps. In 2011, the total annual potable water production was over 28.93 million m^3 with 68.8% water drawn from river Vrbas, 29.5% from the nine wells and 1.7% from the Subotica well.

Water treatment old facility and the five pumping station, Novoselija



Next to the existing water treatment plant in Novoselija, a new water treatment facility has been established in late 2011 by building a filter room, clean water reservoir, pumping stations and a distribution network. This newly constructed facility of 10,500 m^3 reservoir capacity has a direct filtration process installed and is currently being pilot tested before becoming fully operational. This new facility will supply water to the areas of Tunjice, Karanovac, and the higher zones of Kocicev vijenac, Paprikovac and Cesma. Vodovod provided conditions for this new construction work to augment water supply capacity and capability and provide sufficient water quantities for the next 15-20 years. So far the investments reached US$ 639 million (or KM 898 million) and this total investment is provided by Vodovod Banja Luka, the city of Banja Luka, the Ministry of Agriculture, Forestry and Water resources Management and through a World Bank credit.

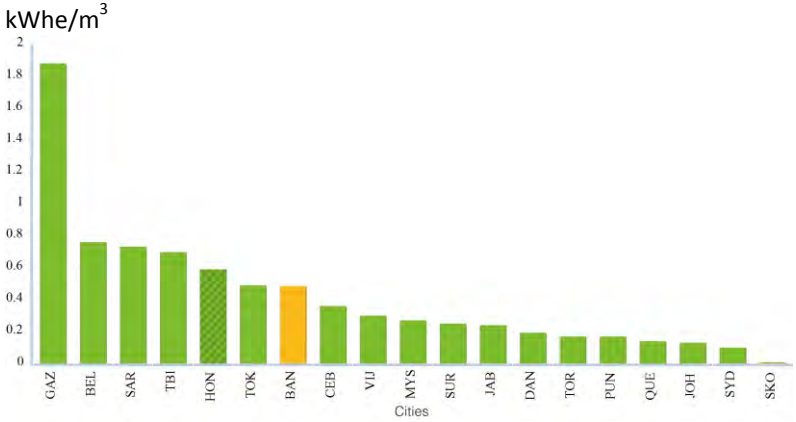
Newly constructed water treatment facility and filter room, Novoselija



The water distribution network in the city is organized under three zones according to city elevation in different areas. Zone 1 has the lowest level of elevation with water pressure maintained at 4 bars with pumps at all times. In Zone 2 (higher level elevation) and Zone 3 (highest level) the water pressure is maintained continuously at higher levels.

The energy used to pump water for treatment and distribution is found to be relatively more efficient in Banja Luka compared to other peer cities such as Gaziantep, Belgrade, Sarajevo, or Tbilisi (see figure below).

Energy Density of Potable Water Production



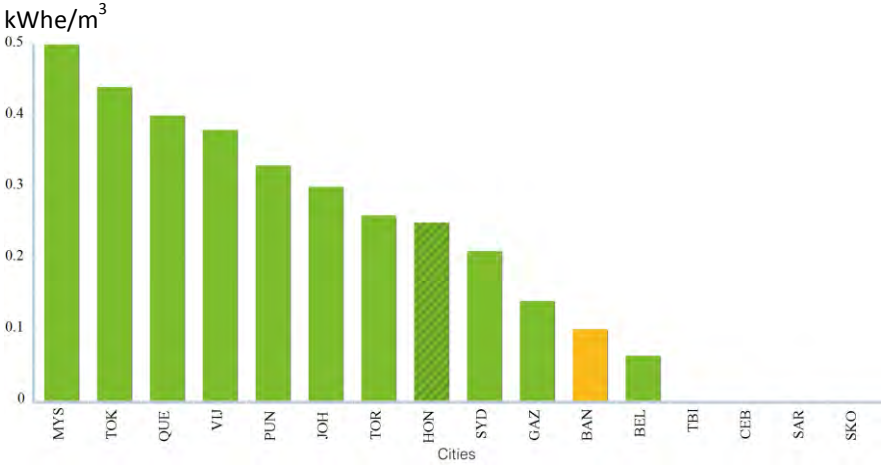
Also, with the implementation of a newly built water treatment facility in Novoselija (currently under pilot testing phase), the scope for improvement in pumping efficiency is rather limited as this new facility can adjust the water pressure automatically. Further, of the total annual expenditure for potable water production and distribution, the share of energy expenditure is between 10 and 15%.

While the water treatment system in Banja Luka is relatively energy efficient, it is quite inefficient in terms of water distribution in the network. Water losses in the water networks are quite high; therefore investment in leak detection and training is one of the key priorities identified by the water company. Another common priority for reducing water losses is the rehabilitation of corroded steel pipelines, which are severely deteriorated. In the last two years the utility company has experienced significant water loss in the distribution network. Water leakages in the pipeline network are usually frequent, caused by a worn-out network. As a result, the percentage of non-revenue water was over 45% in 2011 (the difference between total amount of potable water produced and actual water sold). Technical losses were around 35%.

Waste Water

VODOVOD Banja Luka is also responsible for managing the city's sewerage system. The wastewater treatment plant runs efficiently as the discharge is carried down by gravity using collectors of small, medium and large size. The energy density of waste water treatment is very low compared to other cities in the TRACE database and therefore energy use for water treatment is highly efficient.

Energy Density of Wastewater Treatment



Solid Waste

The landfill in Banja Luka is located at Ramichi about 10 km northwest from the city center and occupies 36 ha. Ramici landfill site is being used for the disposal of waste since 1977. Until 2003, the waste disposed at the landfill was only from the territory of the City of Banja Luka, and since 2003, the landfill receives a regional character, and in addition to Banja Luka's waste, the waste from neighboring seven municipalities of Banja Luka is also being disposed at the site. The estimated population of the region is about 460,000. On average, about 300 tons of waste a day is being disposed at the landfill in Ramici. The entire solid waste management (SWM) system in Banja Luka, including collection, transportation, and disposal at landfill was managed by one public company -- Cistoca. The landfill was not properly managed and controlled. There was almost no collection in the rural areas, with wild dumping along roads, in abandoned mines and in rivers. Even a minimum of prescribed standards were not fulfilled, nor did the company posses a necessary using permit. As a result the waste disposal site had pollution of land, surface and ground waters, spreading of unpleasant odors and smoke and blowing away of garbage. To overcome this problem, a public company DEP-OT took over the management of the landfill from July 1, 2004. Since then, two companies serve these eight municipalities. While Cistoca is now responsible for collection, transportation and disposal, DEP-OT is responsible for the overall coordination and management of the landfill.

Ramichi Regional Landfill before 2004

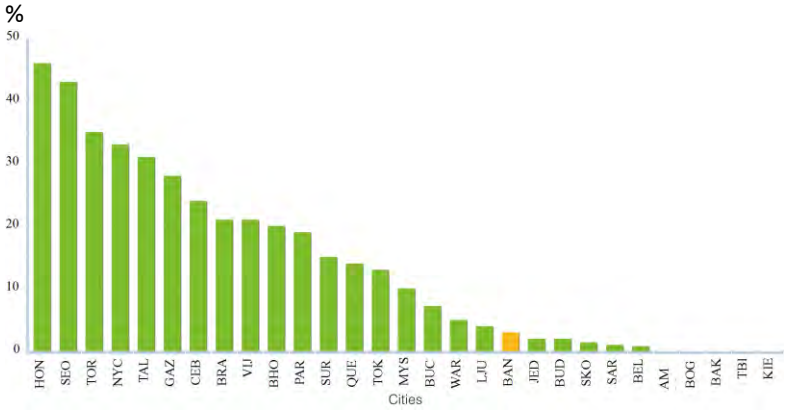
Few statistics on municipal waste generation are available because at present there is no regular nationwide reporting system. Municipal waste contains organic material, durable and non-durable goods, packaging plastics, and textiles. It also contains small quantities of hazardous waste like paint, motor oil, batteries and agrochemicals from households, shops, small enterprises, workshops, garages, and light to heavy industry. In addition, large quantities of construction waste get generated from the reconstruction of residential areas. Sometimes hazardous waste and medical waste are dumped together with municipal waste.

The two companies' together (i.e Cistoca and DEP-OT) have been able to cover majority of the population in the Banja Luka city area. Considering the serious threat of illegal waste dumping to the environment and the health of the local population, 32 wild dumps were cleaned and closed. With collection of 8,040 m^3 of waste and a landfill remediation has resulted in the preservation of 20,700 m^2 of land. The entire landfill is surrounded by newly constructed security fencing.

Security Fencing in Ramichi

In terms of recycling, there is no system for waste separation in the city. The only separation that takes place is informal, carried out by a few entrepreneurs and individuals who separate small quantities of papers and metals from municipal waste. There is also no recycling or treatment in the city. In Banja Luka, the recyclables separated from the mixed municipal waste amount to less than 3% (very low compared to other cities in the TRACE database shown on next page).

Percentage of Solid Waste Recycled



Banja Luka has now established recycling arrangements with private recycling factories for paper, plastic, metal, and tires. The nearest plastic bottle processing plant from Banja Luka is in Doboj municipality, 45 km east of Banja Luka. For similar companies, there is a growing market of used mixed plastic bottles and PET bottles. The prevailing market price is 110 EUR/t for mixed bottles and 130 EUR/t for PET bottles. Similarly, for a paper processing company like Natron-Hayat in Maglaj, the prevailing market price for used paper is 30 EUR/t; for metal recycling the price is 150 EUR/t. As of now, there is a growing market for plastic, paper and metal but there is no market for glass.

According to DEP-OT, about 40% of the recyclable waste can be recycled in its present form. The main problem with the separation of municipal waste is the unavailability of equipment for processing the separated components (paper, glass, metal, aluminum, organic waste).

Landfill gas emissions present potential sources of energy generation from the regional landfill 'Ramici'. This landfill has been used for waste disposal for 30 years. Approximately 2 million cubic meters of waste have been disposed in the landfill so far. Daily quantity of waste sent to landfill from the city of Banja Luka and seven other municipalities is between 250-300 tons of waste. One of the sub-components of the European Commission's financial assistance under the Instrument for Pre-Accession Assistance (IPA) National Program 2010 – BiH Banja Luka is *'Expansion of regional landfill 'Ramici' in Banja Luka'*. The total value of the investment program is EUR 13.5 million (the IPA contribution will be EUR 3 million 2010; the World Bank loan EUR 5 million; and the remaining EUR 5.5 million contribution from the municipalities). DEP-OT's plan is to use EUR 3 million grant from IPA by 2014 to address the following specific components:

(i) Gas capture from the landfill (horizontal versus and vertical gas extraction pipes) for one year to monitor quantity and quality of the gas and preparation of a feasibility report about gas utilization for electricity production and for heating;
(ii) Reverse Osmosis (RO) technique to extract clean water from the aqueous solution of organic and inorganic contaminants that constitute the landfill leachate; and
(iii) Construction of sanitary cells on the landfill adopting layer multi-barrier.

According to the financial data collected from DEP-OT, the municipal waste collection rate for households is 0.115 KM/m^2 (excluding VAT); thus households with larger plinth area pay higher. In the landfill site, with World Bank assistance, DEP-OT has installed a weighing bridge facility, as shown below. Each incoming garbage truck is weighed in the weighing bridge before garbage is finally disposed.

Weigh Station in Ramichi

For residential and commercial waste Cistoca pays 20 KM/t plus VAT to DEP-OT , while for industrial waste the discharge rate is 10 KM/t plus VAT. The annual expenditure of DEP-OT is reported to be higher than their revenue earning. For instance in 2011, while the total annual expenditure of DEP-OT to maintain and control the landfill site was 2,332,655 KM, the annual earning was 2,196,101 KM. Further, of the

total annual expenditure, nearly 8% was spent on fuel for working machines in the landfill area (compactor, bulldozer, wheel loader, crawler excavator, 3-way tipper, and tractor) and over 1% was on consumption of electricity and heating fuel.

Municipal Buildings

In general, the existing municipal building stock has a different age structure in Banja Luka, which strongly influences energy consumption patterns in these buildings. The associated technology and materials for construction, quality of construction, regulations for construction and maintenance at the time of construction, differ widely. The oldest buildings have thick full-brick walls (from 38 to 90 cm) and were built from the late 19th to early 20th century. The city has a large number of buildings that were built from 1945 to 1970 with generally poor heat-insulated materials. Starting in the 1980s, with changing building regulations, the quality of building walls improved, and buildings were generally better thermally insulated. The building regulations that were adopted in the late 1990s are still valid in the city.

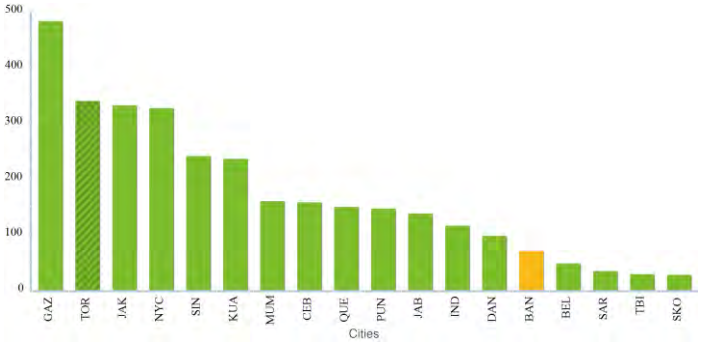
City authorities own and manage 60 administrative buildings with a floor area of 18,870 m^2. (The entire municipal building stock is larger, but data for all buildings is not yet available.). All these buildings combined consume a lot of energy (electrical and thermal) and spend a lot of money..

City Town Hall Administration Building

In Banja Luka, the electricity consumption per unit of plinth area in municipal buildings is relatively low (69.74 kWh/m^2) compared to the entire city database in TRACE (see figure below). However, electricity consumption is relatively high when compared to other neighboring cities – Belgrade, Sarajevo, Tbilisi and Skopje.

Municipal Buildings Electricity Consumption

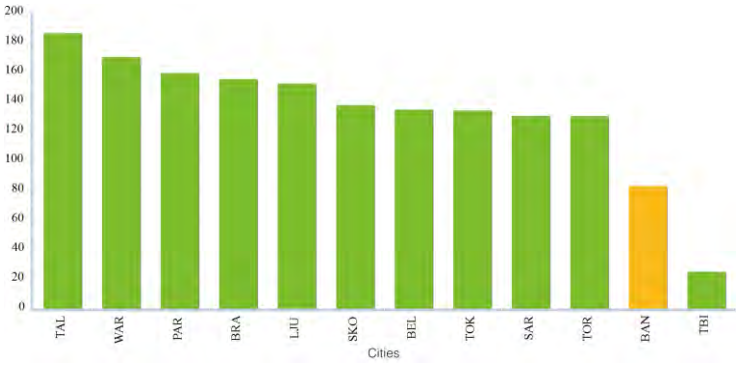
kWhe/m^2



Space heating seems to be an area where city municipal buildings are doing comparatively well compared to other cities in the TRACE database (see the following figure).

Municipal Buildings Heat Consumption

kWhth/m^2



In 2011, city owned municipal buildings consumed 82.78 kWhth/m^2 of heating energy, which is considered very efficient. The main reason for this is recently, the city administration has adopted a number of measures to improve EE in their facilities. The most important one is they now pay their energy bill according to the installed capacity of the heating load in the buildings, which was earlier according to a flat rate in terms of the plinth area of a building. In addition, the city has done energy audits of their main buildings and has implemented a number of building retrofit measures. They include: installation of new windows, improving building insulation material, etc. Also, they now use software provided by UNDP which gives city authorities a good understanding of the municipal buildings energy expenditure on a regular basis.

Public Lighting

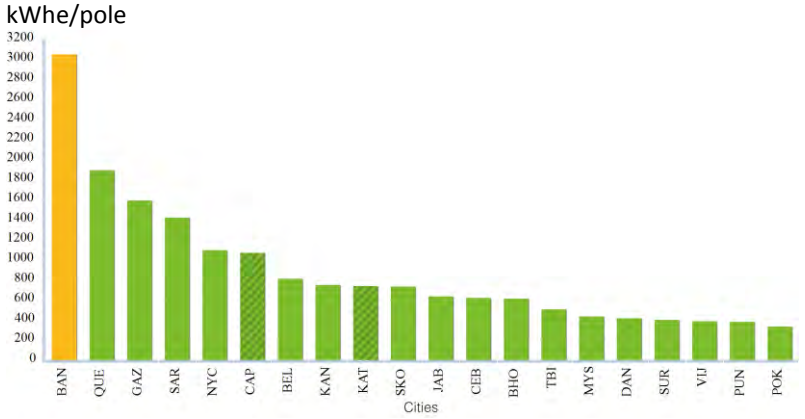
The street lighting system in the city downtown area is fairly well developed, although coverage in the city periphery and sub-urban areas leaves to be desired. The city has 14,000 street light poles and the city's electricity consumption for street lighting is monitored by 360 meters. The City pays electricity bills based on meter readings. In 2011, the total annual consumption of electricity for street lighting was 42.7 GWh. The street lighting system in the city is used in a highly inefficient manner with regards to electricity consumed per light pole. This happens although 92% of the old generation mercury lamps were replaced with energy efficient High Pressure Sodium (HPS) lamps in 2011.

Distribution of street lamps and their wattage, 2011

Type of lamp	Street lights		Watt	
	Number	% breakdown	Min.	Max.
HPS	14,700	92.0%	70	400
Metal Halide	100	0.5%	35	250
Mercury Vapor	1,000	7.0%	125	400
Other	100	0.5%	8	24

The electricity consumption figure per light pole in 2011 was the highest compared to all other cities in the TRACE data base (see figure below). In 2011, over one-third of the city's total electricity expenditure was spent on public lighting and on traffic lights. One of the main reasons for this is the long hours of street lighting use over summer and winter time. Three major things are required to improve overall efficiency of the public lighting network: street coverage needs to be uniformly expanded; the existing network needs to be better monitored and maintained (e.g. ensuring the street lights are turned off during the day, and making sure that light bulbs that don't work are promptly replaced); and lighting timing systems could be introduced. A lighting timing program to intelligently monitor lighting according to varying weather and activity levels can significantly help reducing the electricity bill.

Electricity Consumed per Light Pole



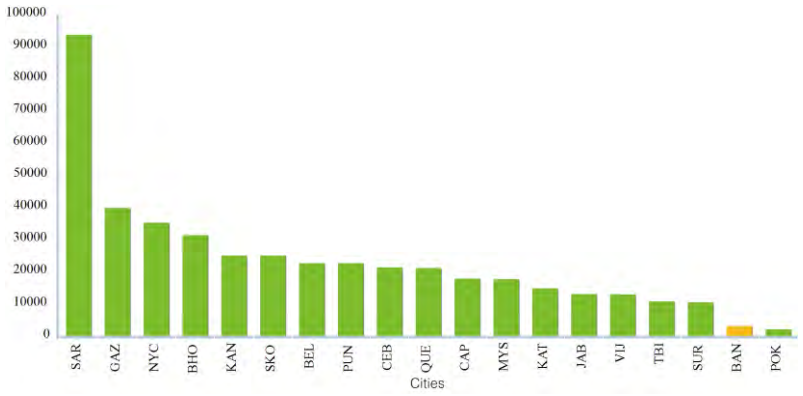
The spacing between individual light poles varies considerably in the city from 15 to 60 m with an average distance between two poles around 35 m. The electricity consumed per kilometer of lit roads in 2011 was lower than in many other cities in the TRACE database, as shown in the figure given on next page. Further, around 72% of roads Banja Luka benefit from street lighting.

Local authorities have also considered introducing the latest and most advanced LED technology for street lighting. However, based on test results, the city authority found HPS lamps are currently more efficient compared to LED both in terms of lux (measured in luminous emittance per unit area) and cost (upfront and operating costs). Their test results have shown that for LED bulbs the light output is 5.5 lux

compared to 13.8 lux for HPS lamps. The authorities found out that the start-up and maintenance costs of using LED technology are quite high (same was the experience of city authorities in Belgrade), so they prefer to wait and learn more about the performance of this new technology before taking any decision.

