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Improving Energy Efficiency in CLUJ-NAPOCA Romania

ROMANIA
REGIONAL DEVELOPMENT PROGRAM

TRACE City Energy Efficiency Diagnostic Study


Municipal Buildings


Water and Wastewater


Solid Waste Management


Public Transport


Public Lighting


Power and Heat

Regio
PROGRAMUL OPERAȚIONAL REGIONAL

Inițiativă locală. Dezvoltare regională.

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Table of Contents

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

ROMANIA
REGIONAL DEVELOPMENT PROGRAM

ESMAP
Energy Sector Management Assistance Program

Executive Summary

Why a study on energy efficiency?

The main impetus for this report (and for the reports prepared for the other six growth poles) is a request received from the Ministry of Regional Development and Public Administration. The request came within the context of on-going preparations for the 2014-2020 Programming Period, with Energy Efficiency being one the major themes of the Europe 2020 strategy, and a critical priority for all EU Member Countries. Within Romania, local authorities that will want to access energy efficiency funds under the 2014-2020 Regional Operational Programme will need to first prepare energy efficiency strategies. The TRACE tool is specifically targeted at local authorities, and is a good instrument for drafting such strategies.

What is TRACE?

The Tool for Rapid Assessment of City Energy (TRACE) is a simple and practical tool for conducting rapid assessments of energy use in cities, The tool helps prioritize sectors with significant energy savings potential, and identifies appropriate energy efficiency interventions across six sectors—transport, municipal buildings, water and waste water, public lighting, solid waste, and power and heat. It is a simple, low-cost, user-friendly, and practical tool that can be applied in any socioeconomic setting.

The advantages of TRACE

TRACE is one of the most powerful energy efficiency tools, specifically developed for cities. It is simple, easy to implement, and quite intuitive, and it allows a quick assessment of energy savings potential in six key public service areas: urban transport; water and wastewater; municipal buildings; street lighting, power and centralized heating; and, solid waste management. The tool can be implemented relatively quickly and is not data- or cost-intensive. Moreover it allows local authorities to get a rapid assessment of their city's energy performance, and to identify sectors that may be subjected to a more in-depth analysis.

The limitations of TRACE

The fact that TRACE is simple and easy to implement, also means that there are limitations with respect to the depth of analysis. For example, the tool may identify District Heating as the a priority sector in terms of potential energy savings, but it does not go into detail on the required costs to complete district heating rehabilitation projects. Thus, even if the energy savings potential is assessed to be high, the costs may be even higher, and an investment in the sector may not be warranted. Similarly, although TRACE specifically focuses on the service areas that fall within the purview of local authorities, the tool cannot factor in the institutional and legislative mechanisms that need to be in place to make a specific energy efficiency recommendation possible.

Boundaries of studied area

While this work focuses on the growth poles in Romania, the analysis was limited to the boundary of the center city. The reasoning for this is quite simple: it is prohibitively difficult to collect individual indicators for all the constituent localities of a metropolitan area. In most cases, this would have required in-depth discussion with over 20 localities, ensuring that all these localities had the necessary indicators for a particular service area, and ensuring that they used the same methodology for the calculation of these indicators. Nonetheless, the sector analysis and recommendations took the metropolitan scale into consideration, and the section on sound urban planning practices was done at the full metropolitan level.

Summary of findings

After the 1989 Revolution, Romania began its transition from a centralized system to a market-run economy. Today the country is a member of the European Union (EU) and NATO. After more than a decade of economic restructuring and political change, the country has taken significant steps to catch up with the economic performance of more developed EU countries. Although radical reforms brought about significant changes, the standard of living of Romanians is still behind the EU average.

Cluj-Napoca (Cluj) is one of cities where such disparities are less pronounced, as the region is more developed and prosperous than most regions in the country. Cluj has developed quite well in the past few years, and it has become one of the most flourishing cities in the country, having

a good growing potential. At present, the city is an important economic center, home to several local brands that have become famous nationwide as well as in Europe. Moreover, Cluj is known today as the "capital" of the IT sector in the country, due to an aggressive expansion of this field in recent years.

The city's recent growth has led to significant changes in the social and economic life of Cluj residents. Most of these developments have positively affected people's life, whereas a few were accompanied by inconveniences and difficulties.

For instance, the increasing number of cars in the city caused heavy traffic congestion, high fuel consumption, and large greenhouse emissions. With only few parking lots, a handful of dedicated bus lanes, and lacking needed ring roads to help re-route through-city traffic, commuting has become quite a struggle for both private and public transport. The district heating system is undergoing significant challenges following the massive disconnection of tens of thousands of customers in last ten years. Despite some modernization and rehabilitation work that has been performed on the network, some of the obsolete heating pipes continue to deteriorate, allowing for water leakages and heat losses. Although the water system is covering the entire city and all water connections are metered, part of that infrastructure has also deteriorated throughout the years and is prompting heavy water losses in the network.

But there are also notable things Cluj has managed to accomplish in the past few years. All streets in the city are lit; old inefficient bulbs have been replaced with modern, efficient ones and, thus, reduced the electricity consumption; the transport network is well developed, connecting the city from one side to another; the generation of solid waste is lower than other cities in the region; and the percentage of solid waste recycled is good. Most of the municipal buildings need rehabilitation work to decrease heating consumption and reduce heating bills. Nonetheless, thermal rehabilitation of residential buildings as well as some of the public schools and kindergartens improved the overall energy efficiency.

Electricity tariffs are regulated by the national government. The government is still subsidizing the energy price for domestic users. However, the liberalization of the energy sector has already started for the industrial users and will continue this year with the non-domestic clients. Subsidies are going to be gradually eliminated by the end of 2017, when the liberalization of the market will be complete. Energy production from renewable sources is encouraged, and Green Certificates are provided to such producers.

The local government has a number of ambitious projects to develop the city, improve its performance and quality and, not in the least, open the doors for more energy efficiency projects. Such plans include expanding the public transport to the wider metropolitan area, developing non-pedestrian networks, purchasing non-polluting buses, improving the street lighting system, continuing rehabilitation of educational facilities, and so forth.

Cluj is one of the most advanced cities in Romania and it should continue to build on this foundation to become more developed and flourishing. Based on the results of the implementation of the TRACE tool, this report outlines some ideas on how that can be done. TRACE (Tool for Rapid Assessment of City Energy) is a simple and quick diagnostic tool that is used to assess a city's energy performance in six service areas (urban transport, municipal buildings, water and wastewater, solid waste management, public lighting, and power and heat) and to provide recommendations for improving energy efficiency. In each of the service areas, TRACE uses a benchmarking algorithm to evaluate energy cost savings potential, and factoring in the level of influence of local authorities, it prioritizes what the authorities should do according to where the biggest savings can be achieved.

To complete data collection and to get a more comprehensive idea of issues in the city, a World Bank field trip was organized in January 2013. Work in Cluj-Napoca was carried out in close collaboration with local authorities and public and private utility services providers. At the end of this quantitative and qualitative analysis, several recommendations were drawn out. These are summarized below.

Non-Pedestrian Network Development

The city authorities are carrying on with the plans started in the late 2000s with regard to non-pedestrian trasport, and they are working on expanding the network to the wider metorpolitan area. The city government is currently implementing a project to build 20 km of bike lanes connecting Cluj to Floresti and Apahida, in addition to the existing 40

km. People will be able to bike using 58 km of dedicated bike lanes and rent out 500 bicycles from 50 self-service bicycle docking stations in the wider metropolitan area.

Public Transport Development

Cluj has a well-developed public transportation system and a testimony to this is the fact that half of the commuters in the city use public transit for their daily trips. Local authorities plan to further invest in the efficiency of the current system by purchasing new, energy-efficient rolling stocks, expanding the tram network, extending the public transport system to the metropolitan area, and introducing e-ticketing. If the electric bus project will go through, then Cluj will be the first city in Romania to have such means of public transportation.

Traffic Flow Optimization

As everywhere else in the country, traffic congestion is a major problem for both Cluj residents and city managers. In order to tackle this issue, the local government should focus on measures channeled at changing driving patterns by technical optimization of traffic signaling or by means of information. For instance, information displayed through GPS or radio-based systems could inform drivers about route switching options and the availability of parking spaces. In the long run, local authorities should take firm steps toward finishing the city's ring road to ease traffic congestion in Cluj and provide commuters with alternative commuting routes.

Traffic Restraint Measures

As the number of private cars has gone up in the recent years, local authorities should identify ways to curb private vehicle usage and focus on more sustainable, efficient, and less costly transport alternatives. The Local Council has already limited private inter-regional bus operators to only three "legal" stops in the city, and such buses will be totally banned from entering the city once "Park and Ride" facilities and intermodal terminals will be developed. The local public administration aims to enforce reduced speed zones in the city center. The city may consider further initiatives, such as setting up "no driving days" to educate and lead by example.

Parking Restraint Measures

One of the best ways to deal with traffic congestion is the development of "Park and Ride" facilities. City government is taking into consideration this efficient method to promote multimodality by linking parking to public transport. People who travel to the city drive their cars to these facilities, from where they take public transport to get to their workplace. In addition, local authorities are planning on building underground parking, as well as hiking prices for remaining parking spaces in the city center. However, before such facilities are developed, one has to have a better understanding of commuting patterns in the larger metropolitan area, and the extension of public transport infrastructure should precede the development of such facilities.

Municipal Buildings Benchmarking Program

The municipal building stock numbers around 100 units, of which 75% are educational facilities. Given that there is no database tracking the energy performance of these buildings, it is important to first get an idea of which buildings offer the greatest saving potential. This can be done through a benchmarking process, using a number of key indicators. Eventually, by publishing the analysis and updating the data on regular basis, this process may enable competition among building managers and, eventually, can lead to a productive exchange of data and collaboration.

Municipal Buildings Audit and Retrofit

In order to draw a plan for how resources can be allocated to improve the energy performance of the municipal buildings in the city, a full audit should be performed on the existing stock of 100 buildings. Depending on results, the city government may have to allocate money for energy efficiency upgrades, purchasing of new equipment, and some renovation of buildings. The City Hall has already started a program to rehabilitate the educational units in the city, and is committed to carry on with such initiatives in the future.

City-Wide Integrated Public Lighting Assessment

Although the energy consumption per lighting pole in the street lighting network is comparable to other cities in the region, there is still room for improving the overall energy efficiency of the system. This can be done

through an evaluation of existing lighting poles, together with an assessment of running and maintenance operations. At the end, the main findings should be published and presented to the media, citizens, and different stakeholders.

Street Lighting Audit and Retrofit

The next step in improving the energy efficiency of the street lighting in Cluj should be an audit of the lighting system and, subsequently, the completion of retrofit work where appropriate. This approach will help city authorities reduce the maintenance cost and develop the system by reducing service interuptions.

Street Lighting Timing Program

Most of the mercury lamps of the street lighting system in Cluj were replaced with more efficient sodium vapor ones. The city government is thinking to further implement solutions for reducing energy consumption by introducing a street lighting timing program. The light can be adjusted for specific needs in a particular area, according to varying weather and activity levels. For instance, more light is needed in the evenings when more people are out than in the night time when there is less activity on the streets.

Prioritizing Recommendations

The process used by the team to get to the recommendations presented above was twofold. On the one hand, the TRACE tool has a step-by-step mechanism analysis system, which enabled the team to identify a number of priority sectors. The chosen priority sectors usually included sectors with a high energy and money savings potential, and sectors where local authorities had a high degree of control. Sectors which were either under the control of private operators, or the control of county councils or national level authorities, were usually not considered.

For each of these priority sectors, the team has chosen a number of key recommendations, based on the discussions with the public utility operators, and based on the site visits and data collection. In turn, these recommendations were discussed with local authorities, and a limited number of priority recommendations (usually around 10), were selected from the list prepared by the team.

In some cases, local authorities have chosen priority sectors and recommendations that did not necessarily offer the highest savings potential. A more in-depth discussion on each of those recommendations, including the position of local authorities is discussed in the Energy Efficiency Recommendations Section. The Matrix below provides a snapshot of the priority sectors and recommendations chosen for the City of Cluj-Napoca.