Electricity Consumed per km of Lit Roads

kWhe/km



To improve overall efficiency of public lighting the following specific measures have been recommended in the SEAP report published by the Banja Luka city authority. *"Public lighting should be turned on only in periods with low natural light illumination level. In summer, it should be turned on 1 hour later and turned off 1 hour earlier, compared to winter".* The city is working on having a centralized city light control management system. A program with strategic timing and/or dimming tailored to the specific needs for lighting in specific areas can significantly reduce electricity consumption while still delivering appropriate levels of lighting and providing safety and sense of security in public areas.

District Heating

Toplana in Banja Luka is the single district heating plant and was established in 1970, right after the 1969 earthquake. This is the second biggest district heating system in the country after Toplana Sarajevo. Toplana is a public utility company and its main area of activity includes the delivery of hot water and steam for heating and industrial purposes. The district heating plant is currently serving one-third of the city's inhabitants with space heating in residential, commercial and administrative buildings. People who are not connected to the heat distribution network use individual heating systems. Small residential houses use wood for space heating.

Currently, Toplana's heat distribution network in Banja Luka is connected to 22,000 residential apartments and covers a total plinth area of 1.3 million m^2 with thermal energy (average heating area of 59 m^2). In addition, there are 1,500 commercial establishments connected to the network covering 300,000 m^2 (average heating area of 20 m^2). All connected commercial consumers for space heating pay according to the thermal energy they consume recorded in heat meters (calorie meter) installed in their premises. However, all connected residential consumers pay according to the plinth area of their apartments.

Toplana supplies heat by pumping hot water in pipes during the winter months, which typically begins on 15th October and continue until 15th April. On average, Toplana supplies 188 days heat in a year using a system of hot-water boilers. During the heating season, hot water is delivered daily using pumps with maximum supply temperatures between 130 and 140 ^{o}C from 6 am to 10 pm. Although the goal is to maintaitain the indoor temperature maintained at +19^{o}C (+/- 1^{o}C),, under the present arrangement Toplana finds it difficult to maintain such a controlled indoor temperature.

The total installed capacity of the boiler house is 246 MW (4 boilers of 58 MW capacity and 2 of 7 MW). Currently, the 4 boilers (232 MW) are in operation and the boiler house is fired by exclusively mazut or heavy fuel oil. Each boiler (58 MW) has two burners: upper one and lower one. Three heavy fuel oil reservoirs are placed outside the facility. Using six pumps, hot water from the boiler house is pushed through the primary network. There are two water reservoirs inside the facility responsible for maintaining water pressure and two 60 meter chimneys (one chimney for two boilers) in the boiler house. Hot water from the primary network is pumped to the 200 substations, and from each substation to different consumers.

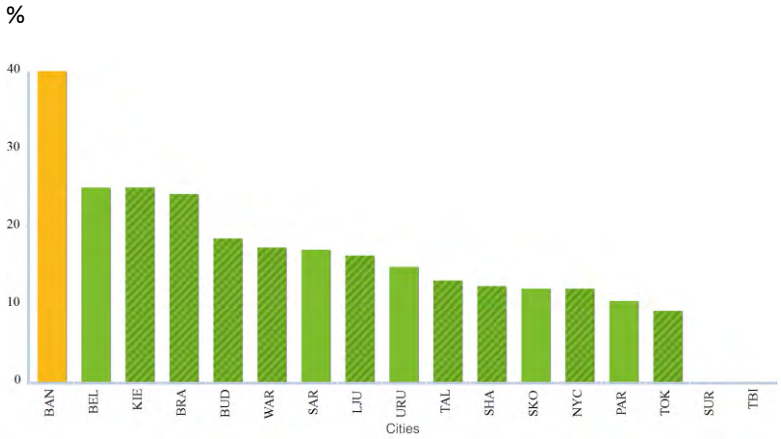
Boiler House Facilities in Toplana, Banja Luka






The length of the pipes in the primary network is 45 km and these primary pipelines are located in concrete channels and insulated with mineral wool. The secondary network is about 110 km of pipelines. Most of the pipes are underground and their average age is about 35 years. The share of modern pre-insulated pipes is about 5% of the total network. The general condition of the overall network is bad and suffers from external and internal corrosion. The external corrosion is due to damaged insulation of the protective coat and these leads to penetration of outside water from the ground into the pipeline structures. The steel are damaged affecting the heat insulations leading to increasing heat losses from the network. Internal corrosion occurs due to inadequate quality of make-up water. The poor condition of the district heating network leads to heavy water loss from the system. According to the information provided in the city SEAP report, Toplana consumes on an average 180,000 m^3 of water in a year, which is about 1,000 m^3/day during the heating season. Due to leakage in the network the water in the Toplana system changes completely in 8 days. The comparable figure in Western Europe is about one change in a year. The water consumption rate for Toplana is 45 times higher than the typical rate in Western Europe. As can be seen in the figure below, the total heat loss from the network is the highest in the TRACE city database.

Percent Heat Lost From Network



The overall efficiency (measured by total energy input versus heat received by consumers) of the Toplana district heating system is about 60% as compared to 80% in Western Europe. The 40% heat loss in Toplana is on account of the following three factors.

- Heat production efficiency 80%.
- Heat losses from the network 11%.
- Hot water loses from the network 13%.

The two major conclusions in the SEAP study on the Toplana district heating system are:

- The current operation of the overall heating system is highly inefficient and wastes large quantity of heavy fuel oil use due to the level of leakage and lack of control system, and
- Complete modernization of the heating system would help in fuel savings by 27%, water consumption by 93%, and electricity consumption by 70%.

Given the plant capacity and the type of fuel used, Toplana district heating system is subject to a number of environmental laws and also subject to IPCC legislation. Total consumption of fuel oil in the heating season 2011/12 was 25,000 tons with total annual energy expenditure of 36 million KM (or 18 million EUR) on fuel oil, which amounts to 75% of the total Toplana annual budget. Every heating season close to around 5 million EUR is lost on fuel due to the high inefficiency built in the heating system.

The implications of the specific recommendations as presented in the SEAP study report to improve the overall system efficiency are briefly discussed below:

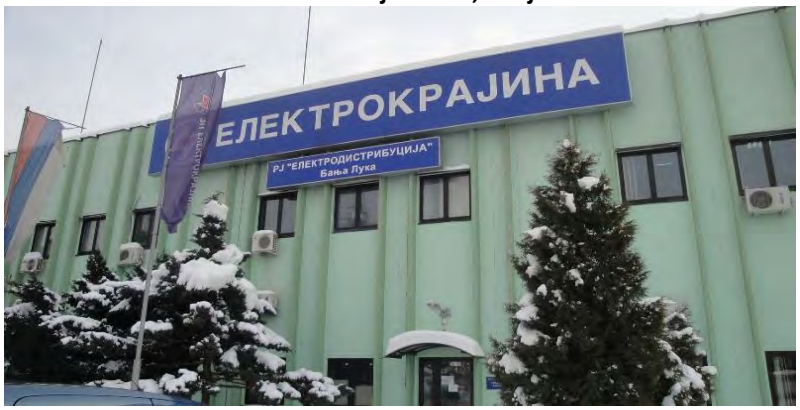
- *Modernization of the primary network*: It is envisaged that in 2020, with replacement of the worst network sections and valves in chambers and other components in the primary network, fuel oil savings will be in the order of 1,395 tons, which is around 15,579 MWh of thermal energy.
- *Modernization of the secondary network*: Similar measures as recommended above for primary network if implemented in the secondary network, would lead to a fuel savings potential of 1,170 tons, which is around 13,066 MWh of thermal energy.
- *Modernization of substations*: Measures such as replacement of control valves and automatic regulators, replacement of heat exchangers (if necessary), installation of water flow meters between primary and secondary networks, installation of heat meters, and automation would help in savings of heavy fuel oil (720 tons) and thermal energy (8,040 MWh) by 2020.
- *Installation of heat meters in buildings*: Installation of heat meters in all customer buildings would help to monitor heat consumption rate in each building and will also create conditions for payment based on actual consumption of heat energy. In addition, it would help to monitor heat loss in the secondary networks, helping to locate pipelines needing rep*lacement. As a result of which, it is en*visaged that in 2020, fuel oil savings will be 45 tons, which is around 503 MWh of thermal energy.

According to Toplana's plan, it would cost them 35 million EUR towards modernization and capacity expansion of the plant (from 232 MW to 350 MW), modernization of substation and the entire piping network, and thermal insulation of residential buildings.

Power

Power generation in RS is carried out by Mixed Holding Company Republike Srpske (EP RS). EP RS makes independent decision, especially on construction of new power plants, and planning of supply of electricity to its wide range of growing consumers in their respective areas of operation. Power generation from EP RS is distributed into 5 areas: Elektro – Trebinje, Pale, Bijeljina, Doboj, and Krajina. Elektro Krajina represents one half of EP RS, while Elektrodistribucija (responsible for electricity distribution in Banja Luka) represents one half of Elektro Krajine therefore, one quarter of EP RS.

Elektrodistribucija Office, Banja Luka



City level final electricity consumption data in physical units (kWh) is not available. According to the information collected from Elektrodistribucija, the total generation of electricity in 2011 was 848.8 GWh – a majority of which is consumed in Banja Luka, and the remaining in the surrounding municipalities of Knezevo, Kotor Varos, and Celinac.

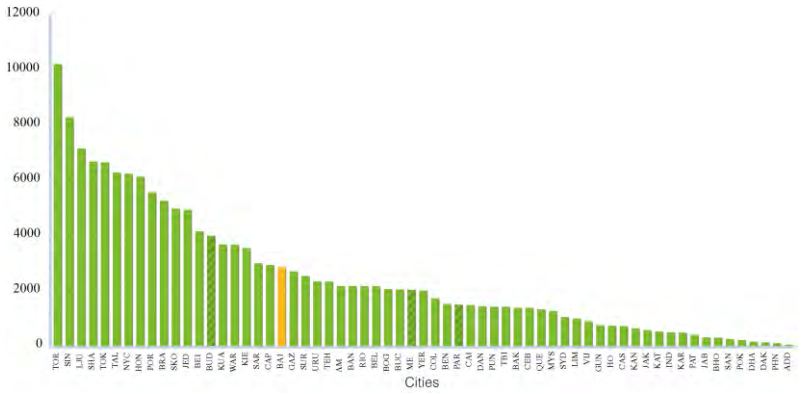
The city of Banja Luka has seven transformer stations (see their installed capacity in the following table). Based on the discussion at Elektrodistribucija, it is estimated that the city's peak demand for electricity is 311.5 MW.

Banja Luka transformer stations	
TS BL 1	2 x 40 MW
TS BL 2	2 x 31.5 MW
TS BL 3	40 + 20 MW
TS BL 4	2 x 20 MW (1 x 20 in use currently)
TS BL 5	20 MW
TS BL 6	2 x 20 MW (1 x 20 in use currently)
TS BL 7	2 x 20 MW (1 x 20 in use currently)

Based on the data supplied by Elektrodistribucija, it is estimated that the city's final electricity consumption was 644.8 GWh[12] in 2011. This places Banja Luka somewhere in the mid-range of the cities with relevant data in TRACE (see figure below).

Primary Electricity Consumption per Capita

kWhe/capita

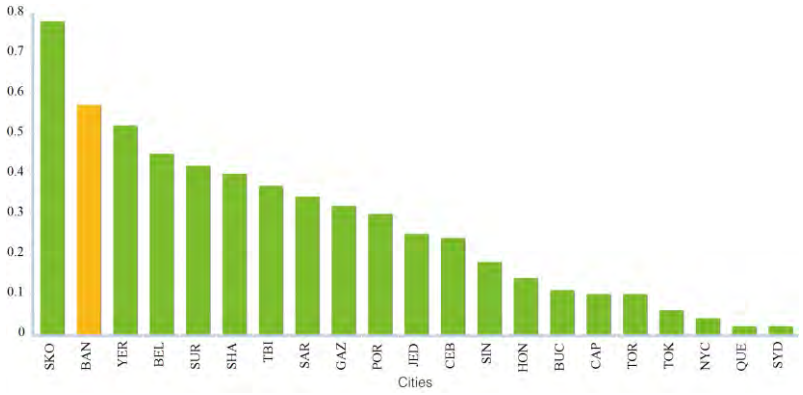


The city also uses large amount of fossil fuels directly that is consumed by the local authorities for space heating (facilities that are not connected to district heating system) and energy consumed in the transportation and industrial sector. Unfortunately, due to unavailability of fossil fuel consumption data directly for heating (as a primary source) at the city level, the total per capita energy (electricity and other energy forms) consumption figure could not be estimated for Banja Luka.

However, the city economy is one of the most energy intensive compared to all other cities in the TRACE database, excepting the city of Skopje in Macedonia as shown in the figure below. Much of this is due to presence of a large number of big, medium and small-sized enterprises that operate in the city today.

Primary Electricity Consumption per GDP

kWhe/$GDP



The total number of electricity consumers in the city went up from 83,990 in 2010 to 86,647 in 2011. Correspondingly, expenditure on electricity also increased from 406 million US$ to 432 million US$. The following table presents the breakup of expenditure by sectors[13] or the service areas in the city for two consecutive years; 2010 and 2011.

[12] based on authors estimate.

[13] Actual consumption of electricity in different sectors in the city of Banja Luka in physical units was not available.

Expenditure on electricity and consumers by sector, Banja Luka

Sectors or service areas	2010		2011	
	USD*	No. of meters	USD*	No. of meters
City official total	201,848,750	7,608	219,381,574	7,725
▪ *Municipal Buildings*	*2,578,402*	*291*	*2,478,582*	*295*
▪ *Pub. & Traffic Lights*	*6,898,371*	*516*	*7,371,597*	*524*
▪ *Water Utility*	*10,010,135*	*27*	*10,472,453*	*27*
▪ *Solid Waste*	*219,607*	*4*	*240,021*	*4*
▪ *District Heating*	*15,886*	*139*	*172,262*	*159*
▪ *Others*	*182,126,349*	*6,631*	*198,646,659*	*6,716*
Households	204,369,293	76,382	234,157,131	78,922
Grand total	406,218,043	83,990	453,538,704	86,647

* based on conversion rate 1 KM = 0.6787 US$ (2010) = 0.7119 US$ (2011)

The share of electricity expenditure for all municipal service areas put together in the city (municipal buildings, water and waste water, public lighting and traffic lights, solid waste, and district heating) is close to 5%. Households in the city pay for over 50% of the electricity consumed and the remaining 45% is consumed by the non-classified 'others' - presumably the commercial and industrial sectors put together.

In addition to direct use of electricity, the city incurs expenditure on direct use of petroleum products in municipal service areas. For example, Toplana district heating boiler houses consume fuel oil to produce heat energy for space heating and use gasoline (or petrol) and diesel for urban transportation. Diesel is also used by the garbage trucks for collection of waste and its disposal to the landfill site. The table below shows the annual expenditure on energy (direct use of electricity and petroleum products) in Banja Luka in 2011.

Annual expenditure on energy in Banja Luka, 2011 (US$)

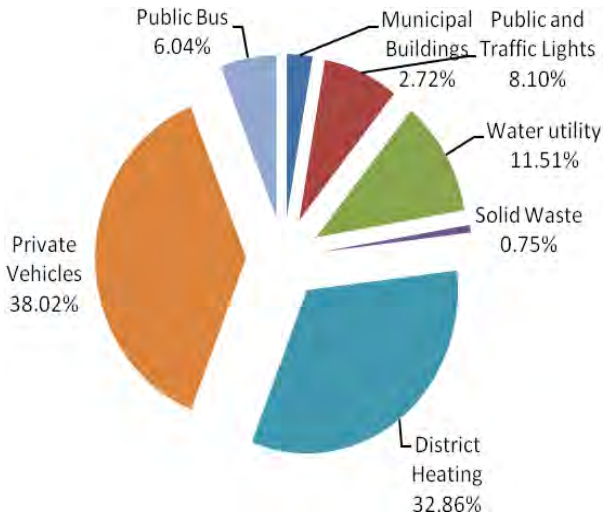
Sector	Electricity	Petroleum Products	Total
Municipal Buildings	2,478,582	-	2,478,582
Public and Traffic Lights	7,371,597	-	7,371,597
Water and Wastewater	10,472,453	-	10,472,453
Solid Waste	240,021	443,565*	683,586
District Heating	172,262	29,735,571**	29,907,833
Private Vehicles	-	34,597,071*	34,597,071
Public Bus	-	5,496,652*	5,496,652
Total	20,734,915	70,272,859	91,007,774

* Gasoline and Diesel; ** Fuel Oil.
Source: City Administration.

The following figure shows the share of city's total energy expenditure (91 million US$ or 128 million KM in 2011)[14] across six service areas covered under TRACE – urban transport (public buses and private vehicles), municipal buildings, water and waste water, public and traffic lighting, solid waste, and district heating. While, city's fuel expenditure on automobiles is the highest (38%) for personal mobility where city has very limited control on fuel savings, the city spends nearly 33% of its energy expenditure on district heating, and close to 12% on water supply, 8% public lighting and traffic lights, and 6% on public transport where city has a very high level of control in influencing energy savings through their implementing appropriate EE measures.

[14] However, this amount does not include direct burning of biomass and/or other fossil fuels for space heating of facilities that are not connected to the Toplana District Heating network due to non availability of data.

Annual energy expenditure in different sectors, Banja Luka (2011)



Energy Efficiency Recommendations

There is no EE Master Plan, Program or Strategy in BiH at any authority level (State, Entity). Yet, Banja Luka's interest in pursuing the TRACE diagnostic underscores its commitment to achieving optimal energy efficiency at the city level. The TRACE analysis provided a number of significant findings which helped focus activity during the early part of the study and contributed to the definition of priority sectors.

The analysis performed in TRACE identifies priority areas where significant energy savings are possible. The table below indicates the amount of energy spent in each of the six service areas or "sectors", the Relative Energy Intensity (the percentage of energy that can be saved in each sector, based on the TRACE benchmarking), and the level of local control the municipality has over these sectors. The savings potential is calculated by multiplying the three previous columns and presented in the last column in the table below. The results of energy use analysis and prioritization of sectors or the municipal service areas were discussed with city officials and finalized before getting into selecting a number of recommendations.

Sector	Energy Consumption 2011 (US$)	Relative Energy Intensity (%)	Level of Local Control*	Savings Potential (US$)** [PRIORITY]
District Heating	29,907,833	30.1%	0.75	6,751,693 **[PRIORITY 1]**
Potable Water	9,770,798	60.0%	0.95	5,311,692 **[PRIORITY 2]**
Municipal Buildings	2,478,582	51.0%	0.90	1,137,991 **[PRIORITY 3]**
Public Transportation	5,496,652@	30.2%	0.51	846,594 **[PRIORITY 3]**
Private Vehicles	34,597,071@	10.2%	0.10	355,061 **[PRIORITY 5]**
Street Lighting	1,067,850	33.9%	0.95	344,137 **[PRIORITY 6]**
Solid Waste	683,586	47.0%	0.75	241,125 **[PRIORITY 7]**

*0 = no control; 1 = full control; @2010 data.
**based on TRACE Benchmarking: these figures are indicative of the quantum of savings that may be possible, not necessarily practicable.

TRACE contains a playbook of 58 EE recommendations applicable across all sectors analyzed above. The recommendations themselves are not meant to be either exhaustive or normative. They simply outline a number of policies and investments that could help local authorities in Banja Luka achieve higher EE standards. Following the sector by sector analysis, each individual recommendation was reviewed to establish its applicability in the context of Banja Luka. This filtering process helped focus the process on those recommendations that are both viable and practical. These recommendations were boiled down to 15, spanning all of the service areas. Each of these recommendations and their relevance for the City of Banja Luka is discussed in more detail below.

A few caveats are in order here before we proceed with the individual recommendations. Comparing the performance of a city in a particular area, with the performance of other cities needs to be done with great care. For the most part, the TRACE tool allows the selection of

"peer" cities for comparisons purposes, based on climate (e.g. cities in colder climates would have higher heating requirements than cities in warmer climates), based on development level (the more developed a city is, the higher its energy consumption is likely to be), and based on city size. There are however some relevant criteria that have not been included. For example, density plays a very important role in how a city performs energy wise - the denser a city is, the more efficient it is likely to be. However, accurate density measures are hard to come by, as they should ideally focus on the built mass of a city not on its entire area (which could include vast tracts of open land).

A second caveat is that inter-city comparison on even the most straight-forward indicators can be tricky. For example, when comparing energy performance of municipal buildings, one has to take into consideration that different cities might have different types of buildings under their management. For example, a city that has a high share of local hospitals that it manages will likely have a more intensive energy profile for its municipal buildings (hospitals consume energy year-round and 24 hours a day). On the other hand, a city like Banja Luka, with mainly city administration buildings and secondary schools under its management, is likely to have a less intensive energy profile as all government hospitals in the city are under the purview of Republika Srpska.

These shortcomings aside, TRACE does considerably well what it's supposed to – it gives a quick radiography of a city and identifies areas with potential energy cost savings. As such, it offers local authorities and policy makers a way of dealing with urban challenges and opportunities in a holistic way. Below are a number of recommendations that were selected after the TRACE analysis, in close consultation with local authorities. A full list of TRACE recommendations supported by good practice case studies are presented in the Annex section. It is however important to note that the methodology used for sector prioritization in TRACE relates to EE only. As the city's urban energy plan extends to issues of energy supply and security as well as opportunities for renewable energy, it seems logical that where these opportunities arise, they are incorporated into the mix of recommendations to be considered in due course without, necessarily, a further prioritization process.

District Heating

The second biggest centralized district heating (DH) facility in the country, Toplana – Banja Luka, supplies heat to one-third of the city's inhabitants covering residential, commercial and administrative buildings. With three-fourth of Toplana's annual budget going to expenditure on mazut or fuel oil, the following specific measures for increasing EE and cost-effective utilization of heat energy needs deserve special attention:

Supply side interventions:

- introduction of oxygen regulation to optimize combustion in the facility;
- implementation of modern sophisticated devices in the facility to regulate heat parameters (flow rate, supply and return temperatures); and
- replacement of the worst network sections and repair of critical parts (control valves and regulators) of the network with improved heat insulation to minimize losses in the primary and secondary distribution network.

Demand side interventions:

- installation of individual metering for facilities with single-point heating system through installation of ultrasonic heat consumption meters; and
- evaluation of applicability of individual metering for older facilities with double-pipe heating system because of the system complexity.

The city has an extensive network of pipes that require continuous maintenance and upgrade to prevent close to about 25% heat and hot water (technical) losses from the network. In addition, much of the system's capacity to cogenerate electricity remains untapped.

District Heating Network Maintenance and Upgrade

First and foremost, the local authorities need to identify spots in the city DH distribution network with the highest heat and water loses. This would require a system-wide survey by the relevant local authorities. Repairing and replacing the piping network requires an integrated approach and close coordination with other departments (e.g. local

authorities responsible for repair and maintenance of roads, water and sewage pipes, and heat distribution pipes in the network) to work together at the same time to improve cost efficiency with as little disturbance to citizens.

The rehabilitation and modernization of DH infrastructure will be very expensive because the infrastructure is in poor condition. The worst problems usually exist in the secondary distribution networks that connect central substations and buildings and that are usually owned by municipal heating companies like, Toplana in Banja Luka. A set of investment measures needs to be taken on both the supply side and the demand side (meters, automation, and controls). Together with consumption-based billing, these investments will serve to convert the traditional DH system, where the heat source in effect regulates the heat demand, to a flexible system that consumers can influence according to their preferences and financial means.

District Cogeneration Thermal Plant

The large centralized district heating system in Banja Luka offers the opportunity to exploit the advantages of cogeneration of power and heat. The efficiency of a cogeneration plant can reach 90 percent or even more. Such combined heat and power generation (CHP) offers a substantial benefit compared with a typical power generation efficiency of about 35 percent at thermal condensing power plants and with separate production of heat at heat-only boilers. The benefits of CHP have not been realized in the city compared to the available DH potential. Together with a lack of maintenance and financing for technological upgrades, the district heating systems and the connected buildings in Banja Luka have become symbols of energy waste. Customers cannot control heat consumption and react to overheating by opening windows, even in winter. The resulting high costs of the district heating systems became apparent in the early 1990s, when primary energy prices increased towards world-market levels. Consequently, expenditures for heat have become major drags on household incomes and municipal budgets.

The way cogeneration works is quite simple. Since all thermal power plants also generate heat, and since this heat just gets released in the atmosphere, it often makes sense to have an adjoining DH plant next to them, which can make use of all the excess heat. There are many examples of how CHP can be put in place where district heating network exist. For example, Skopje in Macedonia is currently developing a CHP plant, which will generate power and use the residual heat to warm-up the water for the already existing DH network.

CHP systems not only offer significant energy dividends, but they also offer significant environmental dividends. Basically one unit of fuel is used to generate both electricity and heat and thus significantly reduces GHG emissions. Given the size of the Banja Luka DH heating network, an integrated CHP system in the city would help make it much more sustainable.

Obviously, expanding CHP capacity in Banja Luka is a move that needs to be carefully weighed and considered. The costs required for investments in CHP systems are quite substantial, and they most often require a liberalization of energy prices. At the same time the benefits from such arrangements can be quite substantial too (e.g. ensuring higher energy security), and with the right legal framework in place, the private sector can be involved to make necessary investments.

Potable Water

The water treatment system in Banja Luka is fairly new and the pumps can adjust water pressure automatically; therefore there is not much scope for EE improvement at the source of water supply. Nonetheless, the water utility company in Banja Luka, Vodovod, has to deal with a partially old and inefficient infrastructure (in some stretches the cast iron pipes are 104 years old), which leads to significant water loses (around 35% technical losses at present). Quality and reliability suffer from steadily deteriorating conditions of the water network, eroding consumer willingness to pay and thereby weakening the income base and funds that are required to finance needed network extensions. In addition, the water utility company is very dissatisfied with the prices set as they do not cover full service costs, but rather a fraction of operational and maintenance costs. The share on non-revenue is around 45% and it had been growing in past years.

Construction and maintenance of infrastructure is financed by the water utility and local communities through subsidies, grants, borrowing etc, and partially by participation of the public water management companies. One of the priority measures identified in the 2003 National Environmental Action Plan for water supply is “identification and

minimization of water losses in water supply systems where losses are up to 60%". This measure is set as a mid-term measure. No further specification is given on this issue. Consequently, improving the energy performance of the water supply system in the city could follow a two-pronged approach: improving energy performance of the old and inefficient piping network system together with adjustment of the water pressure and an effective water conservation awareness (WCA) measures.

Newly constructed water treatment facility and filter room, Novoselija

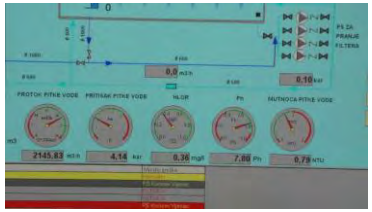
Despite a commercially oriented organizational structure of Vodovod, water company operations are financially unsustainable. EE gains alone will be insufficient to mobilize the needed resources to modernize the rapidly deteriorating condition of assets and infrastructure. The pricing structure must be adjusted to cost-recovery levels by city municipal councils because prevailing water tariffs are too low to even cover current operation and maintenance costs. Although there is a need to maintain affordable prices for socially vulnerable groups, the vulnerable section of the society also suffer disproportionately from current practices. This is because they are very often the same people who are excluded from the water distribution network. Low tariffs constitute untargeted subsidies that benefit higher income groups with their high consumption water per capita per day in the city (191 liter per capita daily in 2011). Instead, to protect the access of vulnerable groups to a reliable water supply, a targeted subsidy with clear eligibility criteria would be preferable. Otherwise, water should be supplied on a user-pays principle and on a cost-recovery basis. It is important to recognize that there are a number of consumers who do not have water meter connections.

Active Leak Detection and Pressure Management

Despite continuous improvements in the system, Vodovod reported 30-35% physical water losses in their system on account of technical losses. An active leak detection and pressure management program, could address both of these two issues at once. Effective management of leaks cannot only help save large quantities of wasted water, but it can also decrease energy expenditure as more water gets to end consumers with the same amount of energy inputs. Pressure management can significantly reduce pumping costs by minimizing the required delivery pressure and leakage. Leakage rates can be lowered with automated controls that reduce pressure in the network, especially at night. Pressure management is generally more cost-effective than extensive repairs to numerous leaks in buried pipes, especially for extensive systems with numerous leaks that would be difficult and expensive to locate and repair.

The most common type of control automation used in water and wastewater systems is the Supervisory Control and Data Acquisition (SCADA). Such a system was recently introduced by Vodovod. SCADA can remotely monitor and control a large array of components spread over large geographic areas, while also providing performance information on individual sites.

SCADA system in Vodovod's water pumping in Novoselija



The basic SCADA system consists of one central computer (the master terminal unit, MTU) that communicates with and controls a number of remote terminal units (RTUs) at key control points such as pumping and metering stations, plus the equipment to communicate between the MTU and RTUs. The RTU serves two functions: it uses information from those sensors connected to it to control system

components such as pumps and valves, and it enables the user to access performance information on the site.

A properly designed SCADA system for water pumping saves time and money while improving service. Some of the many benefits include: complete information on pumping operation provided in real time; pump operation adjusted automatically as needed to ensure reliable water supply; the need for service personnel to visit sites for inspection, data collection or adjustments is greatly reduced; alarms are sent to the central control location in case of emergency; optimal pressure maintained in the water supply network, minimizing service interruptions; electricity consumption reduced and pump productivity increased; equipment life increased; reports generated automatically. Although the Vodovod system is still its infancy, utility officials indicate that it has significantly improved the performance of the Water System.

To double the efficiency gains obtained through SCADA, the local utility company should start a more extensive leakage detection program, and determine investment needs for the replacement of old infrastructure (e.g. old piping).

Educational Measures for Water Conservation

Water conservation awareness (WCA) is an understanding of the need to use water efficiently at all stages from capture to consumption in order to promote change in attitudes and behavior with regard to water management and use. Education and information programs are central to promoting WCA in Banja Luka. The methods of organizing this may include promotional leaflets sent with monthly bills, adverts, information on water company websites etc. A deeper understanding of the implications of water wastage, both in terms of energy used for pumping treatment and resource availability in the long term, will encourage consumers to use less water, hence lowering the energy that is required to treat and pump the flow at source. This will also benefit the consumers as it will give them heightened awareness of water saving measures and the reasons for saving water. This improved awareness is something that they are likely to transfer to other locations.

Household customers should be given practical tips for water-saving in the home, details of water-saving devices and information on the real cost of water services, either enclosed with their water bill or sent as separate mailings. The role of women in WCA programs can be significant since they are often household water managers and can bring improved potential for family economic and social development. Educating children and students inculcates a future society with a water conservation culture. It also helps to educate present society when children return home and show their families what they have learned.

Support from water utilities is valuable. They can provide teacher and student packs, establish student visitor centers and mobile exhibitions, organize educational visits to water facilities and provide guest speakers to schools. They can also offer short-term training courses for teachers and provide holiday working experience for older children.

To maintain political and financial support for WCA promotion, it is necessary to monitor and evaluate program inputs and outputs to demonstrate a positive trend. The cost of monitoring and evaluation should be included in the starting budget. Two interrelated aspects need to be monitored and evaluated: delivery of the program itself; and results achieved. The former is part of program management and will enable logistical adjustments to keep the program on track, while the latter takes more effort but is needed to demonstrate program success. Results depend to a large extent on delivery and this is where the two aspects of monitoring come together.

Municipal Buildings

The local authorities have been particularly pro-active in implementing EE measures in the buildings they own and manage in the city. From simple initiatives like conducting building energy audits using computerized software, to implementing specific EE measures, like replacing windows with energy-saving glass, payment for space heating according to the installed capacity in the city town hall (main municipal building), there are a range of measures that Banja Luka can continue to develop. In fact, There is a lot of interest on part of local authorities to determine ways in which EE in municipal buildings can be improved. Since municipal buildings in Banja Luka seem to be doing much better that other cities with pertinent data in the TRACE database, it will be important for local authorities to think of how EE improvements can be scaled up to the entire city. That is, how can the accumulated experience be used to encourage households, businesses, and other public and private institutions to improve the energy performance of the buildings they occupy. City municipality should strengthen their support for the

refurbishment of the existing building stock by private and public actors and continue their support for relevant demonstrations of high efficiency buildings in order to raise awareness amongst consumers, investors and other key market players.

The following specific measures can offer immediate benefits, not only allowing for a significant decrease of electricity and heating bills in the city annual budget, also allowing for a fast amortization of investment costs.

Municipal Offices Audit and Retrofit Program

One of the key challenges is the lack of accurate data to analyze the existing building stock in the city. The detailed database of all types of buildings in the city was collected during the 1991 census. The large variation in the age of the physical structures and the type of technology and materials used in construction of buildings (the oldest buildings were built from the late 19th and 20th century to the newest ones constructed after 1995) influence energy consumption in the existent building stock. The building regulations and building by-laws were changed over time. Old buildings tend to be built out of brick (which has good insulating properties) and generally have thick walls. Newer buildings are subjected to stricter building standards, including clear thermal insulation guidelines, so they are generally in good shape. However, a large number of buildings in the city were built from 1945 to 1970. These buildings used materials and techniques that on the whole had a poor thermal performance.

According to the SEAP report, there is a big potential (60–80%) to reduce energy consumption in buildings that were constructed until 1980s. The suggested measures to improve EE of the building shell include thermal insulation of roofs, exterior walls, floors, better sealing, replacement of windows and improving or replacing HVAC systems. The report provides the following approximate estimate of the possible energy savings with these measures:

- 11% savings with 20 cm roof insulation;
- 20-25% savings with 12 cm of insulation of exterior walls;
- 6% savings with 6 cm insulation of ground floor; and
- 20% savings with replacement of windows

What the city clearly requires is a comprehensive understanding of their building stock in terms of their energy use performance. One of the recommendations made during TRACE implementation process was the performance audit of the municipal building stock. The audit would not only allow a better energy and cost savings estimate, but more importantly would also help determine key areas for intervention. The program will identify immediate savings opportunities, and implement rapid payback items to yield cost savings that can go to other municipal services.

Municipal Buildings Benchmarking

A full audit of the municipal building stock would also allow a benchmarking exercise with more credible information which is currently missing. Given the size of Banja Luka, and with very different age structures of the of the buildings it owns and manages, developing a buildings energy benchmarking program is critical for directing resources to buildings to achieve the highest impacts. Therefore the goal of the benchmarking program is to identify the highest energy intensive buildings in the city authority's portfolio so as to focus on the best EE opportunities. The benefits of the program are to use EE 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 requires careful planning and coordination between different departments and a careful analysis of different building types and their categorization for a like-to-like comparison. For each building, information and reports need to be collected on an annual basis (e.g. energy use, energy bills, water use, water bills, floor areas) to track energy performance.

Regular monitoring and analysis of building energy consumption indicators and identifying improvement opportunities is a good starting point. However, setting a proper benchmark requires detailed analysis because similar buildings can have significantly varying underlying factors, for example, types of tenants, or occupancy density (people per square meter). In addition, the results of the benchmarking process should be published on a regular basis. This often helps generate healthy competitions between different building managers, and it will also foster the exchange of knowledge and experience.

Mandatory Building Energy Efficiency Codes for New Buildings

According to the SEAP report, achieving greater savings, with a much greater insulation thickness in the older buildings, is not a path that should be pursued, because increased thickness would require adjustments in façade and in the roof (e.g. 20 cm insulation on the façade and 30 cm in the roof). However, it is possible to achieve this in some cases where the existing construction of the buildings enables it. Further, in some cases, as the report states, it is possible to reach the standards of passive buildings with only 15 kWh/m^2 of the energy needed for heating.

Once local authorities have done their due diligence in improving the energy performance of municipal buildings, and once they have gained some experience in the field, they can consider introducing mandatory building EE codes for new buildings, both private and public. Adopting such a strategy to improve EE in the city's entire building stock would be essential as by signing up to the Covenant of Mayors the city Mayor commit to the Banja Luka city community to voluntary achievements of EU's "20-20-20" climate change targets (reduce GHG emissions by at least 20% below 1990 levels, increase use of renewable energy sources to 20%, reduce primary energy use through improving EE by 20%).

The EE building 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 not only on EE, 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, and 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.

Public Transport

It is well known that public transport occupies less road space and causes less pollution per passenger-kilometre than personal motor vehicles. As such, public transport is a more sustainable form of transport and its development is critical to the welfare of the urban poor and a crucial element in any city development strategy. Public transportation in Banja Luka is exclusively run by the bus services operated by only private operators. One of the top priority sectors under the Banja Luka City Development Strategy (2007-2015) is the development of urban and suburban public transport systems. The overall aim is to increase the attractiveness of public transportation (encourage greater ridership on mass transport and discourage use of private vehicles) for improving city's overall transport EE, improve air quality and reduce GHG emissions. By offering frequent, reliable, comfortable, ubiquitous public transportation options, local authorities create some of the most important premises for enabling the shift from private cars to more sustainable modes of transportation.

Public Transport Development

Recognizing the importance of developing an efficient urban and suburban public transport system, the municipality in its SEAP report has recommended the following specific measures, some of which are technical while others are organizational in nature:

- The use of biodiesel in public transport would result in reducing diesel fuel use by 0.02 million liters.
- The improvement of bicycle traffic with construction of new and reconstruction of existing bicycle paths and construction of parking for bikes would help reducing the use of diesel and gasoline by 1.68 and 1.37 million liters respectively.
- The use of emission control devices to control exhaust gases from vehicle tailpipes and introducing technical safety features will improve roadworthiness of vehicles.
- The setting up of a centre for automatic control and regulation of traffic will improve speed of traffic flow; reduce time losses in traffic and pollution, noise etc. This would result in reducing diesel fuel use by 2.39 million liter and gasoline use by 1.95 million liter.
- The setting up of a center to continuously monitor performance of public transportation services, implement passenger information system in bus stops to indicate when the next bus arrives, introduce a new way of fare collection system using electronic tickets to make public transportation in the city highly attractive and wean away riders from private vehicles. With such measures the use of diesel fuel will be reduced by 0.722 million liter and use of gasoline by 1.73 million liter.

- The launching of a campaign called 'Eco Inspection in Eco vehicles'. In this campaign, the city environmental inspectors perform their daily activities with electrically driven vehicles. This would help city to set its own example in city leadership and contribute to the development of ecological consciousness of its citizens.

Local authorities also need to think of introducing different types of public transport services for different segments of commuters. Those who place a premium on cost are the poorest sections of society and need to be given affordable prices. The cost of providing public transport for them needs to be subsidized by other sections of society. However, there is another segment that values time saved and comfort more than price. This segment is comparatively better off and would shift to public transport if high quality systems are available to them. The cost of providing public transport to them need not be subsidized and can be met from fare revenues. To facilitate this, local authorities should think of developing a premium service infrastructure, such as improved bus stations and terminals, improved passenger information systems, use of intelligent transport systems for monitoring and control, etc. To make public transport attractive in Banja Luka, it is essential to improve access to its services. It is useful to lay down standards for accessibility in terms of the distance within which public transport access points should be available. This necessitates the use of personal transport. This can be done by planned integration of public and personal transport operations. Typically this calls for good parking facilities at public transit stations and easy access to public transport from there. The park and ride facilities that exist in many developed countries seek to achieve this.

Traffic signal priority for buses, bus tracking and passenger information system (through provision of interactive terminals, bus stop schedule displays, and use of satellite based global positioning systems) can go a long way in improving bus speeds, reducing waiting times at bus stops and in scheduling journeys. Experience has shown that faster moving buses, short waiting times (10 minutes or less) and reliable service increase bus ridership and reduce air pollution significantly. The recent experience of the bus schedule LCD board displays in Tbilisi, Georgia can be a good learning experience for Banja Luka on what can be achieved with innovative, affordable, and well implemented measures.