Cross growth pole comparison

Having the benefit of implementing TRACE in seven of the largest cities in Romania, the team identified a number of common challenges, and a number of common approaches for addressing energy efficiency issues. For example, it became quite obvious that almost every city with a district heating in Romania has issues running this system in an efficient manner. District heating systems in Romanian cities were almost exclusively built before 1989, and they now have large segments of o leaky and poorly insulated pipes. Moreover, the district heating systems were not built to also serve large industrial facilities (which now are largely gone), and they were not designed for individual metering (i.e. with a vertical distribution system in apartment blocks, instead of a horizontal system). Because of the losses in the system (which ultimately get reflected in the monthly bill), because heating cannot be adjusted or turned off when not needed, and because of the high and growing price of thermal energy, many people have decided to de-branch themselves from district heating networks. Virtually, every growth poles has witnessed disconnection from the centralized heating system, as people have resorted to individual heating options (e.g. individual gas powered heating units). In some cities, such as Brașov, the share of people who de-branched from district heating represents a large majority of the population; in other cities, such as Constanța, the number of people who left the centralized heating system is lower.

Matrix with energy efficiency priorities and proposed programs

PRIORITY 1 Private Vehicles	Energy spending in the sector		Potential savings	
	$64,000,000		$4,500,000	
	Responsible Institution	Cost	Energy savings potential	Time of implementation
1. Non-motorized transport modes	City Hall	$$$	**	> 2 years
2. Parking restraint measures	City Hall	$	**	> 2 years
3. Traffic restraint measures	City Hall	$$	**	1-2 years
4. Traffic flow optimization	City Hall	$$	***	> 2 years
PRIORITY 2 Public Transport	Energy spending in the sector		Potential savings	
	$6,000,000		$1,800,000	
	Responsible Institution	Cost	Energy savings potential	Time of implementation
5. Public transport development	RATUC	$$$	***	> 2 years
PRIORITY 3 Municipal Buildings	Energy spending in the sector		Potential savings	
	$3,800,000		$1,400,000	
	Responsible Institution	Cost	Energy savings potential	Time of implementation
6. Municipal buildings audit and retrofit	City Hall	$$$	***	1-2 years
7. Buildings Benchmarking	City Hall	$	**	1-2 years
PRIORITY 4 Street Lighting	Energy spending in the sector		Potential savings	
	$1,400,000		$400,000	
	Responsible Institution	Cost	Energy savings potential	Time of implementation
8. City-wide integrated public lighting assessment	City Hall	$	**	1-2 years
9. Street lighting audit and retrofit	City Hall	$$	***	1-2 years
10. Street lighting timing program	City Hall	$	***	< 1 year
PRIORITY 5 District Heating	Energy spending in the sector		Potential savings	
	$18,000,000		$6,900,000	
	Responsible Institution	Cost	Energy savings potential	Time of implementation
11. District heating network maintenance	RATCJ	$$$	***	> 2 years

Priority sectors for energy efficiency improvements in growth poles

	Brasov	Cluj	Constanta	Craiova	Iasi	Ploiesti	Timisoara
Private Vehicles	3	1	1	2	2	3	2
Public Transport	2	2	3	1	4	4	4
District Heating	1	5	2		1	2	1
Municipal Buildings	5	3	4	3	3	5	5
Street Lighting	4	4	5	4	5	-	3
Solid Waste Management	-	-	-	-	-	-	-
Water and Wastewater	6	-	-	-	-	-	-
Local Authority Management	-	-	-	5	-	1	-

For most growth poles, urban transport (private vehicles and public transport) was identified as a key sector, although cities like Iași and Timișoara (which have the largest tram networks in Romania outside Bucharest), generally have energy efficient public transport systems and as such have this sector lower on the priority list.

Generally, solid waste management, as well as water and wastewater, did not make it on the priority list of growth poles. For one, solid waste management systems in Romania tend to largely be operated by private companies, and energy efficiency improvements in these systems are accrued by these private operators. On the other hand, water and wastewater systems are generally run by public companies, with county councils being the majority shareholders.

Also a number of the growth poles had drafted or were in the process of drafting Covenant of Mayors SEAP reports (e.g. Brașov, Cluj-Napoca, Timișoara), while others (e.g. Ploiești or Craiova) were considering to start the process.

All in all, every growth poles that has been part of this study has undertaken energy efficiency measures in the past years, and all have good practice lessons they can share with other cities.

The importance of good urban planning for energy efficiency

While TRACE does not explicitly deal with this issue, urban planning plays a crucial role in energy efficiency. Cities that promote and encourage a dense and compact urban development pattern tend on the whole to be more energy efficient. On the whole, dense cities require less investment in public services infrastructure development and maintenance (roads, water networks, sewer lines, street lighting, solid waste management, public transport, etc.), they allow higher profitability for public transport operators (since every transit stop serves on average more people than in less dense cities), they enable walking and biking as means of commuting, they discourage car use and transport-related pollution, they can help lower greenhouse gas (GHG) emissions, they require less energy expenditures for the delivery of key public services (e.g., pump costs for water, fuel costs for garbage collection).It is estimated that the energy consumed for transport needs in a city with a density of less than 25 people per hectare may reach an annual average of 55,000 mega joules per person. By comparison, in an urban area with a density of 100 people per hectare, this figure is about three times lower.[1] Consequently, a separate section on spatial planning was introduced in the report, discussing some key related issues for each city studied. A more complete analysis of spatial planning challenges in Romanian cities is included in the *Enhanced Spatial Planning* report.

[1] European Environment Agency. 2006. *Urban sprawl in Europe: The ignored challenge.* Copenhagen: European Environment Agency (Report No. 10/2006).

Methodology

The Tool for Rapid Assessment of City Energy (TRACE) TRACE consists of three principal components: (i) an **energy benchmarking** module which compares key performance indicators (KPIs) among peer cities (ii) a **sector prioritization** module which identifies sectors that offer the greatest potential with respect to energy-cost savings, and (iii) an **intervention selection** module which functions like a "playbook" of tried-and-tested EE measures. These three components are woven into a user-friendly software application that takes the city through a series of sequential steps: from initial data gathering to a report containing a matrix of energy efficiency recommendations tailored to the city's individual context, with implementation and financing options. The steps are as follows:

1. Collection of Candidate City Energy Use Data

TRACE contains a database of 28 key performance indicators (KPIs) collected from over 100 cities. Each of the data points that make up these KPIs is collected prior to the application of the tool and, as TRACE is launched, this collection of information will grow with current and reliable data.

2. Analysis of City Energy Use Against Peer Cities

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

3. Assessment and Ranking of Individual Sectors

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

The main frame of TRACE

4. Ranking of Energy Efficiency Recommendations

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

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

The TRACE Benchmarking Module

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

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

5. Report Preparation and Submission

A Final City Report records the city review, along with city background information and various aspects of the city visit included in introductory sections and annexes. The report includes:

- City background information, such as city contextual data, key city development priorities, energy efficiency drivers, barriers etc.
- An analysis of the six sectors, including a summary of the benchmarking results.
- A summary of sector prioritization based on city-owned and city-wide scales
- A draft summary of recommendations provided as the City Action Plan
- An Annex section, with a more in-depth discussion on energy efficiency recommendations and best-practice cases.

The Final City Report enables the city to move forward with the most feasible recommendations in a structured manner to allow the city to eventually improve its overall rankings, performance, and save money.

Background

The 7th largest country by population in the European Union (EU), Romania is located in Southeastern Europe, in the lower basin of Danube river. It has a stretch of coastline along the Black Sea and also owns much of the Danube Delta. Romania borders Hungary, Serbia in the West and South West, Bulgaria in the South, the Republic of Moldova in the East, and the Ukraine in the North and East. Almost 50% of Romania's territory is part of the Carpathian Mountains range. The country has a temperate continental climate, with hot summers and cold winters. As part of the communist bloc countries for nearly half a century, Romania brought down the authoritarian regime with the 1989 Revolution, and then it began its transition from a centralized system towards democracy and market economy by implementing a series of structural changes and reforms. If initially the economy was centered on agriculture, during communism it gradually shifted to an industrial one, ultimately making significant steps towards a service-based economy over the past two decades. In 2004 Romania joined NATO and three years later it became a member of the EU.

After a period of massive economic restructuring and political change, the country has taken significant steps to catch up with the economic performance of more developed EU countries. Although government policies and radical reforms brought about significant changes, income levels of Romanians are still behind the average level in the EU countries. In addition, the disparities within Romania mean that there are significant differences in terms of standards of living between the country's regions. The country is divided into 41 counties, plus the capital city, București (Bucharest), and into eight development regions (although regions do not have formal administrative powers as of April 2013). Apart from București, each development region is organized around a growth pole center (city), and comprises four to seven counties. Despite of being among the most populous countries in Europe, Romania has experienced a decline in population in recent years. The stable population declined by 7.1% over the last decade, from nearly 22 million to 20.1 million, according to the final results of the 2012 census. However, the population decline did not necessarily come as a surprise. After Romania joined the EU, many Romanians left the country to pursue better opportunities in Western Europe. Other factors responsible for this decline are the aging of population as well as a significant rise in number of the families with no children. Romania is predominantly urban, although the urbanization level is still below that of countries in Western Europe; half of population resides in municipalities, cities and towns, while up to 10% lives in the capital city.

According to the final results of the 2012 census, the most populous cities in Romania are the following:

Table 1. Ranking of select Romanian cities by population

City	2012 census	2002 census / Rank	
București	1,883,425	1,934,449	(#1)
Cluj-Napoca	324,576	318,027	(#3)
Timișoara	319,279	317,651	(#4)
Iasi	290,422	321,580	(#2)
Constanța	283,872	310,526	(#5)
Craiova	269,506	302,622	(#6)
Brașov	253,200	283,901	(#8)
Galați	249,432	298,584	(#7)
Ploiești	209,945	232,452	(#9)
Oradea	196,367	206,527	(#11)

Source: National Institute of Statistics, 2012 Census (http://www.recensamantromania.ro/rezultate-2/)

National Legislation regarding Energy Efficiency

Romania's energy consumption per capita is almost twice as low as the average in the EU, at 1.6 toe (ton of oil equivalent). Between 1990 and 2000, energy consumption fell by an average of 5 % per year, and then increased slightly after 2000 by 1.3% per year. At the beginning of the economic crisis in 2009, energy consumption dropped by 14 percent, and then increased by only 1.3%in 2010. Amid the economic recession, the country's GDP followed a similar decreasing trend and fell by 8.3%. Energy efficiency at the national level has increased significantly between 1990 and 2000, from 23% to 39%. It is a consequence of the rising share of high efficiency power sources (hydropower) in the electricity mix, as well as

improving efficiency of thermal power plants. However, it still remains lower than the EU average.

In the early 1990s, Romania created its first institutional framework for energy efficiency when the **Romanian Agency for Energy Conservation**, the country's main specialized body in the field of energy efficiency, was established. Ten years later Romania adopted the National Energy Efficiency Strategy, a document outlining steps to be taken to increase energy efficiency. In the 2000s, Romania ratified the Kyoto Protocol to the United Nations Conventions on Climate Change, under which the country has committed to cut its emissions of greenhouses gases, between 2008 and 2012, by 8% from 1989 levels.

The **Romanian Fund for Energy Efficiency** became operational in 2003 and ever since it has provided subsidies for investments to 27 energy efficiency projects promoted by large industrial operators, totalizing $14.4 million.[2] In order to comply with EU requirements, the Government transposed the Directive No.2006/32/EC regarding energy efficiency among the end users and energy suppliers into national legislation, requiring EU member states to undertake steps to reduce energy consumption by at least 9 % for 2008-2016, as compared to consumption for the previous five years.

The Energy Road Map for Romania was approved in 2003 during the negotiations for EU membership. Pursuant to EU Directive on energy reduction, the **First Energy Efficiency Action Plan** for the period 2007-20103 set an energy saving target of 2.8 Million toe by 2016, and it further aims for 1.5% annual reduction for the period 2008-2016. The intermediate target of 940,000 toe by 2010 was far exceeded, as Romania achieved 2.2 Million toe in energy saving. The plan document foresees great potential for energy savings for the industrial sector through voluntary long-term agreements between industrial agents and the Government, in addition to investments in equipment to oversee energy consumption. Estimates indicate that EU countries that have implemented such agreements reached 10 to 20% in energy savings. Large consumers must carry out energy audits and energy efficiency improvement programs, while an energy balance must be produced every year for those consuming 1,000 toe/year and every two years for those who use between 200 and 1,000 toe/year. From 2000 onwards an energy saving certificate has been issued for all new buildings, single-family dwellings and apartment that are sold or rented. Heat insulation work benefitted from tax breaks and co-financing was provided for renovation work.

The Second Energy Efficiency Action Plan[4] focuses on energy savings in the primary energy and power sectors, and promotion of energy from renewable sources.