Clearly, urgent reforms are inevitable for sustainable solutions to Banja Luka's challenge of urban transport services by addressing the following objectives: (i) to bring about better integration of land use and transport planning so as to improve access to jobs, education, etc.; (ii) to encourage public transport and non-motorized transport so that the dependence on personal motor vehicles is reduced; (iii) to offer central government support for investments in public transport systems; (iv) to have a more coordinated approach to management of urban public transport; (v) to provide concessions for the adoption of cleaner fuel and bus propulsion technologies so that the pollution caused by public transport gets reduced.

Non Motorized Transport Modes

The two major modes of non-motorized transport (NMT) are walking and various forms of cycling. Given the city size, clearly, walking dominates for shorter trips in Banja Luka, but even in terms of distances traveled, walking accounts for majority of all trips. Pedestrian improvements are usually implemented by local governments. It usually begins with a pedestrian plan to identify problems and prioritize projects. Right now the city does not have the basic infrastructure to separate motor traffics from other NMT modes. But, as indicated in the SEAP recommendations, the city authority plans to introduce a network of protected lanes for bicycles in some designated areas. It would be important therefore for the city government to seriously consider some pilot NMT projects and supporting policies that encourage walking and bicycle use by prioritizing non-motorized over motorized vehicle access to address a key objective of protecting urban environment.

NMT modes tend to have high shares in countries such as the Netherlands and Switzerland. The major elements of a strategy for NMT should include the following strategies:[15]

- Clear provision for the rights, as well as responsibilities, of pedestrians and bicyclists in traffic law;
- Formulation of a national strategy for NMT as a facilitating framework for local plans;

[15] Source: World Bank 2002. Cities on the Move – A World Bank Urban Transport Strategy Review.

- Explicit formulation of local plans for NMT as part of the planning procedures of municipal authorities;
- Provision of separate infrastructure where appropriate (for safe movement and for secure parking of vehicles);
- Incorporation of standards of provision for bicyclists and pedestrians in new road infrastructure design;
- Focusing traffic management on improving the movement of people rather than of motorized vehicles;
- Training of police to enforce the rights of NMT in traffic priorities, as well as in accident recording and prevention;
- Incorporation of responsibilities for provision for NMT in road fund statutes and procedures;
- Development of small-scale credit mechanisms for finance of bicycles.

NMT Facilities in the Downtown Area

Private Vehicles

A rapid increase in private car ownership and use, the lack of proper regulation for car energy and engine performance, and people's strong preference for using cars over other modes of transportation, have lead to a very energy intensive transport sector. Today, more and more of Banja Luka's streets are congested, and more and more of its neighborhoods are polluted by car exhaust. The more space is created on city streets for cars, the more will people see this as an invitation to use their cars. Consequently, it is important that local authorities also invest time and resources in determining how traffic flow could be restraint in certain areas, and how alternative modes of transportation could be encouraged. The easier it is for people to use public transportation, walking, or biking, and the more comfortable and safe these alternatives are, the more will decide to go that route as discussed earlier.

City Streets Occupied by Cars

Traffic Restraint Measures

With increasing motorization level, traffic congestion is expected to grow rapidly in Banja Luka. Significant efforts have been made in recent years to improve the quality of traffic management through marking or traffic lights but much more needs to be done. City transport planners in Banja Luka need to give increasing attention to the possibility of reducing downtown use of cars by such means as limited parking, higher parking charges and tolls, sale of special central area permits or licenses, or a complete ban on automobiles on selected streets. Among the possible benefits of these auto restraint schemes is less congestion - even if only a small percentage of automobiles are eliminated from central area streets during the peak hours. Reduced use of cars in the central area may also alleviate air pollution and other environmental problems there and help to conserve energy.

Like any other city in the region, there is a bias for private cars in Banja Luka, and the city has developed a car-oriented culture in recent years. Directly restraining road traffic through travel demand management is therefore critical. However, little has happened in this area due to a number of critical factors: (i) lack of an attractive high quality public transport alternatives that provide the same level of convenience and time saving which a private car offers; (ii) lack of staff for design and enforcement; (iii) political unwillingness to implement and enforce. To be more effective, a range of traffic restraint instruments need to be planned as part of a comprehensive city transport strategy,

for which city government needs to take effective action. The new challenges of environmental and financial sustainability thus require government to increase their understanding of the process through which transport impacts the environment, while extending and refining the range of fiscal and regulatory instruments to address the problem.

In Europe, car free central districts have contributed to a remarkable increase in the quality of urban life and of the attractiveness of central districts. The City Authority can also impose vehicle-type bans which exclude entire vehicle categories from circulation. But such direct controls are not without problems. In the absence of high quality public transport, and inadequate facilities for modal interchange (bus to rail, bicycle to transit, etc.) it is hard to make a case for private car restraint measures. “Non-auto days”, as put in place by Mexico City, selective license plate enforcement as done by the City of Athens, or “no-driving days – one-day rest” as in Puerto Princesa City (the Philippines), have shown perverse effects in rescheduling activities or encouraging increased car ownership rather than restraining total amounts of traffic.

Street Lighting

The public lighting system in Banja Luka is generally in good shape, although energy expenditure per light pole is quite high. Three major things could help improve system performance: street coverage needs to be expanded; the existent network needs to be better monitored and maintained (e.g. ensuring that lights are turned on only in periods with low natural light illumination level, and making sure that light bulbs that don’t work are promptly replaced); overall energy efficiency of the system can be enhanced (e.g. by replacing remaining energy inefficient bulbs, using light bulbs with a longer life-span, and by introducing improved lighting timing systems). Extending the street lighting system will ultimately mean higher energy costs for local authorities, but these costs can be offset by increasing the efficiency of the existent system.

Overall, there are two major recommendations that seem to make sense in the case of Banja Luka. On the one hand there is a need for a better audit and monitoring system to ensure the system is running efficiently. On the other hand, lighting timing can help improve the performance of existing bulbs by adjusting use according to the intensity of the natural light outside (e.g. higher use in the winter time and on cloudy days) and according to the time of day (e.g. lower light intensity when streets are less travelled, such as after midnight on a week-day).

Street Lighting Audit and Retrofit

The aim of this recommendation is to both assess current lighting efficiency and to retrofit where appropriate. With a proper procurement guide in place, and with a clear idea of what street light technologies have the lowest life-cycle cost, local authorities should continually perform a system audit to determine retrofit needs. 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.

The City of Banja Luka, who is in charge of street lights on the main boulevards and public community areas, has done an almost complete revamping of the system, replacing inefficient mercury bulbs with more efficient high pressure sodium bulbs. Currently, local authorities have focused on using high-pressure sodium bulbs for street-lighting purposes. Those are quite efficient and cheaper than newer technologies. In particular, the City has considered introducing LED technology, which is supposed to have a longer life and better EE. However the technology is still quite new and its life-cycle performance is not yet understood. Therefore, local authorities have opted to wait and see how LED street bulbs perform in other cities, and, if deemed viable, to consider their introduction in Banja Luka too. This is a sensible approach as not everything that glitters is gold. However, if new LED technologies, as well as other innovations in the field, prove to have a lower life-cycle cost than the current high-pressure sodium vapor bulbs, the City should consider upgrading the system once the existent bulbs have served their life.

Lighting Timing

While many of the inefficient street light bulbs have been replaced, public lighting in Banja Luka continues to have two states of operation – 'ON' and 'OFF'. Moreover, in some cases, there seems to be no off button with lights being left to run in the middle of the day. The fact of the matter is that depending on the season and the time of the day, there are different demands for street lighting. For example, on bright long

summer days, street lights may only have to be turned on after 9:00 PM. Moreover, given that few people still walk the streets after midnight on week-days, there is no need for the same light intensity as during the high-traffic hours.

Consequently, it makes sense to introduce a lighting timing system, which automatically turns the lights on only when it is sufficiently dark outside, and which automatically dims the light after a certain hour (e.g. midnight). Lighting timing systems could also have motion-based detectors, which turn lights on only when someone is actually in the area. Such programs can be implemented in a fairly cost effective way, and they make a lot of sense in places like Banja Luka, where much has already been done about improving the performance of the street light bulbs. The Annex includes a more detailed account of options in this field, as well as the experience of some cities that have successfully implemented lighting timing programs.

Solid Waste

The regional solid waste management (SWM) system for Banja Luka is operated and managed in an efficient manner. DEP-OT, a public company, took over the management of Ramici landfill (catering to 7 adjoining municipalities in addition to Banja Luka municipality) from July 1, 2004. Cistoca, another public company is responsible for collection, transportation and disposal of municipal waste to the Ramici landfill from these eight municipalities. While the system whole is quite basic, and while recycling rates are insignificant, the leadership of DEP-OT has very ambitious plans to transform the SWM system in a state of the art one.

Although in TRACE 'Solid Waste' only came out as the last Priority for Banja Luka, it is quite possible that this sector will weigh much heavier in terms of EE in the future. Given the potential of landfill gas to be captured and turned into valuable electricity, heat, or fuel, this is one area that deserves more attention from local authorities. Also, markets have been identified for many recyclables, and there is great opportunity to extract value from waste.

In terms of EE in SWM, there are three recommendations that make particular sense for Banja Luka right now: waste sorting and transfer facilities, land fill gas capture, and waste to energy.

Waste Sorting and Recycling

Recycling is one of the main topics of interest to DEP-OT in the city and for the adjoining areas. Recycling ultimately means less waste that has to go to the landfill and less energy that needs to be spent on handling that waste (collection, transport, disposal).

Of course, recycling itself requires energy inputs – energy inputs which are often higher than simple disposal. However, these energy inputs and costs are almost always offset by the revenue generated from selling these recyclables. In a nut-shell, there is wealth in trash, and every city should take full advantage of that. Even when markets for recyclables are not fully developed, local authorities can spur market formation by doing recycling on a pilot basis.

DEP-OT is looking into developing an integrated SWM strategy, with a big component dedicated to recycling. Such a system needs to put in place incentives to encourage people to recycle the waste they generate. For example, if a household does proper recycling, a certain amount is taken off their final SWM bill. The utility company generates back the loss in tariff by selling those recyclables. If the system is properly managed, recycling can even become a profit making activity for the local operators, and may even be privatized. Right now, garbage trucks in some of Banja Luka's suburban communities have to run long distances to dump collected waste at the Ramici landfill. Local authorities may like to consider the possibility of developing a system of transfer stations, which will allow small garbage trucks to consolidate waste in bigger trucks, so that fewer trips are made to the landfill. Such a logistics system would not only allow a reduction in fuel costs, but it will also prolong the life of the trucks and will reduce maintenance costs.

Special attention needs to be paid however to how the transfer station system will be devised. Transfer stations can help improve logistics dramatically, but they are not always a silver bullet for all logistics problems. Depending on the distance to the landfill, and depending on the waste that is actually being transported, some transfer stations may reduce operating costs, some may actually increase them. International best-practice indicates that transportation via a transfer station is usually viable in the following simplified scenarios:

- generated waste exceeds 100,000 tons/year, for a travel distance of around 25 km;

- generated waste is between 25,000-30,000 tons/year for a transport distance of around 50 km;
- generated waste is between 5,000-10,000 tons/year, for a travel distance of over 75 km.

Obviously other factors, such as topography and actual fuel price, play a role in determining the feasibility of transfer stations, and they should be carefully considered when devising such a system.

Land Fill Gas Capture

During decomposition, waste releases a number of gases. Methane is one of those gases, and it represents both a problem and an opportunity. From an environmental perspective, methane is one of the most potent green-house gases – once released in the atmosphere, it has a global warming potential that is 72 times higher than CO_2 in the first 20 years. From an economic perspective, methane can be converted to generate electricity, heat, or fuel. Some cities use converted landfill gas as fuel for their garbage trucks, some use it to generate electricity and heat, some collect, clean, and sell the gas to private users (e.g. taxi drivers). Options in the area abound, and more and more options will become available as technologies in the field are improved.

In the Ramici Landfill, DEP-OT is presently doing a feasibility study to monitor and evaluate the quantity and quality of methane gas potential that can be produced annually to produce electricity and heat. It is however not yet clear how the methane will be used for productive purposes. Depending on gas yields and generation rates from the results of the feasibility study, and depending on capital and operational costs, there are different ways in which captured landfill gas could be used. More options and examples are outlined in the Annexes.

What is important for local authorities is to consider the life-cycle cost of new technologies – i.e. if investments in methane capture and use facility prove to generate a profit over the lifetime of the investment, they deserve the proper consideration. Of course other factors play an important role, and local authorities often have to choose between a limited numbers of investments they can make at a specific point in time. However, they should avoid the trap of short-sightedness and give proper consideration to potential long-term benefits, not just immediate ones.

Waste to Energy

The objective of this recommendation is to capitalise on the energy generation potential of Municipal Solid Waste (MSW) by introducing new forms of waste treatment. In order to implement this recommendation, the city will have met essential waste collection and transportation requirements that enable sorting of solid waste for incineration, gas capture, and heat and/or power generation.

The introduction of waste-to-energy processes can be used to support existing energy infrastructure and reduce reliance on traditional energy providers. By reducing waste going to landfill, waste-to-energy programs will not only reduce land-take pressures, but will also help reduce future methane gas emissions from landfills.

ECA Sustainable Cities:

Improving Energy Efficiency in BANJA LUKA

Bosnia and Herzegovina

Republika Srpska

TRACE Study

Annexes

September, 2012
Washington, DC

ANNEXES: DETAILED RECOMMENDATIONS

ANNEX 1: DISTRICT HEATING NETWORK MAINTENANCE & UPGRADE

DESCRIPTION

Many cities already have established district heating networks. The primary plant (boilers), may be operating at low efficiencies, or the pipework distribution networks may have poor or no insulation thereby losing thermal energy or considerable amounts of water through leakage. Advances in materials, boiler design or alternative system configuration (for example, improved heat exchange) mean that higher efficiencies can be achieved, and there are various different methods for detecting leaks. More energy can be delivered to the end user through primary plant upgrades, pipework repair and replacement and better insulation.

The aim is of this recommendation is to develop a program for maintenance and retrofits to upgrade boiler plant, pumps, pipework or insulation.

District energy networks are inherently more efficient than individual systems, but further energy efficiencies could be gained through repairing pipework and upgrading insulation, delivering more resource, operational cost and carbon emission savings.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Feasibility Study	The City Authority establishes appropriate partnerships to undertake a feasibility study. The CA should engage a team that includes network planners, power and heat engineers, environmental specialists and financial advisors to ensure the feasibility study captures all pertinent aspects. The feasibility study establishes the technological and financial viability, as well as procurement and policy options. It establishes the baseline city energy expenditure associated with power and heat supply and the efficiency of their distribution across the network(s). Technical ability, procurement methodology, incentives and taxes should also be given consideration. Each option should be appraised against the specific requirements and capabilities of the CA.

Attributes

Energy Savings Potential
> 200,000 kWh/annum

First Cost
> US$1,000,000

Speed of Implementation
> 2 years

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

Direct expenditures & procurement	The City Authority invests in the maintenance of the network as well as upgrades of the infrastructure where necessary. The main expenditures associated with a replacement program are the capital cost of plant and the civil works to access networks where the pipework is buried. The City Authority can pay for these items directly out of the city budget, and recoup the investment through lower primary fuel costs. The City Authority invests in the maintenance of the network as well as upgrades of the infrastructure where necessary. The main expenditures associated with a replacement program are the capital cost of plant and pumps and the civil works to access networks where the pipework is buried. The City Authority can pay for these items directly out of the city budget, and recoup the investment through lower primary fuel costs.
Energy Services Company	The City Authority contracts with an Energy Services Company (ESCO) to assume management of the district heating network, and maintain and investing in repairs to ensure consistent and efficient supply to users. The benefit of this approach is that the CA does not have to commit to significant financial investment in the project or retain ownership of the project related risks. There are a number of potential ESCO contractual structures and it is recommended that if the City Authority explores the various advantages and disadvantages of each. See Jiamusi case study for further details.
Legal or Statutory	The City Authority passes legislation or creates policy that requires minimum efficiency levels in both the generation and supply infrastructure of the district heating network. The efficiency levels should be set to ensure that the replacement program is staggered, targeting the worst performing assets first.

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:

- Establish baseline energy losses due to pipework and pumps(kWh/annum)
- Establish baseline water losses due to pipework and pumps(l/annum)
- Establish the City Authority goal for losses (kWh/annum) due to potential network upgrades
- Compare actual program performance with targeted performance

CASE STUDIES

District heating network pipe maintenance, Seoul, Korea

DBDH, Direct Access to District Heating Technology "Seoul Metropolitan District Heating Network", http://www.e-pages.dk/dbdh/12/

Established in 1985 by a public corporation, the district heating network in Seoul supplies 10,604 GWh of district heating and cooling to 832,000 households, commercial buildings and public buildings. During its first five years of operation, the network suffered from service interruptions caused by construction failures as pre-insulated pipe construction had only just been introduced in Korea and construction skills were too low to assure a good quality pipe construction. By the mid 2000s, 300 km of pre-insulated pipelines (20% of the total length) were around 20 years old, and investigation into pipe construction failure showed that these were mainly caused by loose casing joints (51%) and the use of improper materials (21%). In order to improve the reliability of the supply network, and thereby reduce the cost of water and energy losses, the company invested in improving pipe construction skills and used a leak detection system which enables them to locate 'defaults'. As the leak detection system does not work well with the old pipes, faults are also located by means of "thermal graphic camera" and "injection gas to pipelines" methods.

District heating network upgrade, Jiamusi, China

DBDH, Direct Access to District Heating Technology "Dalkia Management of Jiamusi Urban Heating Network" http://dbdh.dk/images/uploads/pdf-news/hotcool_1_2010_low.pdf

Due to a chronic lack of funds, the Jiamusi district heating network had for many years suffered from reduced maintenance, which had resulted in large energy and water losses. As interruption of service and low in-door temperature were the norm, the operator of the network, Jiamusi Heating Company (JHC), experienced increased dissatisfaction from its users. In May 2007 JHC, which was owned by the municipality, signed a 25-year agreement with an energy services company to take responsibility for the management of the network. A large-scale initiative to improve performance and upgrade the network's facilities was implemented. The heat supply temperature was raised; 90 new substations were built; and a SCADA (Supervisory Control and Data Acquisition) system was installed, enabling real-time management of the substations and the network, and resulting in improved optimization of energy efficiency and user's comfort. As a result, water losses were reduced by 30%, and energy consumption by 13.5%. By improving service quality, the company improved its customer relationships and was able to reduce the bad debt rate from 7% to 2%.

The network has begun expansion and after two years of operation, it has increased its supply from 5.5 million sq. m (29% of the total heating surface) by 56% to 8.6 million sq. m.

TOOLS & GUIDANCE

Tools & Guidance
DHCAN "District Heating System Rehabilitation and Modernisation and Modernisation Guide" projects.bre.co.uk/DHCAN/pdf/Modernisation.pdf. A guidance document for technical improvements resulting in higher energy efficiency and reduction of primary energy use. It attempts to set out a range of solutions from low-cost to high-cost, with consideration of financial circumstances, and links this to the fundamental need for a strategic view.
IEA "Coming in from the Cold- Improving District Heating Policy in Transition Economies" http://www.iea.org/textbase/nppdf/free/2004/cold.pdf. A document which summarises the institutional experiences of district heating rehabilitation, with focus on delivering clear policy on district heating.
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: DISTRICT COGENERATION THERMAL NETWORK

DESCRIPTION

Upgrading power plants so that low grade waste heat is captured and used in district heating networks improves the energy efficiency of each plant by utilising an energy source that would otherwise be rejected to the environment, as well as enabling a continuous supply to the user. The aim of this recommendation is to develop a district steam or hot water networks in high density areas in relatively close proximity to new or existing power plants.

Waste heat from power stations represents a significant resource and can deliver lower cost energy as well as carbon reductions.

Power sector regulations, which are implemented at a national level in many countries, can sometimes be a barrier to implementing cogeneration in district heating.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Feasibility Study	The City Authority establishes appropriate partnerships to undertake a feasibility study. The CA should engage a team that includes network planners, power and heat engineers, environmental specialists and financial advisors to ensure the feasibility study captures all pertinent aspects. The feasibility study establishes the technological and financial viability, as well as procurement and policy options. It establishes the baseline city energy expenditure associated with power and heat supply and the efficiency of their distribution across the network(s). Technical ability, procurement methodology, incentives and taxes should also be given consideration. Each option should be appraised against the specific requirements and capabilities of the CA.
Network Installation	The City Authority invests in the development of a district heating network. The main expenditures associated with a cogeneration heat network are the capital cost associated with the installation of the pipe network, modifications to the end user's equipment and also to the power plant itself. The City Authority can pay for

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
Security of supply

	these items directly out of the city budget, and recoup the investment by acting as the network operator and/ or heat supplier. See Kotka case study for further details.
Energy Services Company	The City Authority contracts with an Energy Services Company (ESCO) to provide finance and ownership of the project, as an alternative to direct expenditure. The benefit of this approach is that the CA does not have to commit to significant financial investment in the project or retain ownership of the project related risks. There are a number of potential ESCO contractual structures and it is recommended that if the City Authority explores the various advantages and disadvantages of each. See Aberdeen case study for further details.
Statutory Requirement	The City Authority passes legislation or creates policy that requires utilisation of waste heat from power stations through a thermal network. This implementation action can be used when the City Authority does not wish to own the district generation network. It should also be noted that in many countries, power sector regulations, which are often national, can act as a barrier to co-generation at the district level. Where this is the case, the CA can work with national government and other stakeholders to find statutory enabling solutions. See Copenhagen case study for further details

MONITORING

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

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

- Establish the baseline primary energy demand to meet the thermal requirements within the proposed network area (kWh/annum).
- Establish the expected primary fuel saving through implementation of heat network (kWh/annum).
- Compare actual program performance with targeted performance.

CASE STUDIES

District heating network, Kotka, Finland

C40 (2010). "Kotka: District heating", http://www.c40cities.org/bestpractices/energy/kotka_heating.jsp

The local energy company which develops and operates the city-wide district heating network is 100% owned by the CA. The district heating and combined heat and power production (CHP) are sourced by renewable and recycled energy sources and natural gas. Recent investments in a large waste-to-energy incineration facility have further strengthened the role of district heating as a form of power generation for the city. Currently, the network has 55% of the market share for heating in Kotka. Despite high investment costs (USD 215 million) the fuels (wind, biofuels and peat) are cheaper for Kotka Energy to purchase than oil, coal or natural gas. As domestic waste used for incineration has a negative price, CHP production is highly profitable for the CA. Turnover was estimated at 29m Euro in 2006, of which 25m Euro went on fuel and operational costs. The cost of establishing a system like that in Kotka is estimated at 150m Euro (USD 215m).

Social housing district network ESCO, Aberdeen, UK

PEPESEC (2009). "Community Energy in Scotland Aberdeen City Council", http://casestudies.pepesec.eu/archives/73

In order to cost-effectively deliver affordable heating to social housing in need of refurbishment and upgrading, the Aberdeen CA proposed a district combined heat and power scheme. The required funding was estimated to be very high, and as operating a combined heat and power scheme was not regarded as a core competency of the CA, there was a desire to obtain and involve appropriate expertise in the delivery of the network. A not-for-profit ESCO was initiated to develop and manage the network. The contractual relationship between the ESCO and CA is regulated by a framework agreement, which sets out the general obligations of the ESCO to supply heat to the CA, for onward supply to housing tenants. Separately, the ESCO can, and has, entered into Heat Supply Agreements with private owner-occupier properties. As a measure to persuade tenants to save energy, heat usage is not individually metered and users are charged a flat rate. As a supplementary measure, the CA has provided controllable heating systems and face-to-face advice on how to be energy efficient. Notably the scheme has ensured tenant and community participation in the delivery of heat energy, and has also resulted in works being carried out on properties which might not otherwise have been possible for 10 years or more.

District heating network, Copenhagen, Denmark

Copenhagen Energy (2010). "District heating in Copenhagen: An energy efficient, low carbon and cost effective energy system", http://dbdh.dk/images/uploads/pdf-diverse/District_heating_in_Copenhagen.pdf

In 1976, the national government passed the Electricity Supply Plan. This established a national policy requiring electricity generating stations to increase their energy efficiency by recovering and reusing waste heat, rather than exhausting useful thermal energy to the oceans and atmosphere. Combined heat and power (CHP) was established as the standard for electricity generation. In 1979, a new heat supply act was implemented which

started a heat planning process in the municipalities - it enabled municipalities to dedicate a certain area to district heating, and to make it mandatory for households to connect to district heating. In 1984, the five Mayors of Copenhagen, Frederiksberg, Gentofte, Gladsaxe and Taarnby decided to scale up and set up a common wholesale district heating network. As a result, take up rates are almost 100% .The heating price, which is a pool system price, is identical for all five municipalities, and has basically been kept at the same level throughout the whole of the project's lifetime.

District heating network, Bishkek, Kyrgyzstan
"Supporting CHP and district energy system development in Asia" (2009)
http://www.powergenworldwide.com/index/display/articledisplay/370226/articles/cogeneration-and-on-site-power-production/volume-10/issue-5/features/supporting-chp-and-district-energy-system-development-in-asia.html
ADB project report (2002) http://www.adb.org/documents/studies/power_heating_kgz/power_heating_project.pdf
ADB has provided funding for the rehabilitation of the Bishkek district heating system which serves the capital of Kyrgyzstan. The project was co-funded with various parties including the World Bank which provided a soft loan to overhaul and increase the generating capacity of the CHP unit, while ADB provided a $30 million loan to upgrade the Bishkek heat distribution system. Rehabilitating and modernizing the Bishkek district heating network began in 1997 and took 10 years to complete. The break up in 2001 of Kyrgyz National Energy Holding Company, which operated the entire CHP district heating system, into seven joint stocked companies caused delays to the project work schedule including lengthy delays replacing outdated heating pipes in various parts of Bishkek.

Rehabilitating the Bishkek heating system also involved repairing and upgrading seven of the systems 19 pumping stations with variable speed pumps, and the renovation of 2,280 heating substations. The Bishkek district heating system was installed during the Soviet era along with heating systems in several other Soviet republics.

TOOLS & GUIDANCE

Tools & Guidance
DHCAN (2005). "District Heating System Institutional Guide". A guidance document summarising the main institutional arrangements that reflect the specifics of district heating, and discusses their rationale and development in a changing business environment.http://projects.bre.co.uk/DHCAN/pdf/InstititionalManage.pdf
ESMAP (2000). "Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union". http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2000/12/15/000094946_00112105321115/Rendered/PDF/multi_page.pdf
Risoe National Laboratory for Sustainable Energy (2010). "STREAM" An energy scenario modelling tool which can be used to provide a quick insight into the different potential energy mixes, which can include the dispatching of power plants in the electricity sector and the district heating system. http://streammodel.org/downloads.html

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

ANNEX 3: ACTIVE LEAK DETECTION & PRESSURE MANAGEMENT

DESCRIPTION

Develop a leak detection and pressure management program to minimise losses along the following systems:

- Extraction works and pipelines
- Long distance water transmission mains
- Distribution networks
- Sewage pumping mains
- District cooling networks
- Irrigation networks

It is anticipated that most systems would already be subject to passive leak detection, i.e. identifying leaks through visual observation, but that provides limited information and benefits. This recommendation therefore focuses on a pro-active and more thorough leak detection program to locate and repair leaks. The following techniques could be used:

- Ground microphones
- Digital leak noise correlator
- Acoustic logger
- Demand management valves, meters and zoning
- Mobile leak detection programs
- Basic acoustic sounding techniques

In addition excess pressure can be reduced by installing:

- Flow modulating valves on gravity networks
- Pump controls and/or pressure sensors to modulate a pump's relative performance to suit the daily variation in flow demand, thus maintaining maximum efficiency and minimum energy use.

A leakage detection program can facilitate the provision of minimal pressures and encourage, through less wastage, a more sustainable use of water resources. In sewerage systems, identification and elimination of leaks can also significantly reduce risk of ground contamination. Pressure management can cost-effectively reduce treatment and pumping costs by minimizing the required delivery pressure and leakage. It is particularly suited to pumped mains and may require estimates of how demand changes over the day. Appropriately rated pressure reducing valves will in turn reduce the flow through leaks and the total flow that must be delivered by the pump upstream at the

Attributes

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

First Cost
US$100,000-1,000,000

Speed of Implementation
1-2 years

Co-Benefits
Reduced carbon emissions
Efficient water use
Enhanced public health & safety
Increased employment opportunities
Financial savings
Security of supply

source/treatment works. This solution may be particularly appropriate in gravity flow networks. The key advantage of pressure management over leak detection is the immediate effectiveness. It is most appropriate where the network is expansive and features multiple small leaks that would be difficult and expensive to locate and repair.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Feasibility Study	The City Authority can help to establish appropriate partnerships to undertake a feasibility study to assess leakage levels across the network(s). The CA should engage a team that includes network planners, water and utilities engineers and financial advisors to ensure the feasibility study captures all pertinent aspects. The feasibility study helps to establish the technological and financial viability, as well as procurement and policy options. Options should be appraised against baseline city energy expenditure associated with water leakage; monitoring flows and demands to refine value and pump controls accordingly. Technical ability, incentives and taxes should also be given consideration.
Direct expenditures & procurement	Where the potable or wastewater network is owned or run by the City Authority, the CA pays for upgrades to the utility infrastructure, directly out of the city budget or through separate funding mechanisms. The advantage of this strategy is that having the legislative authority to take ownership of the intervention will facilitate compliance with local legislation, policies and obtaining planning permission. The main expenditure associated with pressure management will be mainly the acquisition and installation costs of the equipment (i.e. valve, control fittings).
Build-Own-Operate-Transfer (BOOT)	If the City Authority lacks ability to access capital and technical expertise, a Build-Own- Operate-Transfer (BOOT) type contracting mechanism may be deemed most suitable to implement an initiative. The Request For Proposals (RFP) calls upon bidders to implement efficiency measures and provide funding for the project, with remuneration paid through the resulting savings.

	This 'shared savings approach' is common in the electricity industry. The contractor is required to provide a basket of services including financing of capital, design, implementation, commissioning, operation and maintenance over the contract period as well as training of municipal staff in operations prior to handover. This sort of arrangement can be complex to set up and it can also be difficult to find an organisation willing to take on the risk associated with this form of partnership. Case Study: Emfuleni, South Africa.
Efficiency Standards	The City Authority regulates the Water Companies to meet leak reduction targets and ensure their pipes meet required standards of operational efficiency.
Community led implementation	The City Authority liaises with the local community to increase understanding of the benefits of leak detection initiatives. Simpler, less technical methods of leak detection and reporting provide a considerable opportunity for community involvement and participation. In so doing, amenity will be maximised and leaks may be identified more quickly. In turn, the baseline infrastructure may also be safeguarded against vandalism or poorly implemented operation and maintenance. This activity may be complemented by offering subsidies to those who take part or by passing on the associated monetary savings to the community through reduced water rates.
Partnering Programs	The City Authority liaises with established organisations and/or coalitions (frequently non-profit such as Alliance to Save Energy) to gain access to their experience and expertise in order to implement the most appropriate changes to the pipe/pumping infrastructure. Such organisations often undertake research, educational programs, and policy advocacy, design and implementation of energy-efficiency projects, promotion of technology development and deployment, and/or help to build

	public-private partnerships. Difficulty can arise where the partnering organisations do not have access or influence over the funds required to implement the initiatives. Case Study: Galati & Iasi, Romania; Phonm Penh, Cambodia.

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:

- % Unaccounted for water (UFW): Measures the percentage of the water lost, due to leakages, wastage, theft, mechanical errors in meters at the source or human errors in correctly recording the meter reader, out of the total treated water produced.
- % Volume of water leakage per kilometre of water main per day: Measures the average volume of water leakage per kilometre of water main per day during the reporting period.
- Length of water mains inspected for leakages: Measures the total length of water mains inspected for water leakages during the reporting period.
- Properties affected by low water pressure: Measures the total number of properties affected by low water pressure due to aged pipe network or repair works during the reporting period.

CASE STUDIES

Pilot Leak Detection and Abatement Program, Iasi, Romania
http://www.resourcesaver.com/ewebeditpro/items/O50F1144.pdf
With an EcoLinks Challenge Grant of $46,820, Regia Autonoma Judeteana Apa-Canal Iasi (RAJAC) partnered with a U.S. environmental technology provider, Cavanaugh & Associates, to develop a pilot leak detection and abatement program. The total project investment was $118,074. The program trained RAJAC personnel in leak detection, implemented a leak detection system and developed a water conservation program and public outreach campaign. This pilot leak detection and abatement study was a prerequisite for the implementation of an infrastructure program.

Awareness of new technology was significantly increased through training and seminars. The company's public awareness-raising program encouraged and enhanced consumers' capacity to participate in water conservation efforts. Environmental and economic benefits were derived from the more efficient use of water and energy resources. In the short-term, it was estimated that three of the leaks identified in the pilot scheme were responsible for a water loss of 60,000 m3/year and a revenue loss of $24,000. Since the equipment used during the pilot project cost approximately $20,000 and no further significant investments were needed to eliminate the leaks, the payback period for the equipment was less then one year. This project contributes to a larger effort to improve water efficiency throughout Iasi County that will ultimately reduce water loss by 8 million m3 and provide a savings of $3 million per year, however, this level of savings, would require significant investment in the infrastructure.

USAID funded Ecolinks Project, Galati, Romania

http://www.munee.org/node/62

As part of a USAID funded Ecolinks Project, the Cadmus Group assessed the city's water supply system and discovered that a series of energy conservation measures could save roughly $250,000 per year in electricity costs. Low cost measures included trimming impellers to better match pumps and motors with required flows and pressures. Moderate cost measures included leak detection and reduction and limited pump replacement.

Pressure Management, Emfuleni, South Africa

Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment in Emfuleni, South Africa

http://www.watergy.org/resources/publications/watergy.pdf

The Sebokeng/Evaton pressure management project use a Build-Own- Operate-Transfer (BOOT) type contracting mechanism because the municipality had only limited access to capital and lacked the technical capacity to implement the project. The savings in water were so significant that both the municipality and contractor gained, with 80% of the savings accruing to the municipality and the remaining 20% used as remuneration to the contractor for services provided over a five year period. As the installed infrastructure is permanent in nature and has a design life of at least 20 years, the municipality will continue to achieve savings well beyond the initial five year period. The staff also benefit from access to additional expertise and training. This project reduced water losses by over 30%, saving about 8 mega-litres per year with an equivalent financial value of around $3.5 million. These water savings also translate into energy savings of around 14,250,000 kWh per annum due to the reduction in energy required to pump water. The project clearly demonstrated that the intervention of a suitable technology with a shared savings arrangement could succeed in low income communities; a private firm providing financing for technical innovation at no cost to the municipality received remuneration from sharing the resulting savings in water purchases.

Good Practices in City Energy Efficiency. Emfuleni Municipality, South Africa: Water Leak Management Project (Case Study)

http://www.esmap.org/esmap/node/663

The water supply project in South Africa’s Emfuleni Municipality resulted in lower costs for water--including lower energy costs associated with water supply--and also improvements in the municipality’s financial status through a new leakage management system for bulk water supply. Innovative pressure management technology was applied to the water supply system of two low-income residential areas, yielding significant savings in water and energy costs for pumping and treating water for distribution. The payback period was only 3 months and financial savings, from both reduced energy use and water losses, was estimated at US$3.8 million per year for a lifetime of 20 years. Under the performance

contracting arrangement employed to finance and implement the project, the municipality retains 80% of the water and energy cost savings during the first five years and 100% of the savings thereafter. The project has been hailed as a great success for South Africa. It clearly demonstrates that the use of suitable technology under a shared savings arrangement can succeed in low-income communities. A private firm providing financing for technical innovation--at no cost to the municipality--received remuneration from sharing savings in water purchases. The contractor provided a basket of services, including financing of upfront investment capital, design, implementation, commissioning, operations and maintenance (O&M) over the contract period, as well as training municipal staff in operations prior to handover of the installation. The project resulted in substantial financial savings that led to a "win-win" situation, both for the municipality and contractor, through a successful public private partnership (PPP).

Water Pressure Management Program, Sydney, Australia
http://www.sydneywater.com.au/OurSystemsAndOperations/WaterPressureManagement/index.cfm
Sydney Water has a water pressure management program to target those areas where pressure levels are well above average and there is a history of water main breaks. Excessive water pressure can lead to water main breaks and cause leaks in the city's water system. Water pressure management aims to adjust water pressure levels in the supply system to achieve more consistent pressure levels which will reduce the number of watermain breaks, improve the reliability of the water supply system and conserve water. The Water Pressure Management program is an important part of Sydney Water's leak prevention program and the New South Wales Government's Metropolitan Water Plan.

Water Supply and Drainage Project, Phnom Penh, Cambodia
http://www.adb.org/water/actions/CAM/PPWSA.asp
http://www.adb.org/water/actions/CAM/Internal-Reforms-Fuel-Performance.asp
Asian Development Bank's (ADB) Phnom Penh Water Supply and Drainage Project provided the opportunity for PPWSA, the government-owned water supply utility, to partner with ADB and demonstrate its capacity for catalyzing water sector reforms. To phase out non-revenue water, i.e. consumers gaining access to water supplies for free, PPWSA started metering all water connections. It gradually equipped each network with a pressure and flow rate data transmitters that provide online data for analyzing big leaks in the system. They also set up a training centre to respond to in-house training needs. PPWSA renewed old pipes using state-of-the-art materials and labour from PPWSA staff. PPWSA also institutionalized performance monitoring, coming up with progress reports and performance indicators on a regular basis and annually subjecting its accounts and procedures to an independent audit. The project advocated the transfer of more managerial autonomy to PPWSA to enable it to use its own funds on maintenance and rehabilitation programs. The result of the project was that PPWSA became financially and operationally autonomous, achieved full cost recovery, and transformed into an outstanding public utility in the region.

TOOLS & GUIDANCE

Tools & Guidance
N/A

ANNEX 4: EDUCATIONAL MEASURES FOR WATER CONSERVATION

DESCRIPTION

Develop a program to educate consumers on water conservation/recycling to reduce energy costs for both supply and treatment. The methods of organising this may include promotional leaflets sent with monthly bills, adverts, information on water company websites etc. A deeper understanding of the implications of water wastage, both in terms of energy used for pumping treatment and resource availability in the long term, will encourage consumers to use less water, hence lowering the energy that is required to treat and pump the flow at source. This will also benefit the consumers as it will give them heightened awareness of water saving measures and the reasons for saving water. This improved awareness is something that they are likely to transfer to other locations.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Collaboration with local population	The City Authority collaborates with the local community providing them with a basic education around a particular subject matter which may affect water and energy efficiency. Details may also include methods of recognizing inefficiencies and potential consequences of not addressing them. By allowing the community to contribute to the efficiency initiative, maintenance policies which help to improve efficient operations are more likely to be adhered to. Case Study: Leicester, UK; Iasi, Romania; Sydney, Australia.
Educational Workshops	The City Authority provides educational material and training to the water authorities and the organisations bearing the costs of water supply and treatment to help them provide water saving educational workshops to the public. Case Study: Leicester, UK; Iasi, Romania; Sydney, Australia.
Exhibition of Sustainability	The City Authority can champion and promote sustainable water and energy use through their website or by sponsoring awards. By practically experiencing how energy and water is saved and by visually displaying saving figures, the potential learning impact can be maximised.