The First National Strategy for Energy Efficiency for 2004-2015[5] set an ambitious 40% target in energy intensity reduction for the period 2005-2014. Decrease in energy intensity should be achieved through programs promoting high energy standards for new installations, as following: 41% in buildings, 29% in the energy sector, 16% in industry, and 14% in transport. Few years later, the **National Strategy for Energy Efficiency for the period 2007-2020**[6] set further targets to reduce energy intensity by 41% through 2020 by advancing feasible solutions to cover the country's future energy demand at a lowest price. By then, estimated primary energy savings and reduction of losses should achieve anything between 25% and 40% (20-25% in industry, 40-50% in buildings, and 35-40% in transport), by improving efficiency in the power sector. The energy saving target was set to 3.4 Million toe by 2020. In this context, 1.9 Million toe saving is expected to come from fuel substitutions, 800 ktoe from high efficiency co-generation (Combined Heat and Power), and 600 ktoe from new coal-fired units.

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[2] Romanian Fund for Energy Efficiency http://www.free.org.ro/index.php?Itemid=112&id=96&lang=ro&option=com_content&task=view

[3] First Energy Efficiency Plan for the period 2007-2010 available at: http://ec.europa.eu/energy/demand/legislation/doc/neeap/romania_en.pdf

[4] Second Energy Efficiency Action Plan available at: http://www.minind.ro/dezbateri_publice/2011/PNAEE_12_cu_anexe_2_11082011.pdf

[5] The First National Strategy for Energy Efficiency for the period 2004-2015 available at: http://www.minind.ro/domenii_sectoare/H163-04.html

[6] National Strategy for Energy Efficiency for the period 2007-2020 - updated version for the period 2011-2020 available at: http://www.minind.ro/dezbateri_publice/2011/Strategie_2007_actualizata_2011_01092011.pdf

The main objective of the **National Strategy Regarding the Thermal Power Supply of Cities**[7] approved in 2004 addresses key issues concerning energy efficiency of the heating system. The thermal power supply system is built on obsolete technologies and old pipeline networks, with low energy efficiency, very high losses (35 % on average), in addition to high production, transport, and distribution costs. Poor insulation of buildings adds another 15% to the losses. Actions meant to increase energy efficiency include implementation of large scale co-generation plants, modernization of network, diversification of primary energy used for thermal power production, and installation of meters in residential buildings. Resource consumption for the centralized heating systems should diminish by 612,000 tons. However, the modernization of the entire heating system is very costly, and it requires investment of billions of euro.

The Strategy for Use of Renewable Energy Sources,[8] approved in 2003, encourages energy production from renewable sources in order to increase the share of electricity produced from such sources. Romania's potential of renewable energy sources is estimated at 14,718 ktoe. However, the development of such energy potential is constrained by obsolete technological limitations, economic efficiency, and environmental restrictions. Therefore, the plan is pushing for transfer of unconventional technologies from experienced companies, joint-ventures, and private public partnerships. The target shares for renewable energy sources out of the total energy consumption were set at 33% for 2010, 35% for 2015 and 38% for 2020. Use of renewable energy could result in 1.8 Million toe energy saving from primary sources by 2020. **The National Renewable Energy Action Plan**[9] outlining the renewable energy national policy was drafted in 2010, in the very difficult context of the economic crisis. It encouraged the use of liquid bio-fuels, liquid gas, geothermal and clean energy, as well as the integration of biogas into the natural gas grid and retrofitting technologies. The Directive 2009/28/EC on renewable energy set the national target for the share of energy from renewable sources in gross final production of energy at 24% for 2020. The expected total energy consumption in 2020 was set at 30,278 ktoe, of which 7,267ktoe in renewable energy. Targets for specific industrial sectors have been designed, such as 10% for transport, 22% for heating, and 42% for electricity.

Romania received support from the European Bank for Reconstruction Development (EBRD) to help companies open credit lines for energy efficiency projects. The country receives financial support through the Operational Sector Program for Boosting Economic Competitiveness aimed at increasing energy efficiency. Small and medium-sized enterprises may receive up to 65% financial support for a period of three years to help them obtain environmental certificates for appliances and office equipment.

Government Ordinance 22/2008[10] regarding energy efficiency and promotion of energy from renewable energy sources to end consumers requires local public administrations in towns with a population greater than 20,000 people to produce action plans to generate the most efficient energy savings in the shortest period of time (3 to 6 years). Similarly, companies and local and central government units owning more than 25 vehicles must develop fuel consumption monitoring and management programs.

The National Multiannual Program for the Thermal Rehabilitation of the Residential Buildings Built between 1950 and 1990 started in 2005 and was improved each year. The program is coordinated by the Ministry of Regional Development and Public Administration (MRDPA) and it is developed in partnership with local authorities. It aims at increasing the energy performance of buildings, improving the quality of life for inhabitants and, not in the least, contributing to a better

[7] National Strategy regarding the thermal power supply of cities http://www.termopitesti.ro/HG%20882-2004.pdf

[8] The National Strategy for Using of Renewable Sources was approved by Government Decision 1535/2003 available at: http://leg-armonizata.minind.ro/leg_armonizata/energie/HG_1535_2003.pdf

[9] The National Renewable Energy Action Plan – available at (in Romanian) http://www.minind.ro/pnaer/PNAER_29%20iunie_2010_final_Alx.pdf English version is available at http://ec.europa.eu/energy/renewables/action_plan_en.htm (click on "Romania").

[10] Government Ordinance 22/2008 available at: http://www.dreptonline.ro/legislatie/og_eficienta_energetica_consumatori_finali_surse_regenerabile_energie_22_2008.php#

townscape. Public buildings and dwellings built between 1950 and 1990 are very poorly insulated and offer low thermal comfort, causing significant loss of energy. The key beneficiaries of the program are owners' associations. Thermal insulation can reduce maintenance costs for heating and hot water consumption and decrease heat loss and consumption. It can achieve up to 25% energy efficiency, while the heating bills are expected to drop by 40% during winter time. Moreover, in the summer, rehabilitated buildings can better keep the appropriate thermal comfort of the dwellings without additional costs for air conditioning. A guide regarding how the rehabilitation work should be done is available on the Ministry's website[11].

A few years later, **Government Ordinance 18/2009**[12] regarding the thermal rehabilitation of blocks of flats added more consistency to the program by specifying the minimum level of the thermal rehabilitation. The execution work is financially supported from Government's state budget (50%), the local budget (30%), and by owners' associations (20%). Since 2009 MDRAP provided funding equivalent to USD 190 million (RON 660 million) for the rehabilitation of 3,500 multi-story residential buildings in over 100 municipalities and cities. The law allows for the local city councils to grant **tax exemptions** on residential buildings for owners who have performed rehabilitation work from their own funds.

At the end of 2012, **Government Emergency Ordinance 63/2012**[13] brought some changes to the rehabilitation program coordinated by the MRDPA. According to new regulations, residential buildings within municipalities that have applied for funding through the Regional Operational Program (Priority Axis 1 Development of Growth Poles– Intervention Axis 1.2 Thermal rehabilitation of residential buildings) will not receive further support through the thermal rehabilitation multiannual program. However, the good news is that the program has been extended to houses that have been developed between 1950 and 1990. The new regulation also clears the way for local authorities to establish the so-called "thermal rehabilitation tax". This tax will be paid by buildings that did not have any financial contribution to the rehabilitation process.

Following the success of the rehabilitation program, the Government thought about reducing the public funding accessible for such projects, and loans with government guarantee were made available. According to **Emergency Ordinance 69/2010**[14] owners associations must have 10% down payment, while the rest is covered from a bank loan. The owners' associations pay back the loan from the savings obtained over the heating bills before the thermal insulation work is complete. This new program includes old buildings built between 1950 and 1990, those developed after 1990, and individual homes.

The **Directive 2010/31/EU on the energy performance of the buildings** requires[15] the Member States to adopt a methodology for calculating the energy performance of the buildings, that should include thermal characteristics, heating insulation, water supply, the air-conditioning installations, the built-in lighting installations, indoor climatic conditions, and not in the least, electricity produce by co-generation. The EU law is concerning both existing and new buildings. The law is exempting the historical buildings, worship facilities, temporary buildings, residential buildings intended for a limited annual time of use, and stand-alone buildings of which the surface area does not exceed 50 square meters. The main objective of the law is to have all new building close to nearly zero-energy by December 2020. Same criteria are applicable by December 31st, 2018 to new buildings occupied and owned by public authorities. Member States should come up with national plans that put

[11] The guide is available at: http://www.mdrt.ro/userfiles/constructii_ancheta_publica_contr429_contr411.pdf)

[12] Government Ordinance 18/2009 available at: http://www.mdrl.ro/_documente/lucrari_publice/reabilitare_termica/OUG_reabilitare.pdf Methodological regulations available at: http://www.mdrl.ro/_documente/lucrari_publice/reabilitare_termica/Norme.pdf

[13] Government Emergency Ordinance 63/2012 available at: http://www.mdrt.ro/dezvoltare-regionala/programul-operational-regional-2007-2013/-8748

[14] Emergency Ordinance 69/2010 approved by Law 76/2011 available at: http://www.dreptonline.ro/legislatie/oug_69_2010_reabilitarea_termica_cladirilor_locuit_finantare_credite_bancare_garantie_guvernamentala.php

[15] Directive 31/2010/EC available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010L0031:EN:NOT

into practice the definition of nearly zero-energy building, and the intermediate targets for improving the energy performance of new buildings by 2015. At the same time, the Member States must issue an energy performance certificates that should include the energy performance of the building along with recommendations for cost improvements. This certificate should be available when renting and selling a building/unit. The municipal buildings with a total floor area of over 500 square meters and buildings of the same size frequently visited by public, must display the energy performance certificate in a prominent place where this could be clearly visible. After July 9, 2015 the 500 square meters threshold will lower to 250 square meters.

As part of EU requirements, Romania adopted Law 372/2005 addressing the energy performance of residential buildings. An **energy performance certificate** is issued based on the final energy consumption of buildings and apartments. The country also transposed into national legislation EU Directive 2003/30 EC[16] on the promotion of the use of bio-fuels or other renewable fuels for transport. **Government Emergency Ordinance 1844/2005**[17] established a 2% share of renewable energy in the transport sector by the date of Romania's accession to EU (2007) and a 5.75% share by 2010.

The **Government Emergency Ordinance 70/2011**[18] establishes social protection measures for the cold season, helping low-income residents pay the heating bills. The Government is supporting people who use the district heating system, as well as heating systems using a different type of fuel, be it natural gas, wood, coal, etc. The financial aid range for single people and families with low income benefitting from aid from the state budget can range between 10 and 90%. Local city budget can also provide financial support between 7% and 63% of the total heating bill.

Sixty-one cities in Romania are signatories of the **Covenant of Mayors**, the mainstream European movement involving local and regional authorities voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories, as well as reducing CO_2 emissions by 20% by 2020. Participants to the Covenant must submit a **Sustainable Energy Action Plan (SEAP)** outlining actions they plan to undertake with regard to energy savings. 22 out of 61 cities have submitted their SEAP to Brussels, namely: Aiud, Sântana, Petrosani, Făgăraș, Zlatna, Moinesti, Arad, București (District 1), Baia Mare, Timișoara, Cugir, Satu Mare, Vaslui, Alba Iulia, Bistrița, Mizil, Slobozia, Brașov, Râmnicu Vâlcea, Avrig, and more recently Cluj-Napoca.

Energy Sector

At the end of 2012, Romania's installed capacity of electrical power plants was 18,481 MW, while the netto available power was 15,998 MW, according to Transelectrica.[19] The netto power provided was 11,424 MW, and domestic consumption accounted for 7,413 MW. In February 2013 the split of domestic consumption by types of energy production showed that the largest share is based on coal (33% - 2,593 MW), followed by hydro carbons (23.9% - 1,877 MW), hydro energy (24.8% - 1,948 MW), and nuclear (18.1% - 1,419 MW). Wind energy is almost nonexistent, with only 0.3% or 24 MW.

The electricity sector is unbundled, with several players in the field. There are quite a few companies in charge with production, a significant number of distributors, and a noteworthy number of suppliers. However, there is only one player responsible for energy transmission and who owns the entire transmission network, Transelectrica, a state-owned company. Energy production is divided into seven major producers, namely Complexul Energetic Oltenia,[20] Complexul Energetic Hunedoara,

[16] Directive 2003/30/EC available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:123:0042:0042:EN:PDF

[17] Government Emergency Ordinance 1844/2005 available at: http://ngo.ro/pipermail/mediu_ngo.ro/2006-February/004597.html

[18] Government Emergency Ordinance 70/2011 regarding social protection measures in the cold season.