Attributes

Energy Savings Potential
< 100,000 kWh/annum

First Cost
< US$100,000

Speed of Implementation
< 1 year

Co-Benefits
Reduced carbon emissions
Efficient water use
Enhanced public health & safety
Increased employment opportunities
Financial savings
Security of supply

	Case Study: Toronto, Canada; Sydney, Australia; Albuquerque, USA.
Raise Awareness of sustainable Products and Services	The City Authority invests in publicity and promotion of Water Efficient Products and Services to raise awareness of the products available and encourage the local community to engage with new water efficient technology. This activity may be complemented by offering subsidies or a rebate to those who are willing to invest in water efficient products. Case Study: Waitakere, NZ; Leicester, UK; Albuquerque, USA; Sydney, Australia.
Leafleting and publicity	The City Authority funds the distribution of signs and leaflets at the point of water use. Such signage can help to remind consumers about minimising water use at point of impact e.g. Every time you leave a tap running for 10 seconds it wastes X etc. Case Study: Leicester, UK; Sydney, Australia.

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 households claiming subsidies/rebates for purchasing water efficient technologies: Measures the number of households correctly claiming subsidies/rebates after purchasing water efficient technologies during the reporting period.
- Number of exhibitions, training courses: Measures the number energy efficiency focused exhibitions/training courses held during the reporting period.
- Number attending exhibitions: Measures the number of people attending energy efficiency focused exhibitions/training courses during the reporting period.
- Households Leafleted: Measures the gross number of households within the municipality leafleted about energy efficiency during the reporting period.

CASE STUDIES

Energy Action Plan, Leicester, UK

www.leicester.gov.uk/index.asp?pgid=15769

As part of the larger Energy Action Plan, the Energy Management Section of Leicester City Council conducted an energy audit and found that offices and buildings owned by the municipality consumed over 170GWhs of energy each year. Alongside retrofitting measures, the council invested in Intelligent Metering systems to monitor the use of energy. This real data is used to engage building users to make savings through changes in their behaviour. The Council also designs and presents its own training programmes to raise energy awareness for staff and the general public. An Energy Efficiency Advice Centre provides information on a range of energy efficient products to the general public; while the Leicester Energy Agency (LEA) gives practical assistance to small businesses on energy related matters. LEA was developed in 1996 as a partnership between Leicester City Council and The Institute of Energy and Sustainable Development at Montfort University.

Pilot Leak Detection and Abatement Program, Iasi, Romania

http://www.resourcesaver.com/ewebeditpro/items/O50F1144.pdf

With an EcoLinks Challenge Grant, Regia Autonoma Judeteana Apa-Canal Iasi (RAJAC) partnered with a U.S. environmental technology provider, Cavanaugh & Associates, to develop a pilot leak detection and abatement program. The program trained RAJAC personnel in leak detection, implemented a leak detection system and developed a water conservation program and public outreach campaign. This pilot leak detection and abatement study was a prerequisite for the implementation of a $40 million infrastructure program. Awareness of new technology was significantly increased through training and seminars. The company's public awareness-raising program encouraged and enhanced consumers' capacity to participate in water conservation efforts. Environmental and economic benefits were derived from the more efficient use of water and energy resources. In the short-term, it was estimated that three of the leaks identified in the pilot scheme were responsible for a water loss of 60,000 m3/year and a revenue loss of $24,000. Since the equipment used during the pilot project cost approximately $20,000 and no further significant investments were needed to eliminate the leaks, the payback period for the equipment was less then one year. This project contributes to a larger effort to improve water efficiency throughout Iasi County that will ultimately reduce water loss by 8 million m3 and provide a savings of $3 million per year, however, this level of savings, would require significant investment in the infrastructure.

Waitakere City Council Website, Waitakere, NZ

http://www.waitakere.govt.nz/abtcnl/to/suppliers.asp

Waitakere City Council Website raises awareness about water and energy efficiency. The products and companies featured on the Waitakere City Council Web pages are not endorsed by the council but rather a suggested starting point for local residents to do their own research to find a product that fits their individual household requirements. Interested parties are advised to contact the suppliers directly for more detailed information.

Water Efficiency Awards, Toronto, Canada

http://www.toronto.ca/greentorontoawards/2010/finalists.htm

The City of Toronto has annual environmental awards. The Water Efficiency Award is sponsored by Toronto Water. It draws attention efforts to

reduce and sustainably manage water use and promote water conservation.
Best Practice Sustainable Design, Sydney, Australia http://www.sydneywater.com.au/Publications/FactSheets/ESDFeaturesFactsheet.pdf http://www.sydneywater.com.au/Education/EDC/index.cfm Sydney Water leads by example in best practice sustainable design. Their head offices feature water and energy efficiency and recycling. The buildings are designed to achieve a 5 star NABERS rating and Green Building Council of Australia Green Star Scheme (office v2 rating). The Green Star rating signifies Australian excellence in sustainable building design and construction. Both buildings are designed to cut greenhouse gas emissions and reduce drinking water use compared to a typical office building. The Every Drop Counts (EDC) in Schools Program supports schools across Sydney, the Illawarra and the Blue Mountains by teaching them to value water and to develop water wise practices. Schools in Sydney Water's area of operations use about 7,790 million litres of water a year, which is six per cent of all non-residential water use. The EDC in Schools Program helps these schools become water efficient. The resources include: lesson plans; student worksheets; fact sheets such as reading water meters, monitoring water use; rainwater tank rebates or finding leaks; templates such as water action plans, school water audits or stormwater audits; games for children to learn about water efficiency.
Rebates, Albuquerque, USA http://www.cabq.gov/albuquerquegreen/green-goals/green-building/green-building-in-albuquerque http://www.cabq.gov/albuquerquegreen/green-goals/water In Albuquerque, the City Government and local companies are leading the way in developing and utilizing sustainable technology in their buildings to reduce water consumption. There are a number of rebates available to those who install efficient fixtures and fittings; e.g. Rebates of $200 per toilet are available when switching out old high flow toilets. These rebates apply to both residential and commercial customers alike. $50 rebates are also available for conversion from low-flow to high efficiency toilets.

TOOLS & GUIDANCE

Tools & Guidance
N/A

ANNEX 5: MUNICIPAL OFFICES 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)

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

	The Municipal Offices EE Spreadsheet includes estimation methods for energy efficiency potential for offices which includes equipment retrofits, behavioural 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:

- $/m^2 - Benchmark annual energy cost on a per-square-meter basis for all municipal office buildings.
- kWhe/m^2 - Benchmark annual electrical energy consumption on a per-square-meter basis for all municipal office buildings in the city.
- kWht/m^2 - Benchmark annual heating energy consumption on a per-square-meter basis for all municipal office buildings in the city.
- $/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. CO2 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 CO2 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 tonnes of CO2 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 CO2-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%) over a period of 8 years. The remaining 46% 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 CO2 emissions by 30% 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 daylighting and by using the building's 'thermal mass' to moderate temperatures.

TOOLS & GUIDANCE

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

ANNEX 6: BUILDINGS 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 metre).

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.
Analyse and Interpret Data	Conduct an analysis of collected data to ensure accuracy and begin to identify opportunities. Some examples of analysis include: ▪ compare kWh/m^2/yr electricity consumption by building type ▪ compare kWh/m^2/yr heating energy by building type ▪ compare total \$/m^2/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/m^2) ▪ building energy management This benchmarking is usually doen for the purposes of building labelling. 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/m^2 - annual electrical energy intensity by type of building (Schools, Offices, Residential, Hospital, Misc)
- kWht/m^2 - annual heating energy intensity by type of building
- \$/m^2 - 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% 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, sopported by MHME, NAER and and European Associationof local authorities "Energie-Cites", Lviv has promoted sustainable energy policy and action plans at a local level.

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

SMEU Software, Romania

http://www.munee.org/files/SMEU-romania.pdf

The SMEU software was created to set priorities for municipal energy action plans and to assess global energy costs and consumption. The goal of this software is to gather, organize and use energy data so that decision-makers could analyze trends in energy use by consumers and by resources and accurately predict the energy budget for the following period.

The SMEU software divides data into individual and interacting modules to collect data on various aspects of the energy cycle. The Locality Module collects information on an annual basis, including area, population, and average temperature, as well as general information on the municipality such as number of buildings and number of dwellings per building.

NYC Greener Buildings, USA

http://council.nyc.gov/html/releases/prestated_4_22_09.shtml

New York City Municipal Buildings were benchmarked for Energy Efficiency. The project, initiated on December 9, 2009 with the passage of the "Greener, Greater Buildings Plan" (formally known as Intro. No. 476-A, Benchmarking Energy and Water Use), puts the city at the head of a national effort to improve building energy efficiency aimed at reducing America's carbon footprint and its use of highly pollutive fossil fuels to generate electricity.

The project used the U.S. Environmental Agency's (EPA's) Energy Star Portfolio Manager energy management tool, which is integral to the LEED (Leadership in Energy and Environmental Design) certification process, as established and managed by the U.S. Green Building Council, or USGBC.

The Plan aims to reduce the city's total carbon footprint by 30 percent by 2030 (originally 2017), with five percent of that reduction coming from government, commercial and residential building. After the initial phase is completed, building owners will be required to benchmark yearly.

TOOLS & GUIDANCE

Tools & Guidance
Target Finder helps users establish an energy performance target for design projects and major building renovations. http://www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder
Portfolio Manager is an interactive energy management tool to track and assess energy and water consumption across the entire portfolio of buildings. http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
A presentation by Berlin Energy Agency on Berlin's Energy Saving Partnership - "a Model of Success" , June 29th, 2010. http://siteresources.worldbank.org/INTRUSSIANFEDERATION/Resources/305499-1280310219472/CArce_BEA_ENG.pdf
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 7: 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 not only 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.

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 a 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	Along with the design guidelines, create a program to incentivize the construction of exceptional green building design by providing tax credits,

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

approach)	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.

CASE STUDIES

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% 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

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

ANNEX 8: PUBLIC TRANSPORT DEVELOPMENT

DESCRIPTION

Develop or improve the public transport system and take measures to increase its accessibility and use. Public transport achieves lower emissions per capita than private cars, and has the potential to provide equitable transport network. A reduction in the number of private vehicles in circulation can lower emissions and improve air quality.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Bus priority	The City Authority establishes dedicated bus priority measures. This enables buses to bypass traffic queues enhancing their reliability and journey times. There are a range of measures including bus lanes and priority at junctions that could be implemented. See the Bogota case study for further details.
Signalling	The City Authority invests in the necessary infrastructure for bus-priority signalling. Such systems are linked to buses via transponders which use GIS information, and favour the circulation of approaching buses either by extending green lights for buses or by shortening cycle for cars.
Information	The City Authority provides good quality passenger waiting facilities and as well as good information services. The provision of real-time bus countdown information allows users to understand and manage waiting times. These services enhance the attractiveness of public transport.
Operations	The City Authority invests in the necessary infrastructure for electronic ticketing. This allows for use of multiple buses within a given amount of time with one ticket, reducing the cost of travel, putting buses within the reach of the poorest, while attracting a wider patron base, when in combination with other modes, such as heavy rail or metro.
Planning & regulations guidelines	The City Authority links development densities to public transport availability and funding. The City Authority reviews the city's zoning ordinances and considers making the following changes: Increase the permitted floor area ratio/ plot ratio on sites located near public transport hubs. In areas where it is

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

	appropriate re-zone single-use lands to allow multiple uses on the same site. Allowing higher densities of development along well-served public transport corridors creates a patron base for public transport and can be used in combination with other planning measures, such as capping parking provision to residential and office buildings, thus discouraging car use. Developers are required to show how a new development links to the existing or planned public transport network in order to gain planning permission. See the Curitiba case study for further details.
Subsidies	The City Authority subsidizes travel on public transport. In certain areas this can provide an incentive for people to use public transport.

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:

- Perform surveys of public transport passenger numbers.
- Determine mode share of people travelling in area or city.

CASE STUDIES

BRT system, Bogota, Colombia

Source: ESMAP (2009). "Good practices in city energy efficiency: Bogota, Colombia - Bus Rapid Transit for Urban Transport Energy", available online from http://esmap.org/esmap/sites/esmap.org/files/Bogota_Case_Study_020310.pdf

With the completion of its first two phases, the TransMilenio BRT system serves about 1.5 million passengers every day and has city-wide fuel consumption by 47%. Key success factors have been city-wide comprehensive planning of infrastructure, use of state-of-the-art technologies, implementation of a variety of design features to accommodate high volumes of passengers, and the use of a simple single price faring system. It does not require subsidies for operation - these are fully covered by fares. The project's capital cost totalled USD 240 million. The system is managed by a company which was set up by the Mayor, but runs independently from the city administration. While the company is in charge of all planning, maintenance and construction of infrastructure as well as organizing of schedules of bus services, buses and drivers are contracted

through private firms, resulting in a complex but innovative management structure.

Land Use and Public Transport Planning, Curitiba, Brazil

Source: World Bank (2010). "Curitiba, Brazil -- Cost Is No Barrier to Ecological and Economic Urban Planning, Development, and Management . In ECO^2 Cities: Ecological Cities as Economic Cities, pages 169-182." available online from http://www.esmap.org/esmap/sites/esmap.org/files/CS_Curitiba.pdf

The case of Curitiba, Brazil, shows that cost is no barrier to ecological and economic urban planning, development, and management. Curitiba has developed a sustainable urban environment through integrated urban planning. To avoid unplanned sprawl, Curitiba directed urban growth linearly along strategic axes, along which the city encouraged highdensity commercial and residential development linked to the city's integrated master plan and land use zoning. Curitiba adopted an affordable but innovative bus system rather than expensive railways that require significant time to implement. Curitiba's efficient and well-designed bus system serves most of the urban area, and public transportation (bus) ridership has reached 45 percent. The city now has less traffic congestion, which has reduced fuel consumption and enhanced air quality. The green area has been increased, mainly in parks that have been created to improve flood prevention and through regulations that have enabled the transfer of development rights to preserve green areas and cultural heritage zones.

Linking development densities to public transport availability, Curitiba, Brazil

Source: Rabinovitch, J. (1992) "Curitiba: towards sustainable urban development", Environment and Urbanization, Vol.4 (2) pp. 62-73

Curitiba's Master Plan integrated transportation with land use planning. Zoning laws are used to direct linear growth by attracting residential and commercial density along a mass transportation lane. High-density residential and commercial development is permitted within walking distance of stops, with much lower densities elsewhere in the city. The city's central area is partly closed to vehicular traffic, and pedestrian streets have been created. In addition, a strict street hierarchy safeguards the right of way for the current BRT, which has significantly contributed to the success of the transportation network.

Integrated urban planning and efficient resource use, Singapore

Good practices in City Energy Efficiency: Eco^2 Cities - Land and Resource Management in Singapore, available online http://www.esmap.org/esmap/node/1230

Singapore is an island city-state at the southern tip of the Malay Peninsula. With a limited land area of 700 square kilometers and a population of 4.8 million, Singapore has become developed because of innovative urban planning integrated with the efficient use of land and natural resources. Singapore's small size poses challenges related to the availability of land and natural resources. To optimize land use, Singapore promotes high-density development not only for businesses and commercial entities, but also for residential structures. High density lends itself to higher economic productivity per unit of land and facilitates the identification of green spaces and natural areas for preservation. Furthermore, high-density development has translated into greater use of public transportation as major business, commercial, and residential areas are well connected to an integrated public transportation network. In 2004, public transportation as a share of all transportation modes during morning peak hours reached 63 percent. The significant use of public transportation helps reduce greenhouse gas emissions. High public transportation ridership also means Singapore has been able to recover all public transportation operating costs from fares, a feat achieved only by Hong Kong, China, and by Singapore among modern, highly developed cities.

Integrated regional urban planning, Auckland, New Zealand

Good Practices in City Energy Efficiency: Eco^2 Cities - Integrated Regional Urban Planning in Auckland, available online http://www.esmap.org/esmap/node/1227

The interconnectedness of national and local Auckland issues (such as housing and education) with growth and innovation and the major required investments (particularly in land transport) have created complex and difficult issues among multiple authorities. Despite Auckland's importance to the New Zealand economy and the areas of common interest, such as transportation and energy provision, the national government did not initially play a close role in directing regional and local government planning. Concern emerged that, without agreement on an overarching regional strategy and framework, decision making in the region could become ad hoc and adversarial if each stakeholder tried to have a say from a narrow perspective and without viewing the region as a whole. As a result, there was a clear need for coordinated strategic planning across the Auckland Region to ensure that Auckland would be able to remain competitive in today's globalized world. The response involved a process undertaken in 2001 to prepare a regional growth strategy that aimed to provide a vision of what Auckland could be like in 50 years.

Tools & Guidance

Public Transport Authority Western Australia (2009). "Bus Priority Measures Principles and Design" A guidance document for planning bus priority methods and approaches. Available online from http://www.pta.wa.gov.au/PublicationsandPolicies/DesignandPlanningGuidelines/tabid/109/Default.aspx

Transport for London (2006). "Accessible bus stop design guidance" A guidance document for designing bus stops which help make boarding easier for passengers. Available online from http://www.tfl.gov.uk/assets/downloads/businessandpartners/accessibile_bus_stop_design_guidance.pdf

ANNEX 9: NON-MOTORIZED TRANSPORT MODES

DESCRIPTION

Non-motorised transport modes have zero operational fuel consumption and require low capital costs for implementation. In addition to improving the health of users, their use reduces noise pollution and improves air quality.

Benefits include improved air quality, lower operating costs for users and providers, and lower infrastructure requirements.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Pedestrianization	The City Authority pedestrianizes networks of streets or larger city areas. Either permanent or temporary, the closure of streets to motor vehicles increases public awareness of non-motorised modes and removes noisy and polluting vehicles, as well as creating opportunities for street markets and other initiatives. The City Authority researches the feasibility and probable take-up from origin and destination surveys, existing mode splits, and subsequently designs networks to suit commuting patterns and local/neighbourhood travel. See Oxford case study for further details.
Dedicated networks	The City Authority includes dedicated cycle / walking route networks in its transportation or city land use plans. Replacement or reservation of rights-of-way in new-built areas creates the necessary conditions for adopting non-motorised modes that may otherwise be less favoured if roads cater to cars only. The key to success is the linkage of cycle and pedestrian networks at local level, and the quality of the environment provided, that requires good drainage and adequate lighting and shading. See Bogota case study for further details.
Microcredits	The City Authority makes micro credits available which can be used to increase the ownership of bicycles. Increased cycle ownership can have significant financial benefits to low-income workers who may no longer be dependent upon expensive, inefficient and infrequent public transport. See Lima case study for further details.

Attributes

Energy Savings Potential
100,000-200,000 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

Rental programs	The City Authority introduces bicycle rental programs which provide bicycles on demand for a fee. The key factor for success to is the setting of tariffs that encourage use as well as security procedures that avoid and penalise theft. Registered-user schemes require a credit card or bank details of users, but are not necessarily open to all. Non-registered user schemes are more flexible, but more open to abuse. Branding of bicycles and facilities can create revenue for local authority. See Paris 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:

- Perform surveys of the number of cycles in circulation by using traffic counters on roads and cycle lanes.
- Determine the mode share of people travelling in the area or city.
- Determine KPIs such as % non-motorised transport mode, modal shift, km of dedicated cycle/walking infrastructure, take-up of cycle promotion schemes by analysing registers of subsidies

CASE STUDIES

Pedestrianization with road closures, Oxford, England European Commission, Directorate General for the Environment (2004). "Reclaiming city streets for people: Chaos or quality of life?", available online from http://ec.europa.eu/environment/pubs/pdf/streets_people.pdf The main retail streets have been fully pedestrianized, while other through roads in the central area are only accessible to buses and pedestrians. The adoption of a step by step, integrated approach to the implementation of the road closure program has been seen as critical to the success of the significant road space reallocation element of the scheme. Opposition to the USD 6 million scheme was raised most notably on the basis that traffic congestion on two key routes in the city would worsen, as well as from retailers concerned about delivery access and trade levels. These concerns were attended to via an extensive consultation process and an effective publicity campaign prior to the implementation of the scheme. This included leaflets, advertisements on buses, city-wide poster boards, and a series of press releases
Dedicated cycle network, Bogota, Colombia

C40 Cities (2010). "Bogota, Colombia: Bogota's CicloRuta is one of the most comprehensive cycling systems in the world", available online from http://www.c40cities.org/bestpractices/transport/bogota_cycling.jsp
CicloRutas is considered a unique cycling network where design has taken the topography of the city into consideration in order to create maximum flow and function (manmade and natural features, hills, waterways, parklands, essential facilities). In a period of just 7 years, following an investment of USD 50 million, the use of bicycles on the network increased by more than 268%. CicloRutas plays an important role for lower income groups, as more than 23% of the trips made by the lowest income group in the city are by walking or by bike. The development of CicloRutas has also helped to recover public space along riverbanks and wetlands, as for many years the city's wetlands were occupied by illegal settlements.

Bicycle micro credits, Lima, Peru
ICLEI (2009). "Case study 46: Assistance to purchase bicycles - Lima, Peru" in Sustainable Urban Energy Planning: A handbook for cities and towns in developing countries, available online from http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2839
In 1990, the Municipality of Lima set up a micro-credit programme to help low income citizens purchase bicycles. By saving on daily public transportation costs, workers can see their income effectively rise more than 12% once the loan is paid off. In order to enhance the success of the program, efforts have been made at standardizing the use of bicycles in the city. Actions to achieve this have so far consisted of the development of a manual of technical standards for the design and planning of cycle ways.

Bicycle rental, Velib, Paris, France
C40 Cities (2010). "Paris, France Velib - a new Paris love affair", available from http://www.c40cities.org/bestpractices/transport/paris_cycling.jsp
Paris launched a 24/7 cycle hire scheme through Velib; a public private partnership between the city of Paris and a company led by a major advertising group. Users must purchase a subscription by day, week or year, and bike rental is free for the first half hour of every individual trip, after which it costs a fixed rate. The increasing price scale ensures the bikes are kept in circulation. Notably, the City of Paris generates revenues from the project without any investment (which cost USD 108 million). The public-private partnership is the reason for this success, with the private company paying operating costs plus rights to advertising space to the City, funded by advertising revenues.

TOOLS & GUIDANCE

Tools & Guidance
Sustrans (2007). "Technical guidelines for the development of cycle facilities" A series of guidance documents for professionals on the details of bicycle network design. Available online from http://www.sustrans.org.uk/resources/design-and-construction/technical-guidelines
Transport for London (2010). "London Cycling Design Standards" A guidance document for designing to reduce barriers to cycling, in order to support road safety targets. Available online from http://www.tfl.gov.uk/businessandpartners/publications/2766.aspx

ANNEX 10: TRAFFIC RESTRAINT MEASURES

DESCRIPTION

Discouraging potential drivers from using their cars leads to fewer cars in circulation. This encourages people to use alternative modes, which in turn will increase their viability (increased public transport patronage for example).

Removing vehicles from circulation reduces fuel use and reduces the need for road space.

Attributes

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

First Cost
US$100,000-1,000,000

Speed of Implementation
1-2 years

Co-Benefits
Reduced carbon emissions
Improved air quality
Enhanced public health & safety

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Blanket bans	The City Authority imposes blanket bans. Possible types of blanket bans include vehicle-type bans which exclude entire vehicle categories from circulation; or licence plate bans, by which certain number plates are banned from circulation. A weakness of licence plate bans are that they tend to result in wealthier residents purchasing second cars, not only negating the aims of the ban, but thereby also disadvantaging those with lower incomes. See Guangzhou case study for further details.
Licensing	The City Authority rations permits. The establishment of quotas for private vehicles allows for only a certain number of vehicle registrations over a given period of time. However, as demand for cars tends to be inelastic, this often results in very high purchase prices for the licenses - a mechanism which favours the wealthy and marginalizes the lower income brackets of society. See Singapore case study for further details.
Civic initiatives	The City Authority sanctions and encourages 'no-driving days' to educate and lead by example. Participation in these initiatives is voluntary, however, and therefore not enforceable. See Puerto Princesa 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:

- Perform traffic surveys of the number of vehicles in circulation pre- and post-implementation.
- Determine the mode share of people travelling in an area or the city.
- Collate registration data of users to paid schemes or voluntary schemes.
- Perform statistical analysis of rate of growth of car registration data.

CASE STUDIES

Vehicle bans: Motorcycle ban, Guangzhou, China Institute for Transportation and Development Policy (2008). "Case study: motorcycles in Guangzhou", available online from http://www.itdp.org/documents/Guangzhou%20Case%20Studies%20-%20Motorcycles%2015-Sep-08.pdf Motorcycles have been completely banned in the City of Guangzhou. The ban was implemented in phases, beginning with a moratorium on new licenses, extending to various roads and time periods. Gradual implementation has been crucial to allow time for the public to adapt, and efficient supply of additional infrastructure/services has supported the induced modal shift. Many motorbike riders have shifted to bicycles and buses, and cycle rickshaws have also emerged as a popular substitute. Road accidents have dropped by 40% since the initial implementation of the ban.
Rationing, Singapore, Singapore Sustainable Urban Transport Project (2010)."The Vehicle Quota System in Singapore", available online from http://www.sutp.org/index2.php?option=com_content&do_pdf=1&id=1582 Singapore fixes the number of new vehicles allowed for registration. Potential buyers need to bid for a non-transferable licence, which entitles them to own a vehicle for a fixed number of years. The scheme had to be modified soon after implementation to safeguard against speculative action. The licences used to be transferable and within the first two months of the first round of release, 20% changed hands in "buy and sell" transactions with speculators making sizable profits of up to S$5000. As the rationing system does not control annual mileage, the success of the rationed registration in limiting vehicle usage has been dependent on support from other traffic restraint measures, such as high road tolls, parking fees, and electronic road pricing.
No-driving days, One Day Rest, Puerto Princesa, Philippines ICLEI (2001). "Vehicular Reduction Strategy for Air Pollution Prevention and Climate Change Mitigation; A Case of Puerto Princesa City, Philippines", available online from http://www.iclei.org/index.php?id=1193 Introduced as part of a zoning and rerouting, this program stipulates a one day rest for tricycle drivers in the central business district. Regulation of illegally operated tri-cycles is a major impediment, as enforcement irregularities pose questions of inequality between illegal and legal tri-cycle taxi drivers. Furthermore, the income potential of those who comply with the rest day is lost to the illegal operators

TOOLS & GUIDANCE

Tools & Guidance
Sierra Club of Canada (2001). "How to Stage a Car Free Day In Your Community" A guidance document for preparing and planning a community-driven car free day. Available online from http://www.worldcarfree.net/wcfd/documents/cfd_howto.pdf

ANNEX 11: STREET LIGHTING AUDIT AND RETROFIT

DESCRIPTION

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

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

Attributes

Energy Savings Potential
> 200,000 kWh/annum

First Cost
US$100,000-1,000,000

Speed of Implementation
1-2 years

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

IMPLEMENTATION OPTIONS

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

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

MONITORING

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

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

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

CASE STUDIES

Light Emitting Diode (LED) street lighting retrofit, Los Angeles, USA

Source: ESMAP (2011). "Good Practices in Energy Efficiency: Los Angeles, USA: LED Street Lighting Retrofit", available online from http://www.esmap.org/esmap/sites/esmap.org/files/LosAngeles_LED_final_edited_11-9-11.pdf

The City of Los Angeles (LA) Light Emitting Diode (LED) street lighting project is the largest LED street lighting retrofit ever undertaken globally—a collaboration between the LA Bureau of Street Lighting, the LA Mayor's Office, the LA Department of Water & Power, and the Clinton Climate Initiative (CCI) Cities Program. Over a period of five years (2009-2014), the project will replace 140,000 of the city's more than 209,000 street lights with LED technology which is expected to enhance the quality of municipal street lighting, reduce light pollution, improve street safety, and save energy and money. The US$56.9 million investment required will provide an estimated US$10 million in annual energy and maintenance

cost savings (68.6 GWh/year) while avoiding at least 40,500 tons of CO2e emissions each year.

ESCO street light retrofit, Akola, India

Source: ESMAP (2009). "Good Practices in Energy Efficiency: Akola Municipal Corporation, India - Performance Contracting for Street Lighting Energy Efficiency", available online from http://www.esmap.org/esmap/sites/esmap.org/files/CS_India_SL_Akola_020910.pdf

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% 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% 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% 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% whilst yielding annual energy savings of 2,819,640 kWh. This saved the CA 91,400 EUR/year.

Street Lighting LED Replacement Program, City of Los Angeles, USA

Clinton Climate Initiative, http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/i/cci-la-lighting

A partnership beween Clinton Climate Initiative (CCI) and the city of Los Anglese, this project will be the largest streetlight retrofit undertaken by a city to date, replacing traditional streetlights with environmentally friend LED lights. It will reduce CO2 emissions by 40,500 tons and save $10 million annually, through reduced maintenance costs and 40% energy savings.

The Mayor of Los Angeles and the Bureau of Street Lighting collaborated with CCI's Outdoor Lighting Program to review the lates technology, financing strategies, and public-prive implementation models for LED retrofits. CCI's modelling and technology analysis, as well as its financial advisory, serves as key reference sources for the development of this comprehensive retrofit plan.

The phased nature of the project allows the city to re-evaluate its approach on an yearly basis. This gives enviable flexibility to the municipality when selecting contractors and the street lighting systems for upgrade. Los Angeles also capitalised on its government status to attract financial institutions offering favourable loans and funding mechanisms as these institutions were looking to establish positive relationships with the city. Due to these and other factors the City of Los Angeles was able to establish a well-developed business case for the retrofit.

Lighting Retrofit, City of Oslo

Clinton Climate Initiative, Climate Leadership Group, C40 Cities http://www.c40cities.org/bestpractices/lighting/oslo_streetlight.jsp

The City of Oslo formed a joint-venture with Hafslund ASA, the largest electricity distribution company in Norway. Old fixtures containing PCB and

mercury were replaced with high performance high pressure sodium lights and an advanced data communication system using powerline 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
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 12: LIGHTING TIMING

DESCRIPTION

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

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

Attributes

Energy Savings Potential
> 200,000 kWh/annum

First Cost
< US$100,000

Speed of Implementation
< 1 year

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

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Study illumination timing alternatives	Prepare a study to estimate the types of streets and luminaires that have the opportunity to have reduced timing and dimming during late night hours.
Install timers and dimmers on existing street lights	Allocate funding to implement upgrades and retrofits for dimming and timing opportunities. Roll out upgrades over the course of multiple years to achieve 100% coverage of all city public lighting and street lighting installations. See Kirklees and Oslo case studies for further details.
Standards for new lighting	Set up timing and dimming standards for new installations of public illumination and street lighting that confirm to global best practice for energy efficiency and IESNA illumination guidelines.

Monitor and publish energy savings	Measure on an annual basis the energy savings achieved by this program and encourage private sector owners to follow the model of the CA.

MONITORING

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

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

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

CASE STUDIES

Control system for public lighting, Kirklees, UK

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

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

Intelligent outdoor city lighting system, Oslo, Norway

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

An intelligent outdoor lighting system has replaced PCB and mercury containing fixtures with high-performance high-pressure sodium lights.

These are monitored and controlled via an advanced data communication system which operates over the existing 230V power lines using specialist power line technology. An operations centre remotely monitors and logs the energy use of streetlights and their running time. It collects information from traffic and weather sensors, and uses an internal astronomical clock to calculate the availability of natural light from the sun and moon. This data is then used to automatically dim some or all of the streetlights. Controlling light levels in this way has not only saved significant amount of energy (estimated at 62%), but has also extended lamp life, thereby reducing replacement costs. The CA has been able to use the monitoring system to identify lamp failures, often fixing them before being notified by residents. By being able to provide predictive failure analyses based on a comparison of actual running hours versus expected lamp life, the efficiency of repair crews has been increased. 10,000 replacements have cost the CA approx. USD 12 million. Currently the program saves approx USD 450,000 in running costs per year. However, it is estimated that if the program is rolled out to the entire city, the increased economies of scale will yield a payback period of less than five years.

Motorway intelligent lights retrofit, Kuala Lumpur, Malaysia

http://www.lighting.philips.com.my/v2/knowledge/case_studies-detail.jsp?id=159544

The project implemented a lighting solution for highways leading to Kuala Lumpur International Airport. The total length of the dual carriage highway covers 66 km. The main requirement for the project was that each individual lamp along the entire 66 km stretch of highway should be independently dimmable. This called for a network linking all 3,300 positions to a central control facility. There was also a need for greater maintenance efficiency while ensuring optimal visibility without compromising on visual comfort on the road. An intelligent lighting system that uses telemanagement control was employed. Telemanagement makes it possible to switch or control every individual light point in the system from a central PC. It also enables specific dimming profiles adjusted to suit conditions on the road for different lamps, instant reception of failure messages, and the creation of a database where all system data is stored. It allows a significant reduction in energy consumption in addition to the 45% savings as a result of the use of dimming circuits.

Tools & Guidance

N/A

ANNEX 13: WASTE SORTING AND RECYCLING

DESCRIPTION

Waste treatment facilities such as materials recycling facilities and landfills can either use excessively large amounts of energy or not fully utilise energy produced by them.

Assessing energy efficiency opportunities in the waste sorting and transfer facilities can help city authorities invest in retrofits with a positive cost benefit. The resulting improvements in maintenance and use or replacement of equipment in waste management facilities can reduce energy use associated with their operation. Other benefits include reduction in environmental and social impacts from operation of waste sorting and transfer facilities, for example, odour control and staff welfare.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Reduce energy use via targets created in AER	Better operations and maintenance programme costs can be offset by savings made in improved energy efficiency performance of facilities. Using Annual Environmental Reports (AERs) can focus individual sites to make a collective improvement to the energy used by this section of the municipality's waste system. See Nenagh case study for more details.
Offer incentives for continued improvement	The city authority offers incentives to encourage facility managers to meet AER targets. Incentives can be financial, planning or contract related or by way of public recognition, for example, an annual awards ceremony. See Summit County case study for more details.
Showcase new practices in waste management	The city authority raises awareness amongst operators about the benefits of fuel-efficient operations. Invite potential suppliers, existing waste management providers and or municipality waste teams to a conference to showcase new waste management equipment, processes and encourage trials. Aim to showcase examples of energy and cost-savings from efficient sorting and transfer operations and encourage attendees to form partnerships to implement energy efficient practices.

Attributes

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

First Cost
US$100,000-1,000,000

Speed of Implementation
1-2 years

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

	See Naga City and Irvine case studies for more 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 used for sorting per tonne of waste (MWh/tonne)
- % of waste recovered by sorting (%)
- fuel use per vehicle per tonne of waste per km travelled (MWh/tonne/km)
- % of waste composted in city (%)

Create baseline for energy use in any municipality owned facilities, targeting individual plant equipment and seek implementation of Annual Environmental Reporting (AER) programme to monitor progress.

Setup monthly maintenance programme to ensure all plant are operating efficiently. Create programme for ensuring options for improved waste treatments are assessed and implemented where possible.

CASE STUDIES

Springfort Cross Waste Transfer Station Reporting Scheme, Nenagh, Ireland http://www.epa.ie/licences/lic_eDMS/090151b280347fbe.pdf The waste transfer station at Springfort Cross, Nenagh produces Annual Environmental Reports (AERs) in line with Integrated Pollution Prevention Control (IPCC) licensing in Ireland to reduce emissions, waste and to encourage efficient energy use. The AER contains annual summary reports on all aspects of environmental performance of the facility for effective site evaluation, including resource and energy consumption. The use of summarised energy efficiency audits and waste generation reports helps to focus specific future targets in energy efficiency improvements, with the scheduling of energy efficiency audits and to decrease fuel consumption in the transfer station. A solid waste management consultancy was hired to produce the AER for submission to Environmental Protection Agency.
Summit County Material Recovery Facility, Summit County, USA http://www.thegbi.org/assets/case_study/MRFCaseStudy.pdf

As the first facility of its kind to be certified as green, the Summit County Material Recovery Facility (MRF) project was awarded two Green Globes by the Green Building Initiative (GBI) for energy efficiency (on the basis that MRFs typically have high energy consumption used for facility ventilation and lighting of the tipping floor). The MRF site location was oriented to optimise solar gain and provide natural day lighting, saving energy in lighting the tipping floor. The most energy efficient element was the mechanical system of the facility, using electric heating with energy recovery ventilators (ERVs) and ducted ventilation. The ERVs provided the largest energy savings and cost nearly $40,000 less to operate than the typical radiant system, with payback of about 3 years. By focusing on specifying high-efficiency lighting fixtures, lamps, lighting controls/occupancy sensors and heating ventilation and air conditioning (HVAC) equipment, the project shows how incentivised investments in retrofits can provide energy efficiency in a cost-effective manner.

Community Materials Recovery Scheme, Naga City, Philippines

"Sustainable Urban Energy Planning: A handbook for cities" pg 46, http://www.unhabitat.org/pmss/getElectronicVersion.aspx?nr=2839&alt=1 (must be downloaded as a .pdf)

To reduce the amount of garbage brought to landfill or dumped into rivers, Naga City begun materials recovery on a community scale in 1999, which developed into a city-wide Materials Recovery Facility (MRF) launched in February 2004. The facility sorts waste into biodegradable waste for conversion into organic fertilisers for sale in the market. Non-biodegradable waste recovered by the facility are either sold or recycled. The facility sorts 40% of the city's waste for recycling, saving 13,862 tonnes of CO2e annually. Key to the project is the Build-Operate-Transfer (BOT) agreement with the Lacto Asia Pacific Corporation, which provides direct sales of equipment, shared training expertise, maintenance and service for the efficient management of MRF equipment. The local government invested in the project in terms of land, machineries and equipment, infrastructure and operational costs, totalling $405,000.

'Waste Management' Sorting Line, Irvine, California, US

WM press release
http://www.wmsecurityservices.com/WM/press/pr2009/20091118_WM_Unveils_New_Sort_Line_to_Reduce_Landfill_Deposits_and_Carbon_Emissions.pdf

"Advanced waste sorting line boasts of higher capacity" http://www.ecoseed.org/en/recycling/waste-management/article/84-waste-management/5198-advanced-waste-sorting-line-boasts-of-higher-capacity

In 2009, the private waste services provider 'Waste Management' unveiled its $1.7 million recycling line that would allow the company to recover more reusable materials and thereby reduce landfill deposits and carbon emissions. The new waste sorting line at the company's Irvine processing and transfer facility will be able to process commercial waste as well as recyclables from municipal solid waste streams.

The facility already has a construction and demolition sorting line in place. With the new sorting line, it will be able to process up to 30,000 tons of waste annually. The recycling line utilizes state-of-the-art infrared optical sorting to separate dry recyclables, along with sorting mechanisms such as drum feeders. The line can process up to 15 tons of materials per hour. Aside from reducing its local carbon footprint, the company said it would generate additional revenues through the new sorting line.

The company, which has several plants across North America, has actively promoting its environmental activities, stating that "Investing in green technology makes good business sense" as it increases consumer demand and provides cost and carbon savings.

The new recycling sort line is part of WMOC's recent environmental initiatives, including: a natural gas power fleet of collection vehicles, GreenOps Tracking Stations, reverse vending machines in Tustin; and food waste recycling machines in Laguna Beach. The company also has plans to provide solar-powered trash and recycling compactors in the near future.

TOOLS & GUIDANCE

Tools & Guidance
N/A

ANNEX 14: WASTE LANDFILL GAS CAPTURE PROGRAM

DESCRIPTION

Landfill gas, or biogas, is a natural by-product of the decomposition of organic waste (such as food waste, green waste and paper) in landfills. If captured, it can be used as a source of energy through the generation of electricity and/or heat or by being processed for gas supply.

Landfill gas capture has the potential to provide alternative energy sources for municipalities.