[19] RET Plan - Period 2010-2014, and perspectives for 2019 http://www.transelectrica.ro/PDF/Planul%20de%20Perspectiva%20al%20RET%202010-2014-2019%2013dec.pdf

[20] Complexul Energetic Oltenia was established in 2012 after the merger of four large energetic companies, namely Societatea Nationala a Lignitului Oltenia Tg. Jiu, Complex Energetic Turceni, Complex Energetic Craiova, and Complex Energetic Rovinari.

Nuclear Electrica, CE Arad, SC Electrocentrale Deva, Hidroeletrica, and OMV Petrom. CEZ, ENEL Energie Muntenia, Enel Energie, E.ON, and Electrica Distributie (with its three branches, namely Electrica Distributie Transilvania Nord, Electrica Distribuție Transilvania Sud, and Electrica Distribuție Muntenia Nord) are the distribution companies. Energy distributors are by default energy suppliers. Accordingly, the main suppliers are Electrica Furnizare, CEZ, ENEL Energie (responsible for Dobrogea and Banat zones), ENEL Energie Muntenia, and E.ON Energie Romania. Of 177 energy suppliers registered in the country, only 20 companies are actually active.

The Romanian Energy Regulatory Authority (ANRE)[21] was established in 1999 and is the regulatory body in the field of electricity (including heat produced in co-generation) and natural gas. The Agency is dealing with licensing, issuing technical and commercial regulations, and protecting of the interests of consumers and investors. The agency regulates tariffs for energy and natural gas for domestic and non-domestic clients, approves the calculation methodology to set up tariffs and prices, and sets tariffs for captive consumers (those who cannot choose the energy provider). It also establishes tariffs for electricity companies, transmission and distribution systems and for activities associated with heat production through co-generation. **OPCOM** is the Romanian energy market operator established in 2000, as a joint stock company subsidiary of the Romanian Transmission and System Operator, Transelectrica. The company is providing the framework for the commercial trades' deployment on the wholesale electricity market; it exercises the role of Day-Ahead market operator and administrator of the Green Certificates, as well as of the greenhouses emissions certificates trading platform. **Green Certificate** is a mechanism promoting energy produced from renewable sources such as from hydro used in power plants with installed capacity up to 10 MW of wind, solar (photovoltaic), geothermal and natural gas associated, biomass, biogas, gas from the landfill waste fermentation and from fermentation of sediment from sewage treatment of used waters. Energy producers receive a Green Certificate for each MW of energy produced from renewable energy and sent to the national grid. The law is forcing suppliers to purchase a mandatory quota of green certificates from the total amount of electricity distributed to the end users. A number of certificates are annually available. The Green Certificate has unlimited validity, and it can be traded separately from the electricity associate through bilateral contracts or on the green certificates centralized market. The price varies from 27 EUR (to protect the producer) to 55 EUR (to protect the consumer). At the end of 2012, 300 Million Green Certificates were available in Romania for the period 2013-2019. The EU approved in July 2012 an additional distribution of 71.4 Million Certificates for greenhouse emissions for 2013-2019.

Recently, in June 2013, the Romanian government reviewed the compensation scheme granted to renewable energy producers, and cut off the number of green certificates, as a „temporary suspension" until March 2017 for hydro and solar/photovoltaic energy, and by January 2018 for wind energy[22]. The new provisions, which are effective July 1st, 2013, are amending the Law 220/2008 for promoting energy from renewable sources. The new law is cutting down the number of green certificates. For each 1 MWh produced, the new small hydro plants with an installed capacity of less or equal to 10 MW will receive one green certificate less, same for the wind energy plants. In case of solar energy facilities, the number of green certificates was cut down by two. In this way, the new small hydro plants would get 2 certificates instead of three, the solar plants would be awarded four certificates instead of six, while the wind facilities would receive one certificate instead of two.

Following the legislative elections in December 2012, the new structure of the Government includes a **Delegated Minister for Energy**, a new institution expected to add more consistency to the country's energy policies.

Liberalization of the natural gas and electricity markets

The Memorandum of Understanding agreed with the IMF, the World Bank, and the European Commission in March 2012 opens the market for

[21] More information on ANRE available at: http://www.anre.ro/

[22] More information available at: http://media.hotnews.ro/media_server1/document-2013-04-2-14540999-0-proiect-privind-suspendarea-schemei-sprijin.pdf

electricity and natural gas. The regulated price for electricity for domestic and non-domestic consumers will be gradually eliminated by 2017, while for natural gas the same principle will be applied by 2018.

The price increase for natural gas for non-domestic consumers (economic agents and industrial consumers) is going to be 35% for years 2013 and 2014 altogether. For domestic consumers, the price will go up by 10% in 2013, by another 10% in 2014, and by 12% each year from 2015 through 2018. Electricity prices will go up gradually, in parallel with the increasing of the quota of electricity traded in the free market. The price of electricity for *non-domestic* consumers went up already starting in September 2012, when the quota traded in the free market increased by 15%, with an additional 30% in January 2013. The elimination of regulated tariffs will be complete by January 2017. *Domestic* consumers will pay more starting July 2013. By the end of 2017 when the gradual elimination of regulated price will be concluded, domestic consumers will be able to choose their energy supplier. The supplier must introduce the "competitive market component" to the final bill, providing to the clients information that should help them choose the best offer, such as prices depending on voltage, tariffs for transport and distribution, payment methods and due days, and meter readings.

Background Cluj-Napoca

Cluj-Napoca, commonly known as Cluj, is the capital of the county with the same name located in the northwestern part of Romania. Geographically, the city is located in the northwestern part of the historical province of Transylvania, at almost equal distance from Bucharest, Budapest, and Belgrade. Cluj is situated at the intersection of Apuseni Mountains, the Transylvania Plain, and the Someș Plateau, on the banks of the Someșul Mic River. The city has a continental climate with hot summers and cold winters, influenced by proximity to the mountains.

Situated at the juncture of a few major national and international roads, with an international airport close by, Cluj has a good road and rail connection to București and major cities, as well as to Budapest. The city is an important hub in the European road network, located on three different European routes (E60, E81 and E576), and on a few other main national roads.

The municipal area is spread over a surface of 179.5 square kilometers, while population density is 1,722 inhabitants/square kilometer, a lower figure compared to other comparable cities in the country. There are 324,576 people residing in Cluj, half the population of Cluj County. Unlike most of the major cities in the country that lost people in the past decade, Cluj is among the few urban centers where the population registered actually a slightly increase since the 2002 census, by 2%. 16% of local residents (almost 50,000 people) have declared Hungarian as their mother tongue, which makes Cluj home to the second largest urban Hungarian minority after Târgu-Mureș.

The Metropolitan area accounts for 392,562 people and comprises, in addition to the City of Cluj, 17 communes: Aiton, Apahida, Banciu, Bonțida, Borșa, Căianu, Chinteni, Ciurila, Cojocna, Feleacu, Florești, Garbau, Gilău, Jucu, Petreștii de Jos, Tureni, and Vultureni. Over the past years, a small migration from urban to neighboring areas has been observed.

Main city square in Cluj-Napoca

Source: vedereturistica.ro

The number of people who moved to the metropolitan zone is greater than those who left the urban area, a fact that stands as proof for the region's social and economic stability. The Cluj Metropolitan Area is spread over 1,510 square kilometers, which accounts for almost a quarter of the surface area of the county (23%). The wider metropolitan area is home to a few natural parks and protected areas, including Botanical Garden Cluj, Fânețele Clujului Reservation, and Lacul Știucii Reservation.

Cluj is an important economic center, home to several local brands that have become famous in Europe, such as beauty care manufacturer Farmec, Ursus breweries, pharmaceutical company Terapia Ranbaxy, dairy producer Napolact, or Transilvania Bank. Cluj houses the headquarters and national offices for a number of European and international companies in the field of oil, construction, real-estate, and confectionaries that have poured into the city massive investments and have boosted the local economy. The economy predominantly relies on services, trade, and industry. The city is acknowledged as a hub for IT and the software sector. Over 90% of private companies in the wider metropolitan area are operating in Cluj. There are three industrial parks in the metropolitan area and a few more are to be developed. Florești and Apahida are the main communes in the region and they have attracted massive strategic investments from multi-national corporations. In the mid-2000s, Nokia, a large Finish telecommunications producer, invested over EUR 200 million to open a factory at Jucu, but the company closed down the facility in 2011. In the meantime, the factory was taken over by DeLonghi, an Italian appliance producer, who planned to start production by the end of 2012.

Local Energy Efficiency Laws

Efforts have been made by local authorities to link Cluj to various national programs aimed at reducing energy consumption and increasing efficiency with regard to energy supply. Actions have targeted all stakeholders including suppliers, distributors, and end users. After Bucharest, Cluj is the main recipient of the **rehabilitation program of old residential buildings** coordinated by the Ministry of Regional Development and Public Administration. From 2009 to 2011, Cluj received RON 57 Million for the thermal rehabilitation of approximately 5,000 apartments from 273 buildings built between 1950 and 1990. Initially, the program was received with some reticence, as most people complained about the burden of co-sharing financing. Moreover, they were reluctant to pay for building improvements as no one was interested in joining a brand new program that involved financial support from their part. Although the process was slow in the beginning, eventually quite a number of owners' associations became interested in improving the thermal performances of their buildings, a process that would not only reduce heating consumption and heating bills, but also change the aesthetic aspect of their buildings.

Thermally insulated buildings in Cluj-Napoca

If in 2009 local authorities had difficulties finding beneficiaries, by 2010 they had some issues in honoring their requests, as waiting lists grew longer by the day. Many household associations gave up waiting for public funding and moved to start similar projects with their own funds. By the summer of 2011, almost 25% of the 83,779 apartments in the city were thermally rehabilitated, out of which only 4,848 benefitted from public assistance. This public initiative had strong local impact and generated a

fast response from the private sector, as it catalyzed approximately $60 million in private local investment.

The city is also taking part in the **thermal rehabilitation of residential buildings program with government guaranteed loans.** The municipality is providing support to household associations to submit at no charge the design papers that have been prepared with financial support from the local budget[23]. Starting in 2013, the City Council is providing **tax breaks** for corporate owners of so-called **"green buildings."**[24] The term refers to buildings that have a high level of energy efficiency and hold an internationally recognized certificate (such as LEED, BREEAM, DGNB). Also, residents can benefit from 50% tax breaks if the building in which they live has been rated as "A class" in terms of energy efficiency.

In 2011, the Mayor of Cluj signed the Covenant of Mayors under which the city agreed to reduce energy consumption and emissions. Under the **Sustainable Energy Action Plan** (SEAP), a document prepared and submitted to Brussels at the end of 2012, the city government assumed responsibility to cut off energy consumption and greenhouse emissions by 20% by 2020, compared to 2011 levels,[25] and increase the share of renewable energy by 8%. The plan lays down 69 measures whose implementation requires EUR 180 million investments. According to the Cluj SEAP, the target sectors for improving energy efficiency are buildings - equipment/facility (municipal, residential, and tertiary buildings), public transport, local energy production from renewable energy, heating & cooling system, and public procurement to include green procurement guidelines.

Urban Growth and Energy Challenges in Cluj

While the TRACE tool does not directly address this issue, one of the most efficient ways of encouraging energy efficiency in cities is by promoting dense development patterns and compact urban expansion. This can be done by strategically using spatial planning tools. The less dense and the more scattered a city is, the larger its energy expenditure will be. Basically, without density public transportation is less viable and more people rely on private cars for commuting; commutes in private cars tend to be longer in sprawled areas and city streets tend to congested, with cars spending more time in traffic. Water and sewage networks have to cover a much wider area, requiring more energy for pumping and water delivery. Garbage trucks have to run longer collection routes and spend more time delivering waste to disposal sites. The street lighting network has to cover a greater number of streets and consume more energy. A district heating network becomes less viable in areas with small density because of the high production and distribution costs, and because heat losses are larger when the distribution network is bigger.

Of course, as a study of the World Bank has shown, the large majority of cities worldwide (whether they are located in the developed or the developing world), are losing density. As more people come to rely on cars, they are also more willing to move further away from city centers. With an increase in expandable incomes, they can also afford larger homes.

Local authorities are not powerless though in addressing those challenges. They have a number of tools they can use to ensure that the loss in density is not too pronounced, and to ensure that the city expands in an organized, compact, and sustainable fashion. Unfortunately, such tools were not skillfully used in recent years in Cluj.

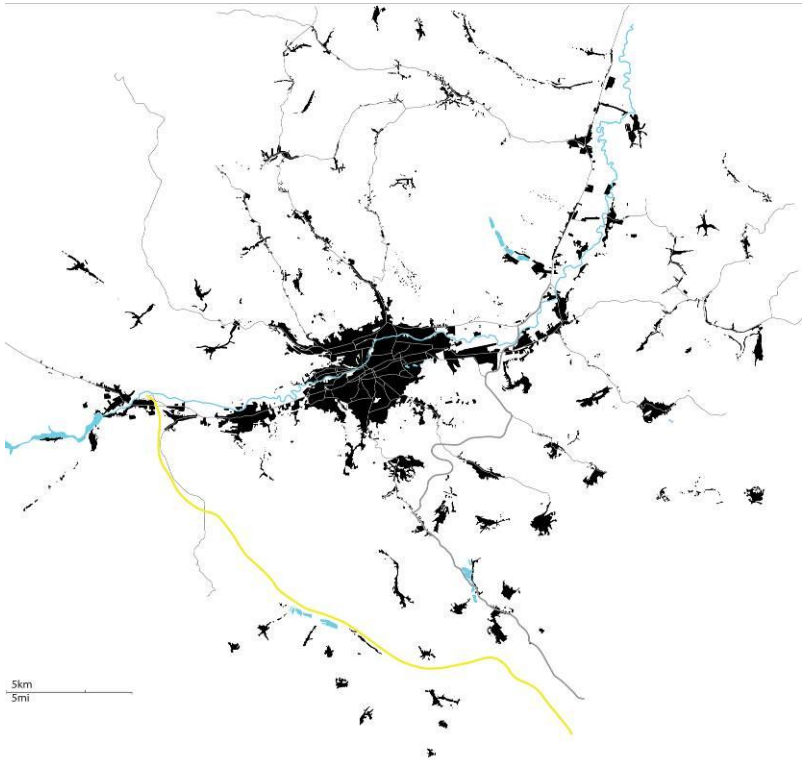
As the two figures below show, Cluj's mass has expanded significantly along the East-West axis, although overall it remains fairly dense in the central areas. The surrounding hills have prevented highly inefficient urban sprawl, to some extent, but also pushed the city's growth along its main horizontal axis, which is less optimal than a more controlled expansion in all directions. Under the current trends, people and businesses locating further and further away from downtown areas will reduce the city's energy efficiency and further strain the delivery of public services.

Smart policies in spatial and urban planning can help promote a more compact development pattern, which means lower costs for public transportation, water, energy, heat, and natural gas delivery, solid waste management, etc. By contrast, chaotic expansion on green-fields outside

[23] City Council decisions available at: http://www.primariaclujnapoca.ro/userfiles/files/hcl%20179.pdf
[24] Cluj Local Council Decisions available at: http://www.primariaclujnapoca.ro/userfiles/files/225.PDF
[25] SEAP Cluj report

the city will mean reduced density and higher expenditures for providing needed services to the areas' residents. As the number of commuters grows, so do congestion and pollution; already, the Florești-Cluj road experiences some of the worst traffic in the country. And if the quality of life is perceived to be decreasing, the city will be increasingly exposed to the risk of losing its most critical resource needed for continued economic growth – its people. This is why achieving sustainable development and building a highly efficient city are critical tasks for Cluj's local authorities.

Cluj's urban mass



Cluj-Napoca Sector Analysis

The following analysis and recommendations are primarily about how Cluj-Napoca can become a more sustainable city. Although the focus will stay on energy efficiency, the scope of the analysis goes beyond that. Energy is easy to quantify and to measure, and is a good binding element for thinking about a city in a comprehensive way. Almost everything that is done in a city requires some form of energy input. Thus, TRACE (Tool for Rapid Assessment of City Energy) is not just a tool for assessing potential energy and cost savings, but it is also an instrument that allows local authorities and policymakers to think about cities as a whole. Eventually, TRACE is a diagnostic tool that helps cities become more sustainable.

TRACE is focusing on six municipal service areas: urban transport (public transport and private transport), municipal buildings, water and wastewater, power and heat, street lighting, and solid waste. For each of these service areas, TRACE requires the collection of a number of indicators. These indicators are both energy related (e.g., the fuel consumption of the public transport fleet) and not (e.g., urban transport modal split). The indicators on energy help analyze energy and cost savings potential in each sector, while the non-energy indicators give a more clear picture of these public utility services, and help choose the most appropriate recommendations so that they go beyond just energy issues.

Energy and cost savings potential are assessed through a benchmarking process. Individual indicators selected for Cluj are compared with similar indicators from other cities included in the TRACE database. There are few different ways to make this comparison. Cities can be compared based on level of development, climate, or population. Those cities that do better than Cluj on a particular indicator can become a benchmark that Cluj itself can aspire to. For example, if several cities have lower energy consumption per passenger kilometer in the public transport sector, it is an indicator that city government in Cluj could achieve energy savings in the 'Public Transport' sector (e.g., by modernizing the bus fleet, purchasing energy efficient rolling stock, etc.). The energy and cost savings potential is calculated for each of the six service areas. Subsequently, a priority list is drawn based on where the most significant cost savings could be achieved. This list is leading to a set of recommendations that are likely to have the biggest impact in terms of energy efficiency, for the lowest amount of effort and resources invested.

Preliminary on-site interviews and field visits have helped form a more accurate picture of sustainability, challenges, and opportunities in Cluj. The following sections include a brief analysis of each of the six sectors analyzed with TRACE, along with some salient findings.

District Heating

Hot water and thermal energy in the city are provided by Regia Autonomă de Termoficare Cluj (RATCJ), an autonomous public company in which Cluj-Napoca City Hall is the main shareholder. The Company has lost a considerable pool of customers in the past decade, from 84,000 households in the mid-2000s to only 34,000 today, as people switched to individual heating units. RATCJ is currently supplying heat and hot water to 1,518 Ownership Associations in residential buildings, with a total of 34,000 apartments (corresponding to 41% of the total number of apartments in the city[26]), catering to 90,000 people. 11,000 apartments are equipped with modern equipment, including meters, heat allocators, and thermostatic valves. The company is operating with 130 employees, down from 1,000 in the past.

The district heating network is made up of a thermal plant of 143 MW with 109 sub-plants and 300 boilers, and a co-generation plant. Heat is generated by both co-generation plants and thermal power stations. The system is split between neighborhood heating plants (at street level) where each facility is serving 20 to 40 residential buildings; and the primary network with 30 thermal small plants connected to residential buildings. Most of the 400 km of network were built in the 1960s and 1970s, and so far only 200 km have been rehabilitated. Although most of the 300 boilers are 25 years old, they are quite efficient.

The vertical water distribution system often creates inconveniences for residents in upper floors, who must wait longer to get hot water. Water intensity and temperature is monitored by a SCADA-type system. There was an attempt to replace conventional energy with

[26] SEAP Cluj report

energy produced from renewable sources, and several solar thermal facilities and heat pumps were installed in recent year. However, as of today, the share of renewable heat generation is less than 1%.

Over the course of time, the City Hall was concerned with the network rehabilitation and made noteworthy investments in the modernization of the system to address energy efficiency issues.

Thermal power plant

Source: RATCJ

From 1998 until today millions of Euros went to the modernization of sub-plants, network rehabilitation, and modern equipment. With EUR 20 million loans from the European Investment Bank, RATCJ managed to upgrade the network and neighborhood heating, and replace manual operation with an automated one. The company used its own resources to replace 55% of the network, including 14 pipelines and five boilers, and install 5,000 connection meters across the city.

RATCJ benefitted from support from the Romanian Agency for Energy Efficiency to change boilers burners and install heat allocators for monitoring heat consumption in residential buildings. RATCJ received little money under the District Heating 2006-2015 program aimed at improving the district heating network. Since 1998 RATCJ is operating a combined heat and power (CHP) system, through Colonia Cluj-Napoca Energie, a joint-venture established in partnership with two German companies, Rhein Energie AG, and E.ON Ruhrgas International AG, respectively. Today 10% of heat is co-generated, from one large plant and two-decentralized facilities. The main co-generation facility is providing heat and electricity to 11,000 apartments and a few education facilities in the Gheorgheni neighborhood.

Co-generation plant

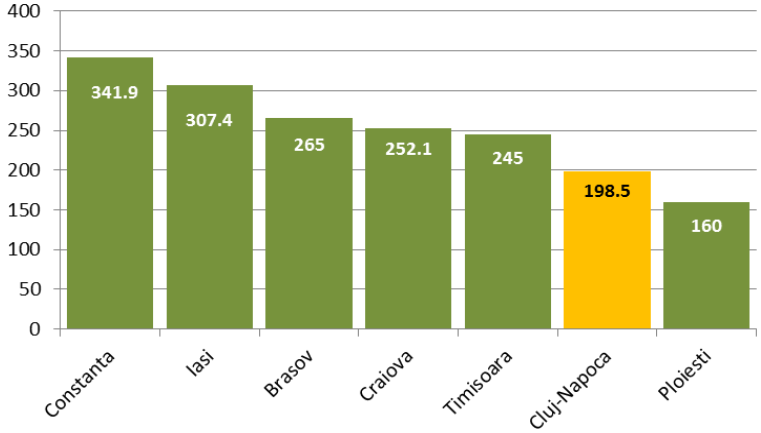
With a very high efficiency rate of 84%, the plant operates with four natural gas-based water boilers of 8 MW, 14 MW, 16MW, and 24MW - a total installed capacity of 62 MW. The installed capacity for electricity in co-generation is 4.5 MW, with three turbines of 1.5 MW each. Most of the electricity produced is sent to the national network and so Green Certificates are earned. The power generation cost is 0.04 EUR/kWh. The plant is producing 40.2 GWh of heat and 37.5 GWh of electricity for which it uses 9 million cubic meters of natural gas. The system is very efficient as it operates based on heat demand. In the cold season, from October through August, all four boilers operate, while in the summer only two of them are in use.

The tariffs for heat vary depending on the type of customer. As of 2012, the full price for heat was 350 RON/Gcal, but the population paid only RON 198.5 per Gcal including VAT. The difference from RON 350 to RON 198.5 is subsidized by the City Hall.

Old radiator

Source: ftr.ro

Heat Tariff – RON per Gcal



Source: ANRSC

Each year the municipality pays around EUR 15 million in heat subsidies, which is about 5% of the city budget, a figure that puts a big burden on city finances. Economic agents pay more, RON 307.8/Gcal including VAT, while public institutions pay between RON 255.4/Gcal and RON 287.2/Gcal. In 2012 RATCJ sold a total of 260,000 Gcal[27]; 95% is catered to domestic consumers who live in old, communist-type neighborhoods built in the 1960s.

One of the main reasons for which RATCJ has lost so much of its customer base has to do with how it charged them in the past. More specifically, households were charged not what they actually consumed, but paid heating bills according to the size of their apartment, and paid hot water bills according to the number of people living in the apartment. This was perceived by many as unjust, as they had to pay relatively high bills even if they did not happen to be at home. To address this issue, RATCJ has started to introduce individual billing, allowing more and more customers to pay for what they actually consumed. The way this was done was through the introduction of heat meters for individual heating units, allowing people to control how much heat they received.

90% of the natural gas necessary to generate hot water is purchased from Petrom, the largest Romanian oil company and a natural gas producer. The gas pipe lines are directly linked to RATCJ, and have been so since 1962. In 2011, the total gas consumption of Cluj exceeded 278 million cubic meters, with private households responsible for 43.6% of consumption, and economic agents and public entities accounting for the rest.

District heating pipeline

Source: Napoca News

[27] 1 Gcal = 1.16 MWh

Of total consumption, 43 million cubic meters (431 GWh/a) were used for supplying heat via the district heating network. Three quarters of the operating budget is for fuel expenses, 15% for maintenance, 8% for electricity, and 5% for salaries.

Like most district heating companies in Romania, the main culprit for losses is the leakage in the transmission and distribution networks. Losses accounted for 27.4 % for the period 2011-2012 (35% on transport - primary network, and 20% on distribution - secondary network). Part of the loss is incorporated in the final price paid by customers and in the subsidies borne by the local government.

It is not a secret that the local district heating company has been in a tight corner in recent years, dealing with several challenges from reducing heat consumption and loss of clients to lack of funds for rehabilitation work. The main problem of the district heating system is the massive loss of its customer base, and thus, diminishing heat production. In the past two decade the company lost 50,000 customers, as people disconnected from the district heating system and switched to micro-heating units. This had a great impact on heat production.