Reduced fuel consumption and energy use as a result of good planning and allocation of suitable facilities. Gas from landfills that contains a high proportion of methane, which can be converted to electricity or used to power vehicles as an alternative fuel. As methane is a potent greenhouse gas, reducing the volume released into the atmosphere has significant environmental benefits.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Feasibility study for landfill gas capture	A feasibility study establishes the technological and policy framework to implement a landfill upgrade program across the city. This should consider: • Gas yields and generation rates over the next 10, 20, 30 years • Technology • Capital and operational costs • Procurement options • Finance options • Operation and management requirements • Coordination with environmental programmes The establishment of appropriate partnerships is central to the success of the study - partners can include national and regional government with industrial and technical support from private sector companies, research companies, or universities. These partnerships help garner support for expansion of the initiative and inform how the program fits into the larger policy and commercial framework. If there is an existing general directive to support programs such as gas capture from landfill, the feasibility study should be formulated to fit with these policy prescriptions.

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 gain
Operational efficiency

	Other municipality cost centres can also benefit from the study if biogas displaces other types of fuels, e.g., biogas-powered bus fleet. See Ho Chi Minh City case studies for further details.
Planning Policy Coordination / Regulation	The coordination of landfill gas capture programs with wider urban plans and planning policy allows the City Authority to develop a high level plan for gas capture, and through the policy system, the responsibility for developing landfill gas capture can be passed onto various bodies including developers or landfill operators. Planning policy that relates to gas capture should be developed in the context of the wider policy framework and existing resources, e.g. technical capability, landfill retrofit potential. See California, Hong Kong and Ho Chi Minh case study for further details.
Procurement Program	The City Authority institutes a procurement policy or guidelines that allow a third party to install and operate a gas capture system on existing or new landfills. This implementation activity has good synergies with Kyoto Protocol Mechanisms: Joint Implementation and the Clean Development Mechanism, and these and other routes for obtaining financial support should be investigated. Coordination with environmental regulations is essential, as some programs require close monitoring to ensure they are safe and don't negatively impact the environment. See Hong Kong, Dar Es Salaam and Ethekwini 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:

- Increase in volume of gas captured (litres/annum)
- Increase in MW electricity produced

Asses gas quantities produced. Establish targets for gas generation rates for the next 10, 20, 30 years in phases.

CASE STUDIES

Landfill gas recovery program, Tianjin, China

Source: ESMAP (2009). "Tianjin, China - Landfill Gas Capture for Electricity Generation – A Case Study", available online from http://www.esmap.org/esmap/node/661

The city of Tianjin, the fifth largest city in China, has implemented a project to recover landfill gas (LFG), which was otherwise being released into the atmosphere, and burn pretreated LFG for electricity generation. The project was located at the Shuangkuo Landfill, one of five municipal waste landfills in Tianjin. The planned capacity of the project is 4.3 MW which is being installed in stages. The first generator, 1.03 MW, started operation in May 2008, currently utilizing 500-600 cubic meters of landfill gas. The electricity produced is being sold to the North China Power Grid under a long-term contract. Through the project, the city was able to use waste to generate revenues and gain local environmental benefits.

The project was initiated by the Tianjin Municipal Government, which has invested CNY46.7 million (US$6.9 million) in the project. The project has been implemented and is being operated by a specially created entity, the Tianjin Clean Energy and Environmental Engineering Co. Ltd. (TCEE). The project will obtain revenues from the sale of electricity which, over the project's life, will amount to CNY245.2 million (US$36.2 million). The project has been registered as a CDM project under the Kyoto protocol and reached an agreement with the World Bank to purchase the certified emission credits (CERs) from the project.

The successful implementation of the project provides an excellent demonstration of the technology and the institutional mechanisms for LFG recovery and electricity generation, which can be applied to many other large Chinese cities.

NENT Landfill Gas Utilisation Scheme, Hong Kong, People's Republic of China

Source: Environmental Protection Department, The Government of Hong Kong, available online from http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/msw_lgu.html

Hong Kong has implemented large-scale schemes to extract gas from landfill sites in order to help reduce the use of fossil fuels in the town gas production process. The North East New Territories (NENT) Landfill Gas Utilisation Scheme is one of the largest off-site landfill gas utilisation schemes in the world, helping to minimise the use of fossil fuel in the town gas production process and reduce the release of methane into the environment. Landfill gas (LFG) is recovered from the NENT Landfill and used for on-site energy demands (electricity for site facilities and heat for wastewater treatment), whilst surplus landfill gas that is not utilised on site is used for the landfill gas export scheme. A LFG treatment plant has been installed at NENT landfill to treat the raw landfill gas, removing CO2, hydrogen sulphide and non-methane hydrocarbons. The product gas (80% methane) is then delivered to the Towngas production plant through a 19km underground pipeline. The scheme produces annual reductions of up to 135,000 tonnes of C02e emissions annually. An agreement to construct the LFG treatment plant is held between the contractor of the NENT Landfill, Far East Landfill Technologies Limited (FELT) and the Hong Kong and China Gas Company Limited (HKCG). FELT and HKCG have invested US$ 10.4 million in the LFG treatment plant and US$ 19.6 million in the gas pipeline respectively.

Sanitary Landfill Gas CDM Project, Ho Chi Minh City, Vietnam

UNFCC "CDM Project 1913: Phuoc Hiep I sanitary Landfill gas CDM project in Ho Chi Minh City" http://cdm.unfccc.int/Projects/DB/DNV-CUK1214915267.84/view

R.E.E. Mechanical & Electrical Engineering Joint Stock Company "Ground Breaking Ceremony the project to recover methane emitting from the landfill and to generate power according to the Clean Development Mechanism" http://www.reeme.com.vn/Eng/tincongtyen.php?Idtin=39

Ho Chi Minh City has contracted KMDK (Vietnam) Co. Ltd to develop projects for methane recovery and power generation from the three landfills of Phuoc Hiep, Cu Chi Ward and Dong Thanh, under the Clean Development Mechanism (CDM). At the three municipal landfills, REE and KMDK South Korea are the main partners responsible for the installation of landfill gas (LFG) collection systems, LFG flaring facilities, leachate recirculation systems and electric power generation facilities. One of the projects (at the Phuoc Hiep I landfill) involved the installation of a full-scale LFG collection system to monitor the flare systems, quantity and quality of gas available from the site. KDMK provided further support by producing a feasibility study and design report on landfill gas collection efficiency.
The CDM projects by KMDK produce 42 million KWh/ year to supply nearly 20,000 households and reduce CO2e emissions by 252,000 tonnes each year. Their estimated total capital investment has been between US$ 25 - 30 million. Socioeconomic benefits from the project include new technology development, local employment and minimized explosion risks by controlling methane emission.

Durban Landfill-to-Electricity Clean Development Mechanism, eThekwini, South Africa
eThekwini Municipality http://www.durban.gov.za/durban/services/cleansing/gastoelec
UN HABITAT, ICLEI, Sustainable Energy Handbook
http://www.iclei.org/fileadmin/user_upload/documents/Africa/Programs/Energy_and_Climate_Change/Sustainable_Energy_Handbook_Low_Res.pdf
South African Government Online "Minister Peters launches component two of the Durban Landfill Gas to Electricity Clean Development Mechanism (CDM) project, the first landfill gas to electricity in Africa" http://www.info.gov.za/speeches/2010/10012616251001.htm
The Durban Landfill-to-Electricity Clean Development Mechanism (CDM) project aims to enhance the collection of methane at three landfill sites of the eThekwini Municipality by installing 180 production wells for more efficient landfill gas extraction. The project aims at a collection efficiency rate of 85% at the highest level and 45% at the end of the project's commercial lifetime, over the three landfill sites. The captured methane gas is to provide fuel for the production of 10MV of electricity for supply to the South African municipal grid. Durban Solid Waste (DSW), the municipal agency responsible for management and operation of multiple landfills in the eThekwini metropolitan area, is the technical advisor and the operational entity of the project. The total cost for the integrated 3-site project is US$ 13.8 million, producing an estimated 350,170 tonnes CO2e reduction at one of the project's landfills (Bisasar Road Landfill).The project is funded from an estimated total project income revenue of approximately US$ 620,000 per month, realised from the sale of carbon credits and methane-generated electricity under a long-term power purchase agreement to Durban municipality.

Landfill Gas Recovery and Electricity Generation Project, Dar Es Salaam, Tanzania
UNFCC "CDM Project CDM Project 0908 : Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam, Tanzania
http://cdm.unfccc.int/Projects/DB/DNV-CUK1169853184.14
UN HABITAT, ICLEI, Sustainable Energy Handbook
http://www.iclei.org/fileadmin/user_upload/documents/Africa/Programs/Energy_and_Climate_Change/Sustainable_Energy_Handbook_Low_Res.pdf
Geneva Trade and Development Forum "Clean Development Mechanism as Tool for Sustainable Development: Case Study of Tanzania"http://www.gtdforum.org/download/Case%20Study%20Tanzania.pdf
The Dar Es Salaam City Council was approached by a private firm from Italy to establish a gas recovery and energy generation project at the Mtoni Dumpsite to reduce methane emissions, as a basis for a CDM project. The city authority granted the private firm, Consorzio Stabile Globus (CSG) the rights to capture and burn all biogas produced at the landfill over a 10 year period. CSG held responsibility for the construction and management of

the gas extraction and flaring system, by setting up and operating an extraction plant. Annually, the project is estimated to reduce emissions by 202,271 tonnes C02e and generate about 200,000 carbon credits. Total investment costs for the project are approximately US$ 5.3million. Revenue from electricity sales and revenue from sale of carbon credits (US$ 2.65 -3.18 million) the expected return on investment is 2 years. CSG invested in the project whilst the city council continued to own and manage the landfill site, making the landfill capture program economically feasible for the city authority.

Altamont Landfill and Resource Recovery Program, California, USA
Waste Management World 2010 "Green Giant" http://www.waste-management-world.com
The Altamont Landfill and Resource Recovery Facility in northern California are owned by the private corporation Waste Management Inc., who commission the world's largest landfill gas (LFG) to liquefied natural gas (LNG) plant. Waste Management and Linde North America (a leading global gases and engineering company) joined ventures to build a LNG facility costing US$ 15.5 million, receiving state grants from the California Integrated Waste Management Board, the California Air Resources Board, the California Energy Commission and the South Coast Air Quality Management District. The plant provides enough fuel to power 60% of Waste Management's LNG vehicles in California, reducing Waste Management's dependence on foreign fossil fuel and introducing a domestic green energy source to the fuel market. An estimated 18 million litres of Altamont biofuel is produced annually, reducing CO2 emissions by an estimated 27,000 tonnes per year.

Tools & Guidance

United States Environmental Protection Agency tool "Landfill Gas to Energy Benefits Calculator" http://www.epa.gov/lmop/projects-candidates/lfge-calculator.html

ANNEX 15: WASTE TO ENERGY

DESCRIPTION

The objective of this recommendation is to capitalise on the energy generation potential of Municipal Solid Waste (MSW) by introducing new forms of waste treatment. In order to implement this recommendation, a city will have met essential waste collection and transportation requirements that enable sorting of solid waste for incineration, gas capture, and heat and/or power generation.

The introduction of waste-to-energy processes can be used to support existing energy infrastructure and reduce reliance on traditional energy providers.

By reducing waste going to landfill, waste-to-energy programs will not only reduce land-take pressures, but will also help reduce future methane gas emissions from landfills.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Develop feasibility study	A feasibility study establishes the technological and policy framework to roll out a waste-to-energy program. Create a team that includes city planners, waste managers and financial advisors so that the feasibility study can be closely linked to waste generation quantities, site availability, waste management strategy, technical ability, incentives and taxes, etc. Establishing appropriate partnerships is central to the success of the study, for example, through the city authority assessing procurement options and possible support from private waste contractors or investors. See Abidjan and Gothenburg case study for more details.
Regulation/ Planning policy coordination	The city authority develops planning policy or guidance that supports the development of waste-to-energy as a treatment option. The resulting waste-to-energy programs should be coordinated with wider urban plans and policy framework. Additionally, taxes on landfill waste and incineration

Attributes

Energy Savings Potential
100,000-200,000 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 gain
Security of Supply

	(without energy generation) can encourage operators to invest in more efficient waste-to-energy technologies. See Gothenburg case study for more details.
Procurement Program (existing and new facilities)	The city authority contracts a third party to capture energy from waste facilities (existing or new). This can be done through landfill gas capture and treatment, anaerobic digestion gas collection and/or MSW incineration with energy generation. This implementation activity has good synergies with Kyoto Protocol Mechanisms: Joint Implementation and the Clean Development Mechanism, and these and other routes for obtaining financial support should be investigated. This approach will enable the city to implement a waste-to-energy program without prohibitive up-front costs. Coordination with environmental programs is essential, as some programs require close monitoring to ensure they are safe and don't negatively impact on the environment. See Abidjan and Singapore case study for more details.
Regulation/ taxes	Taxes on landfill waste and incineration can be a good mechanism to encourage operators to implement waste-to-energy programs to bring in additional revenue that can in turn be used to invest in more efficient technologies. This implementation activity will benefit from mandatory minimum standards for all waste treatment sites. See Austria and Gothenburg case study for more 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:

- Net energy generated per ton or m3 of waste.
- tonnes of waste converted into energy
- % waste treated by waste-to-energy
- % increase in net energy generated (after facility energy use)

Estimate waste generation potential over next 30 years. Set KPI's based on performance and or size of other regional and or countrywide facilities, for example, minimum energy exported after facility energy use and maximum waste treated by waste to energy. Measure and report on any existing or planned regional or national waste to energy provision in tonnes and energy generated.

CASE STUDIES

Recycling of waste and generation of electricity, Yokohama, Japan

ECO2 Cities: Waste Use and Recycling in Yokohama, available online from http://www.esmap.org/esmap/node/1229

Yokohama is the largest city in Japan. It reduced waste by 38.7 percent between fiscal years 2001 and 2007, despite the growth of 165,875 people in the city's population. This reduction in waste is attributable to the city's success in raising public awareness about environmental issues and the active participation of citizens and businesses in Yokohama's 3Rs program (reduce, reuse, and recycle).

Yokohama has been able to shut down two incinerators because of the significant reduction in waste. The incinerator closures have saved US$6 million4 in annual operating costs and US$1.1 billion that would have been needed to renovate the incinerators (City of Yokohama 2006). Around 5 percent of the fiscal year 2008 budget of the Resources and Wastes Recycling Bureau, the city's waste management entity, was derived from the sale of recycled material (US$23.5 million). In addition, the city raises US$24.6 million annually by selling the electricity generated during the incineration process.

Abidjan Municipal Solid Waste-To-Energy Project, Abidjan, Ivory Coast

UNFCC (2010) "Abidjan Municipal Solid Waste-To-Energy Project"
http://cdm.unfccc.int/Projects/Validation/DB/WMCZWV34G1WDMVMQGPB2AXI3CZXQXF/view.html

The municipal solid waste treatment plant in Bingerville was developed under a Clean Development Mechanism (CDM) project to manage 200,000 tons of municipal solid waste/year. After sorting, the project treats the waste by anaerobic fermentation. The resultant biogas is captured and used to produce renewable electricity for on-site consumption as well as for sale to a state-owned electricity company under Power Purchase Agreement (at US$ 25.66/MWh). Residual waste from the fermentation process is also transformed into compost and sold to local farmers. The project was set to avoid 583,965 tCO2 equivalent over the first 7 years crediting period, create more than 180 jobs, and generate 3MW of electricity per year at full operation in October 2009.

A key success factor to the project is the adoption of technology from an Italian-based company (PROMECO Spa) specialised in engineering, planning and turnkey building of urban and industrial waste treatment plants. The Ivorian project developer (SITRADE) receives trainees from the technology provider, benefiting the project from know-how transfer. Due to the reliance on imported components and equipment, the project requires special assistance in the first months of operations to alleviate the risk of technological failure. Lack of public funding and difficulties in attracting investors in a high-risk business climate are a barrier to success, resulting in project developers taking out loans from local banks.

Singapore Waste Management Project, Singapore

"9.5 MW Food Waste Based Grid Connected Power Project implemented by IUT Singapore Pte Ltd., Singapore"
http://cdm.unfccc.int/Projects/Validation/DB/OFKVAJIKYTB05GUR4JXMRLC0DREF3G/view.html

IUT Global Pte Ltd., a Singapore-based waste management company has implemented a 9.5 MW grid connected power project produced by bio-methanisation of food waste generated in Singapore, using the ADOS (Anaerobic Digestion of Organic Slurry) technology. An additional benefit of this project is that it increases energy efficiency of solid waste incinerators, especially as food wastes have high moisture content (around 80%) and consume more energy to incinerate. The electricity generated is sold in the wholesale electricity market and residual material is processed for bio-compost for commercial use as an organic soil conditioner. At full capacity, the waste-to-energy plant will process more than half of the food waste being delivered to local incineration plants for disposal in 2008. Phase 1 of the project was expected to produce 10,599 MWh net incremental power per year and reduce emissions by 5,088 tCO2 equivalent per year.

As Asia's first major organic bio-methanisation power plant based on food wastes, the project presents high operating and performance risks, requires training man-power with new skill sets, and incurs high capital costs for relatively small installed power capacity. An additional disadvantage in Singapore is that, because of the absence of a long-term Power Purchase Agreement, the tariff of power is determined by the open wholesale market, which means that the revenue brought in by the sale of electricity is inconsistent. The advantage of this project is that the design, implementation and operational experience of the state-of-the-art technology involved in the project can lead to its replication across Asia and the Middle East with Singapore as a base for export of such skills and technological advances.

Gothenburg Waste Management Project, Gothenburg, Sweden

Clinton Climate Initiative, Climate Leadership Group, C40 Cities http://www.c40cities.org/bestpractices/waste/gothenburg_system.jsp

In Sweden, there is a tax on all landfill and a further tax on incineration, with tax benefits if electricity is produced. This encourages landfill operators to generate power from waste through gas capture or incineration.

Gothenburg uses an integrated waste system to collect, sort and burn the city's rubbish. Waste incineration is used to provide energy for heating and electricity through a highly efficient system at 3.3MWh/ton of waste. The project involves the coordination of city authority planners and waste management service companies in the sorting of wastes. Waste management services are contracted out to private companies such as Renova (Sweden's largest waste management company) and IL Recycling who bid for tenders to collect, treat and dispose of industrial and business waste, whilst the local authority is responsible for the collection and treatment of household waste.

Renova incinerates the waste in the Savenas plant, which provides 27% of the 3,970 GWh required for the district heating system. As a result of the construction of new boilers, flue gas condensers, other technologies and increased efficiency in sorting and separation of waste, the energy produced by the plant has increased by sixfold between 1974 and 2006 whilst incinerated waste volumes have only doubled. The waste-to-energy program reduces landfill reliance (of all the waste that is collected, only 8% remains for landfill) and the production of electricity reduces Renova's incineration taxes.

Durnrohr EfW Facility, Austria

"Delivering Key Waste Management Infrastructure: Lessons Learned from Europe" http://www.wasteawareness.org/mediastore/FILES/12134.pdf

Durnrohr Energy From Waste facility is situated in Lower Austria. The project was conceived by EVN (a power supplier in the Region of Lower

Austria) in 1995 in response to the requirements of the Landfill Ordinance and the increasing rate of landfill tax. EVN subsequently formed AVN, which although representing a partnership with the Region of Lower Austria, is made up of entirely private shareholders.
EVN financed the plant using both its own equity and private investment, which was raised on the back of securing two key contracts, one for 154kTpa of MSW from a network of waste management associations and another from a private contractor collecting non-hazardous industrial wastes from sources across Lower Austria. Gate fees charged by the facility are typically in the region of Euro 100 / tonne on both public and private contracts.

TOOLS & GUIDANCE

Tools & Guidance
Approved CDM methodology documents "Tool to calculate the emission factor for an electricity system" https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf/history_view
"Approved CDM baseline and monitoring technologies" http://www.co2-info.com/downloads.html#Methodologies
"Energy from Waste: A good practice guide" http://www.iswa.ch/Info/Documents/PublicationAwards04/Energy%20from%20Waste(CIWM).pdf