According to the Cluj Integrated Development Plan, the amount of thermal energy distributed between 1996 and 2006 dwindled by 50%, from 1.2 million Gcal to a little over 600,000 Gcal. Currently, the amount of heat sold is even lower, only 260,000 Gcal. The decline in the number of clients has several reasons. Following the drop in natural gas prices as early as 2000s, many customers, fed up with paying high bills to RATCJ, saw in this a good opportunity to switch from a centralized system with several inconveniences to an individual, self-controlled one. Basically, instead of paying for the losses in the system, and the over-consumption of other, people decided to only pay for what they actually consumed.

At that time, Hungary restricted the micro-heating units on its territory and so a large number of second-hand gas-based micro-heating units poured into Romania at very reasonable prices. Not in the least, people wanted to feel independent and break away from any constraints and restrictions that would remind them of the old communist regime, and they did not find attractive the centralized system, in any of its forms. Small, tiny chimneys protruding from the outer walls of kitchens in old communist buildings speak for themselves about how popular micro-heating units have become in the city. But in spite of being pretty successful among residents, these units are criticized for lack of appropriately enforced regulations and for posing serious environmental concerns.

However, the poor quality of the network and the lack of funds available for rehabilitation of obsolete pipelines, as well as poor quality services, are additional explanations for why district heating is not appealing to people. RATCJ is not eligible to apply for EU funds that could help improve and revive the network because of its double role as heat producer and distributor. Moreover, the EU does not perceive district heating as a public service, because in most European countries heat and hot water is provided by privately held companies. This could explain, perhaps, why the EU has been so reluctant in financing such programs so far.

Chimneys from individual micro-heating units, protruding through outer walls

RATCJ complains that disconnections from the system have been done in a very chaotic way, and most of the time related laws were not enforced. The fluctuation of clients is preventing RATCJ from developing a medium and long-term strategy. Some people who disconnected from the system reconsider their decision and want to reconnect; then again, after a while, they want to switch back to individual micro-units… and so on. RATCJ is arguing that it is almost impossible to have reliable estimates of its

number of clients and build a strategy accordingly. For their part, local authorities avoid making a decision pertaining to substantial rehabilitation work because of the inconveniences that such projects cause to the city. This would require digging up the streets, which may disrupt transportation and commuting for months or even years. The national Government is equally unsupportive of the centralized heating system. Lack of a coherent policy at the national level and lack of support for substantial investments are adding up to the deterioration of the system, raising serious questions about its sustainability in the medium-to-long term.

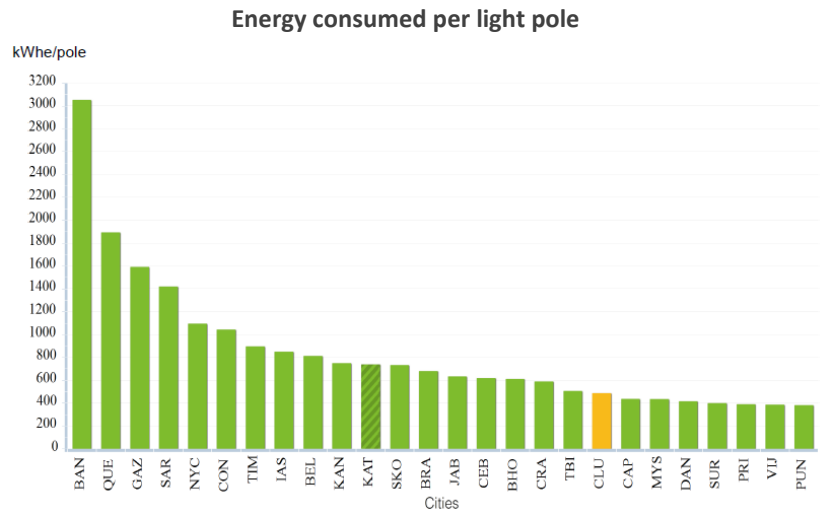
Street Lighting

The street lighting system in Cluj-Napoca has continuously expanded in recent years to cover new streets, old streets that had not been covered previously, as well as parking lots in neighborhoods and uncovered spaces in-between residential buildings. All 403 km of streets in the city are lit.

The expansion process resulted in the installation of thousands of modern lighting poles. For instance, 2,159 new lighting poles were installed in 2011 only, while 561 lighting systems were replaced during the same year. Rehabilitation and modernization of the city public lighting system was carried on the following year, when 11.5 kilometers of lighting network were modernized, including replacement of 650 light poles.[28] Overall, street lighting in the city is relying on 18,000 light poles. Since 2007, City Hall spent RON 66 million for the modernization of the system. Most of rehabilitation and modernization work has been done mainly from the city budget and with some support from the National Agency for Energy Conservation (ARCE).

The city is doing pretty good in terms of energy consumption for the street lighting. The annual electricity consumption per lighting pole in 2012 (487 kWh) put Cluj city at the lower range in the TRACE data base, comparable to cities like Sarajevo, Belgrade, or Tbilisi. In 2012, USD 1.4 million from the city budget were spent to cover the street lighting expenditures.

The management of the street lighting system is done by the private sector. Siemens Austria, through two of its energy saving companies, Siemens Elin Austria and Siemens Gebäudemanagement & Services GmbH, is responsible for the street lighting infrastructure and maintenance work. In 2007, Siemens signed a EUR 12 million concession agreement for the street lighting system with City Hall Cluj for a period of 15 years[29]. The municipality is paying annually 800,000 EUR to Siemens; in exchange, the company is taking care of the modernization and expansion of the system by delivering services, installing equipment, and performing maintenance work on the public lighting infrastructure.



[28] Information on public lighting available at: http://www.primariaclujnapoca.ro/userfiles/files/iluminat%20public%202012.pdf; http://www.primariaclujnapoca.ro/userfiles/files/Extindere%20iluminat%202011.pdf

[29] Siemens press release available at : https://www.cee.siemens.com/web/ro/ro/corporate/portal/Presa/canalstiri/Pages/siemens_austria_modernizeaza_iluminatul_public_al_municipiului_cluj-napoca.aspx

The company hopes that through modernization work, 30% energy saving can be achieved annually, a figure that would help significantly reduce operational costs. Initially, the modernization process focused more on the downtown area, but subsequently the attention shifted to other neighborhoods.

All inefficient mercury light bulbs have been replaced with more energy efficient sodium-vapor light bulbs. Currently, 99% of the street lighting functions with sodium-vapor bulbs with an output ranging from 75 Watt to 150 Watt. Street lighting consumption for 2012 was 8.7 million kWh, which would account for 487 kWh for each of the existing 18,000 lighting poles in the city. This figure places Cluj in the lower side of the TRACE database compared to cities with similar climate. At the same time, Cluj's performance is the best among all seven growth poles in the country. It is The Electricity expenditure cost the municipality almost USD 1.4 million, which is about 0.5% of the city budget. The street traffic lighting system is LED-based and has a very little consumption.

Despite expanding the street lighting network throughout the city, the system is dealing with several issues in this area. One of the key problems of the public lighting in the city is the ownership of the land on which the light poles have to be installed. Parts of new streets that are currently being developed belong to private owners. As such, local authorities cannot intervene there, and it also does not make sense to use public money to light-up private spaces. In order to avoid such inconveniences in the future, the city government should rule that the responsibility of lighting private spaces should stay with the developers. Some of the light poles are owned by Electrica Distributie Transilvania Nord (the regional electricity distribution company). Electrica is also responsible for starting the street lighting system every night. Initially, they installed a light-sensitive system which would only start the light-bulbs when it was sufficiently dark outside.

However, this system often misfired, so local authorities decided to start the lighting from a central system – i.e., someone turns on the entire system when they decide it is sufficiently dark outside. The system does not allow adjusting light intensity based on how dark it is outside, or based on the time of the day (e.g., in the early hours, like 2 AM, there is no need to have as much light in the city as in the late afternoon).

Lighting pole with vapor sodium lamps

Not in the least, another challenge to the system is posed by the small number of staff within the City Hall responsible with public lighting. There are only few people dealing with this issue and even those are under-paid. The lack of personnel and investments makes it quite difficult to develop new projects and bring innovations to the system.

Municipal Buildings

Some of the buildings in Romania built before the World War II were never reinforced, while some of the buildings developed between 1945 until the 1977 earthquake did not follow the most optimal construction standards, nor did use appropriate construction materials.

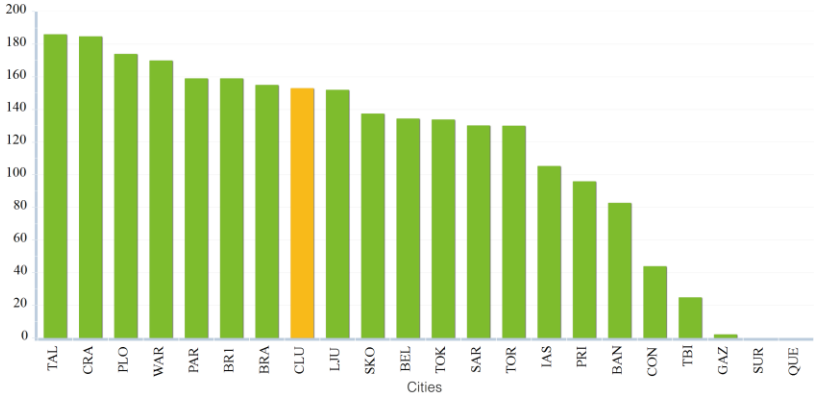
After the 1977 earthquake in which dozens of large buildings in București collapsed and thousands were seriously damaged, the building standards in the country have improved, as the government imposed tougher construction standards. Buildings built right after the earthquake until mid-2000s followed certain rules aimed at improving the safety and comfort of the buildings. For instance, the new regulation required that the thermal insulation of the walls in residential buildings would ensure an indoor temperature of 18 degrees Celsius. In the case of hospitals, the required indoor temperature was slightly higher, i.e., 21 degrees Celsius. The new buildings constructed after 2005 comply with new thermal insulation policies, thus raising the quality and comfort of thermal

insulation, as well as the energy efficiency. Starting 2005, from the planning phase only, all constructions require compliance with energy efficiency standards.

However, there are still buildings with thin wall insulation and quite poor-quality material and equipment. In this context, the lack of quality of structural elements that usually enclose a building, such as walls, roof tops, windows, leads to high heat consumption, which ultimately becomes a heavy burden for residents' pockets. Cluj also falls within this trend.

Local authorities in Cluj have 100 municipal buildings under their management with a total surface of over 450,000 square meters. Of these, 78 are education facilities, i.e., kindergartens, primary schools, and high-schools. One educational unit may include more than one building, such as sports hall, dining halls, dormitories, art and performance halls, building annexes, etc. The city's public property assets include two administrative buildings in the city center and eight neighborhood city halls, as each city neighborhood has its own city hall.

Municipal Buildings Heat Consumption - kWhth per square meter



The city government is also managing a municipal hospital and five public parking structures. In addition, there are a number of commercial spaces that are leased out, and for which the municipality is not paying heating and electricity bills.

The majority of municipal buildings are connected to the local district heating network, which is supplying heat and hot water. According to the City Hall, in 2011, the total electricity consumption in municipal buildings was 7,856,000 kWh, which would account for 17 kWh per square meter. This is a very small figure, which should normally stand for extremely efficient energy consumption. However, this figure is questionable compared to the given floor area of 456,000 square meters, but also to what municipal buildings from comparable cities would normally spend. In the same year, public buildings in Cluj-Napoca consumed 69,791,548 kWhth of fuel for heating.

This stands for 153 kWhth per square meter, a figure comparable to other cities in the TRACE database. The city is performing better than some of the growth poles in Romania, such as Craiova, Ploiești or Brașov but consumes more heat per square meter of municipal building, such as Iași or Constanța. According to the figures provided by municipality, electricity and heating for all municipal buildings cost a little over USD 3.7 million, which stands for 1.5 % of the annual city budget.

City Hall Cluj-Napoca

Source: primariaclujnapoca.ro

The city government has actively supported energy savings and encouraged buildings, public and private, to be pro-active and save energy in any of its forms. Quite a few steps have been taken in this respect, including funding thermal rehabilitation work and providing incentives to bringing down energy consumption. Most of improvements were implemented starting in 2002. A large majority of municipal buildings built

in the 1960s and 1970s have undergone rehabilitation work to improve energy efficiency. Thus, over 95% of schools are now equipped with thermopane (double-glazed glass) windows. Most of the schools that have their own boilers have had them replaced with high-efficiency ones (i.e., with a minimum efficiency of 92%). Also, in most buildings, they have installed energy efficient bulbs and have insulated roofs and basements.

As it was already mentioned before, the local city council has recently approved the "Green Building Law" that eliminates local taxes for corporate buildings that enforced green building standards, and are therefore called "green buildings", starting in fiscal year 2013. According to the law, "a green building" is a building that is highly efficient, and holds an internationally recognized certificate of LEED, BREEAM, and DGNB types. The law also has a provision giving residents a 50% tax break provided the building in which they live is rated as "A class building" in terms of energy efficiency.

Amera Tower, first "Green Building" in Cluj

Source: ameratower.ro

In order to benefit from these tax breaks, residents and corporate building owners must prove that the building meets the required criteria, and submit along with their application an energy performance "A class" certificate, an international certificate "Green building," and the conformity declaration issued by the Romanian Council for Green Buildings. A "Green Building" project was initiated by the municipality, which aims to install solar panels on buildings to help complement the thermal system. The program is yet to be approved by the local city council. To make the city more attractive, the municipality is developing a project called "Green City - Smart City" that allow people learn about buildings directly from their cell phones. One will simply take a picture with one's phone of the building and the history of the building will be displayed on the cell's screen.

Education facilities are a good example of how successful and useful building rehabilitation processes can be, and how they can make a difference in terms of energy efficiency. Many of the 14 public daycares operating in Cluj, serving altogether more than 1,000 children from age 0 to 3, have undergone rehabilitation work that helped significantly improve energy efficiency and, thus, reduced the heating bills. A 1,442 square meters five-story building built in the 1960s, Daycare Lizuca, is a good example in this respect. In 2012, the daycare underwent rehabilitation work worth RON 120,000 (approximately USD 37,000) from the city budget.

Daycare Lizuca

Walls were thermally insulated, new double-glazed windows replaced the old ones, one balcony was closed, and the old roof top was replaced. The daycare also got disconnected from the centralized heating system and switched to a natural gas-based, micro-heating system with a number of micro units installed on several floors. After the work was completed, the heating bills dropped by 25% in the following winter. If in 2009 the heating cost was 40 RON/square meter, in 2012 it dropped to 29.3 RON/square meter.

Now the building is paying only for natural gas consumption, which is measured in cubic meters. Other daycares that have undergone similar rehabilitation work and also switched to an individual heating system and accomplished comparable results or even better, managing to save up to 60% of heating bills.

New radiator and individual natural gas based unit at Daycare Lizuca

Table 2: Comparison heat consumption

Building	Square meter	2012 (RON/m^2/year)	2009 (RON/m^2/year)
Daycare 1	156	12.00	44.30
Daycare Lizuca	1,441	29.30	40.00
Daycare 3	330	34.00	83.00
Daycare 4	2,100	17.00	New building

It is quite obvious that thermal insulation combined with individual heating systems can bring good results in terms of energy consumption and expenditures. New buildings connected to individual micro-heating systems are also paying smaller bills. The local council is requiring all new kindergarten buildings to have green certificates.

But despite the city government's good work, much still remains to be done. Data collection on municipal buildings is scarce and often not reliable; it is not centralized, nor regularly monitored, and not strategically used to promote energy efficiency measures. The city government does not have an energy efficiency task unit that could take on such issues, better plan the steps the city should do to increase efficiency, and prioritize actions. Some simple measures also remain to be widely implemented – e.g., automatic lighting systems, which only turn on when someone is in the room. Such measures were already put in place in many apartment blocks. Some apartment blocks have systems that turn on all the lights in the stairwell for a couple of minutes, while others have motion-sensors which trigger a light switch for an individual light-bulb when someone is on that floor. Thus, the light turns on only on a particular floor, and only stays on for as long as the person is there.

Only a few heat thermostats allowing the heat level to be adjusted have been installed in some buildings that are branched to the central heating system. More of these should be installed. Not in the least, financial support with regard to energy efficiency in buildings is often hard to undertake, because funds are allocated from the central budget, based on the number of pupils in the educational facility. Thus, schools with a low number of students receive only limited funds, and in order to be able to undergo modernization work, they often have to rely on the City Hall to supplement the budget.

Power Sector

There are 34 power suppliers in Cluj-Napoca, but most of the electricity comes from Electrica Distribuție Transilvania Nord, one of key power suppliers in the country. The company is catering for six counties, including Cluj. 80% of Electrica's costumers are domestic clients living in residential buildings, households, and municipal buildings.

The company is supplying electricity for the street lighting and public utilities companies. In 2012, the estimated total power consumption within the municipal territory was 1,271,356,000 kWh in 2012, slightly up from 1,231,445,000 kWh in 2011. The losses amounted to 5.7%, equivalent to 84, 615,148 kWh. Electricity within the municipal territory is mainly generated by three gas-operated municipal cogeneration power plants (37.5 GWh/a). No electricity is generated from hydropower, biomass or wind renewable sources, and there are currently only few photovoltaic systems operating.

Electricity pillars and voltage meter

Source: electrica.ro; newsbv.ro

The price of electricity depends on consumption, time of day, type of electricity, level of voltage, and type of consumer. For domestic consumers the tariff may range from RON 0.1730 and RON 0.428 per kWh RON 0.3748 and RON 0.5757 per kWh for medium or low voltage. People with low income pay less, what is a called "social tariff." Starting in November 2005, the social tariff is applying only to domestic consumers with a monthly income less than or equal to the minimum wage. Non-domestic consumers pay more than domestic ones, anything between RON 0.15 per kWh to RON 0.8772 per kWh.

Romania is promoting renewable energy from various sources, including wind, solar, thermal, biomass, waves, hydrogen made of renewable sources, and electric energy produced in hydropower plants with a installed capacity less than 10 MW. As explained earlier, Green Certificates can be earned for each MW of renewable energy supplied to the national grid. In Romania, hydro-power has the largest share of renewable energy production, a quota that has varied in the past years from 26 to 30% of the gross domestic consumption of electricity.

The country's technical hydropower potential is harnessed to 36TWh/year, while the economic energetic potential is estimated at 23-25 TWh, with an installed capacity of 8,000 MW and a production potential of 1,870 GWh/year. Experts consider that solar energy is Romania's safest energy source. One square meter of horizontal surface can capture anything between 900 and 1,450 kWh of solar energy, depending on season.

Photovoltaic Park at Fântanele – Cogealac, Romania

Source: renews.biz

City authorities looked into opportunities to diversify the city's sources of energy, and came up with a plan of reconverting a social housing development plan into a solar energy project. In order to maximize the solar potential of the city, the City Hall entered into a partnership with a local branch of a US-based company, Green Energy Holding, to develop a photovoltaic park on 197.8 hectares located in Muncii Boulevard – Paşunea Someşeni area. However, although the project obtained all necessary permits, the construction of the photovoltaic facility has been delayed because of some misunderstanding between the private entities

involved in this project. Until the issues will be sorted out the project is put on hold.

Anyway, if the project will follow through, the investor would be able to use the municipality land for free for a period of 49 years, and has to put down the initial investment of 42 million EUR (including VAT). In exchange, the municipality should receive free electricity for street lighting for almost half a century, and some shares of the profit. Local Council Decision 274/2011 establishes that Green Energy Cluj should supply to Cluj municipality 30% of the energy produced in the photovoltaic park, but not less than 3,500 MWh/year, i.e., 170,000 MWh for 49 years, equivalent of 17,850,000 EUR without VAT, at a price of 105 EUR/MWh without VAT. At the same time, the municipality should receive 2% from the profit, including trading of green certificates, as well as 2% of the energy production, after reaching an installed capacity of 10 MW. The production cost for 1 MW is estimated at 191.5 EUR. After the project will be eventually launched, the total amount of energy to be distributed to municipality could reach 46,954 MWh over the next 15 years. The prognosis for the annual energy consumption is estimated at 12,000 MWh, which involves an operating cost of 2.29 million EUR per year. The total annual expenses to produce electricity for the municipality would amount to EUR 176,000. Overall, it is expected that the project should make EUR 5.4 million in annual revenues, of which EUR 4.8 million from the trading of green certificates.

Urban Transport

Private transport

As many other cities in Eastern Europe, traffic in Romania is a serious problem. The key factor responsible for this situation is the constant increase in private car ownership over the past two decades. Only few people had cars before the change of regime in 1989. Cars required long waiting lists, and strict driving rules were enforced at that time. For instance, cars were classified into “even and uneven numbered,” according to their license plates; one weekend only the even-numbered cars were allowed to drive, and next weekend the odd-numbered ones. During the transition period, all kinds of new and second-hand cars poured into the country. Roads became overcrowded with the large number of vehicles. Moreover, streets and parking lots built in the 70s and 80s were designed for a much smaller number of vehicles; today they cannot accommodate the millions of cars that are on Romania’s streets and country roads.

Cluj is not different from this picture. As of 2011, 73,096 private passenger cars were registered in the city, in addition to 4,747 mopeds, approximately 20,000 trucks, and 2,000 garbage trucks. Almost two-third of private vehicles runs on gas, and one-third uses diesel. Most vehicles are used cars, only 10% of the registered private vehicles are EURO 2 and EURO 3 compliant.

In fact, Cluj is known for representing a large second-hand car market. The proximity to the Western border and the easy access to neighboring countries make possible for people to bring in used and cheap cars from Hungary, Austria, or Germany. Private transport in Cluj city is using almost 6.5 million liters of diesel and petrol annually for which car owners must take out of their pockets more than USD 64 million. Comparing to data from TRACE database, including cities from Eastern Europe, Cluj is doing pretty well in terms of energy spent by vehicle per private car by passenger kilometer. It has in fact one of the lowest consumption of energy per passenger kilometer travelled. Nonetheless, there is room for improvement.

Traffic congestion in Cluj

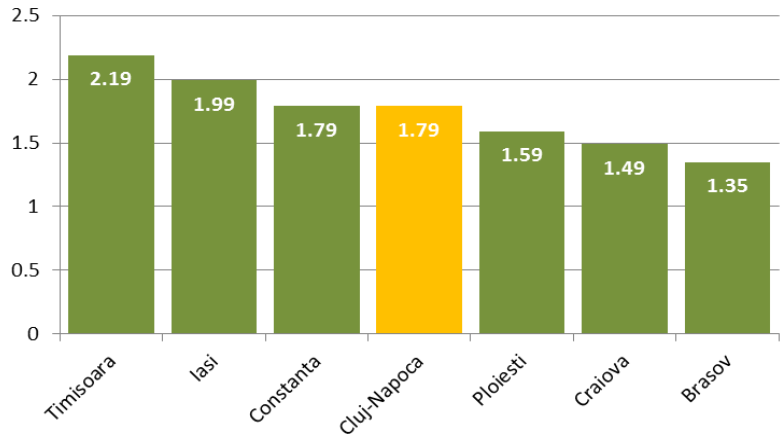
Source: monitorulcj.ro

Of the total number of private cars, over 50% of are over 10 years old and will reach their operating age limit soon, while only 5% cars are newer than three years. The national scrappage program (which offers people who bring old cars in a premium towards buying a new car) has gone a long way in helping renew the vehicle fleet in Romania. Cluj has benefited from this program too.

Beyond such national programs however, local authorities have also tried to implement energy efficiency measures of their own. For example, to obtain a taxi licenses, taxi operators have to use cars that are no older than 12 years. There are 2,536 taxis operating in Cluj now.

Taxis must obtain authorization from City Hall, which is also responsible for regulating the tariffs and colors of the cars. Taxis charge RON 1.79 per kilometer, a tariff comparable to other growth poles.

Taxi Tariffs – RON per km

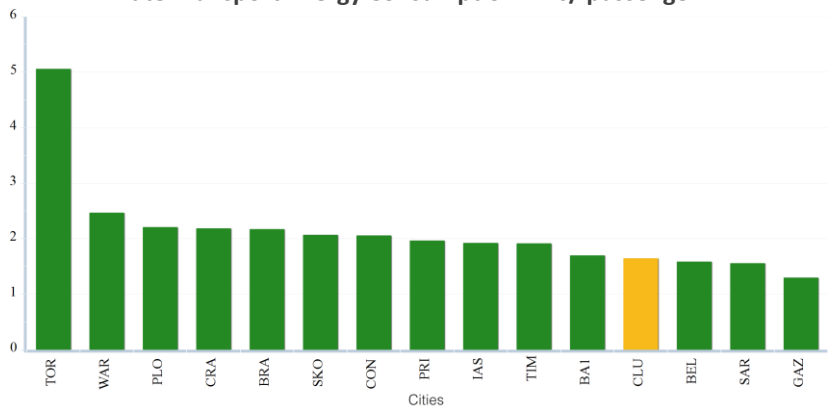


Source: Taxi companies from the growth poles

Nearly all taxies are owned by private companies, which most of the time tend to maximize the profit and, therefore, they have the cars out on the streets 24 hours/day, with 2-3 drivers on each car. Since the number of parking spots for taxis was designed for only 8 hours/operation per day, and the cars run 24/7 instead, taxis are adding up to the parking difficulties in the city.

The private transport energy consumption in Cluj is in the lower side of the TRACE database comparable to cities with similar climate. From this perspective, the city is the most energy efficient among all seven growth poles, with 1.649 MJ per passenger kilometer.

Private Transport Energy Consumption - MJ/ passenger km



Access corridors from one side of the city to another are split between 8 km of roads length from East to West, and another 7 km from South to North. The City Hall is in charge with monitoring and signaling the traffic. The monitoring management system is operating from the City Hall, where they receive information in real time from 265 cameras installed throughout the city.

The system helps ensure traffic safety, and identify bottlenecks or traffic congestions due to bad weather. For instance, city authorities can learn in real time about snowed-in roads and they can quickly deploy crews and equipment to clear off the streets. However, most of the time they are overwhelmed by the level of traffic congestion and bottlenecks especially during rush hour.

Since the mid-2000s, city authorities have been preoccupied to find alternative transportation means to decrease traffic congestion and reduce energy consumption and greenhouse emissions.

Traffic monitoring management system

The 2006 Development Strategy of Cluj-Napoca[30] was set to develop a sustainable and efficient transport system for the wider metropolitan area. A central point to this end was reducing transport by private cars and, instead, strongly encouraging non-pollutant transportation, like walking and cycling. Today the municipality is taking steps to this end by extending cycling in the city and to suburbs, by developing 18.8 kilometers of new bicycle lanes from Florești to Apahida via Cluj, in addition to the existing 40 km.

On the total length of 58 km of bike lanes, 50 self-service bicycle docking stations in the metropolitan area are to be built. Previously, the municipality put some bike racks on one public bus, but people did not really respond to that and did not use the system, signaling that some change in mentalities is still needed. The city has a pretty good pedestrian infrastructure. As of 2012, 80% of pedestrian footpaths were in pretty good shape.

Bike lane in Cluj

Source: ziare.com

Traffic has worsened in the years after the Revolution and poses serious a challenge to both city authorities and citizens. Cluj does not have a ring corridor, so all cars heading outskirts must get into the city and most of the times overflow into the downtown area. Parking is another serious problem. There are only 5 parking lots in the city; two of them are owned by the City Hall, with a few others under construction. However, these parking structures and not sufficient and they cannot accommodate the city's growing parking needs. That is why parking is often a nightmare for both drivers and pedestrians. Cars parked on narrow streets blocking one side of the street are common sights in the city. But many times cars are not only parked on the streets, but also on sidewalks, with pedestrians rightly frustrated to detour into the street around the cars or squeeze between cars and buildings in order to pass.

Like most cities in the country, Cluj is not doing too well when it comes to public utility related data. The city lacks information on the transport mode split. The local government has no precise idea of how many people ride the public transport, how many walk, and how many of

[30] Development Strategy for Cluj available at: http://www.primariaclujnapoca.ro/doc/strategie/Strategia_Municipiului_Cluj_Napoca.pdf

them commute using their own cars. City authority must document information on trips, understanding exactly how many people complete trips and commute in the city and by what means. Without documenting such information, it is almost impossible to prepare a plan that the city really needs in order to develop a sustainable transport network. At last, Cluj does not yet have Park and Ride stations where people from outside the city can drive their cars, park, and then take public transportation to get into the city. However, city authorities plan to take care of this matter in upcoming years, as the Park and Ride concept is included in the city's development strategy.

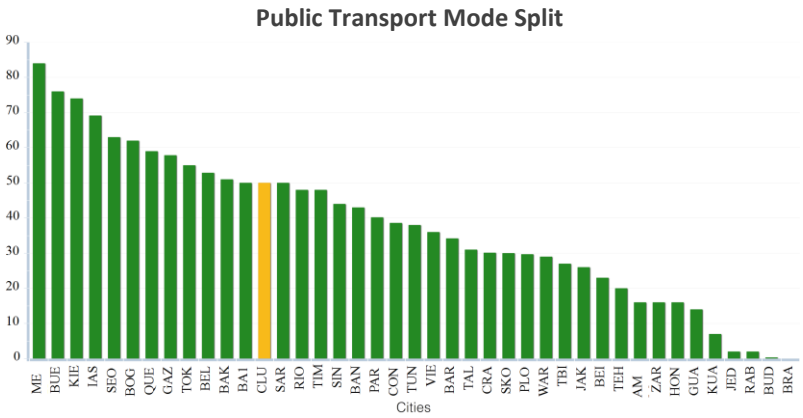
Public Transport

Cluj has a pretty well-developed public transport managed by Regia Autonomă de Transport Urban Cluj (RATUC), the local transport authority operating under the City Hall Cluj.

The public transport fleet comprises more than 340 vehicles, through which a good connection is provided throughout the city, from downtown to all neighborhoods and industrialized areas located in the city outskirts. For example, from 4:30 AM through midnight, buses and trams run every 5 minutes in the downtown area, and a little less frequently in the city outskirts. On average, 140,000 one-way tickets are sold daily. Half of the commuters in Cluj use public transport, a quite high figure comparable to the cities in the TRACE data base.

RATUC is operating with 192 buses, of which 171 standard size diesel, 21 long buses, and 8 small buses that can transport up to 15 people. Only 1% of the fleet, i.e. two buses, is new; 25% of buses are between 3 and 8 years old, while three quarters of the bus fleet goes beyond 8 years old. Only two buses are on EURO 4 engines, 45% are on gas emission European standards EURO 2 and EURO 3, while more than half the fleet is on non-EURO. Most of the city's 101 trolleybuses are pretty old; only 15 of them were modernized in recent years.

50% of the commuters rely on public transportation, a figure that places Cluj in the higher end of the TRACE database. It is the second highest percentage among the seven growth poles, after Iași.



In the past years, RATUC was preoccupied with finding means to reduce energy/fuel consumption, especially with regard to trams and trolleybuses, than with purchasing new rolling stock and renewing the fleet.

The city has 23.9 km of tram network, single track. Of the 34 trams operating in the city, few are modern and sophisticated. In 2012 the municipality purchased four new, modern, large trams for 6 million EUR from PESA, a Polish company. Each tram can carry 296 passengers and has an option to count passengers. These trams are twice as efficient as the older ones. In a short time they have became the "stars" of the public transports system in the city.

When many cities in Romania were giving up on their trams and instead focusing only on buses and trolleybuses, Cluj decided to keep the tram network and modernize the old tram lines. It was a strategic decision that later paid off. The city replaced and upgraded the tram lines connecting the railaway station to Mănăştur neighborhood with EU 30 million support from EU funds, and expanded the network to the periphery.

Table 3: Public Transport Fleet in Cluj

Type of vehicle	Number of vehicles	Length vehicle (meters)	Capacity	Number of routes	Length of routes (km)
Buses - big	21	18	152		
-standard	171	12	99	37	97.3
-small	8	9	15		
Trolleybuses	101			6	22
Trams	34			3	13.2
Total	**335**			**46**	**132.5**

Source: RATUC

New energy-efficient tram in Cluj

Source: monitorulcj.ro

The trams are now connecting the downtown to industrialized areas where multinational companies are located. Keeping trams alive and modernizing and upgrading the network turned out to be a good bet. Now tramlines are much quieter and cars more confortable, which makes them more attractive to people, and thus tram ridership went up.

More residents prefer trams nowadays, unlike in previous years when people were reluctant to ride trams because of noisy, uncomfortable, and unsafe cars. According to RATUC, 46% of public transport users ride buses, 31% of the use trolley buses, and a quarter go by trams. The public transport fare in Cluj-Napoca is similar to that of other growth poles in Romania, i.e., RON 2 per trip.

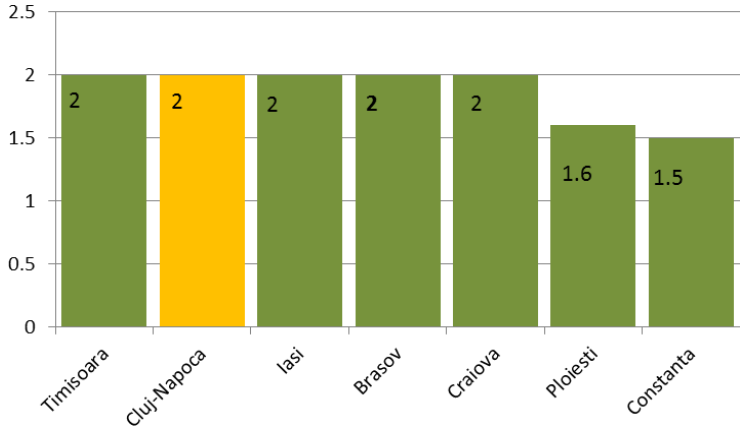
Trolleybus in Cluj

Fuel consumption went down by 50% following investments in more efficient rolling stock in recent years. However, the municipality needs 3.5 million liters of diesel to operate the bus fleet, which accounts for almost USD 5 million in 2012, i.e., 85% of the total USD 6.1 million annual budget. Electricity for trams and trolleybuses accounted for 14.2 GWh/a.

Fuel consumption monitoring is done quite often through monthly reports that can point to any fluctuations on the higher side. RATUC makes the initial price recommendation for the tariff, but the final decision is taken by the Local Council. As many other cities in Romania, there are ridership incentives for certain categories of citizens. Retired people and children under age of five ride for free, while students enjoy

discounted fares. The City Hall subsidizes public transporation tickets and monthly passes with more than EUR 5.5 million per year.

Public Transport Tariffs – RON/trip



Source: Local transport companies from the seven growth poles

Bus stop in Cluj

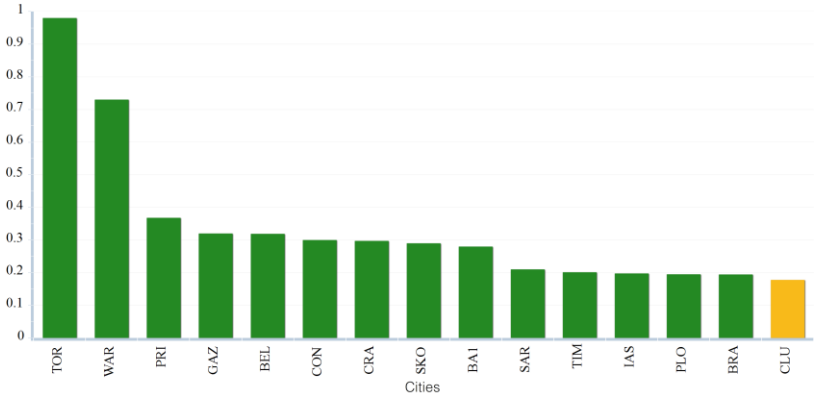
Source: monitorulcj.ro

An e-ticketing system is currently under implementation. Soon, passengers will be able to use one ticket for several buses within a certain amount of time. The new modern ticketing system will help with the counting of passengers. Currently, the data on ridership is collected ad-hoc, based on „visual observation," which is actually done very basically by counting people on buses and in stations at different times of day.

RATUC is well connected to EU-level thinking, which aims to completely take out diesel-based public transport from cities by 2050, and double ridership by 2025. To this end, the City is developing a project in partnership with the Swiss Government to purchase 12 electric buses that are three times more energy efficient that conventional ones. The project is not fully approved yet. If awarded (the winner will receive between 1 and 7.4 million Swiss Francs), then five buses will be purchased in 2013, and it will be a first of its kind for Romania.

With an energy consumption of 0.178 MJ per passenger kilometer, the public transport in Cluj is the most efficient among comparable cities in the TRACE database with similar climate. It is also the most efficient among the seven growth poles in Romania.

Public Transport Energy Intensity - MJ /passenger kilometer



A few years ago, some students from the Technical University of Cluj-Napoca in cooperation with the Local Transport Authority, tried to find efficient non-diesel means of transportation. They came up with an original project in which new buses were equipped to run entirely on cooking /rapeseed oil. It was expected that the use of cooking oil would

diminish pollution by one third. The project was perceived as an attempt to comply with Government Ordinance requiring that a minimum 2% of the auto fleet should run on clean fuel. The monthly consumption of rapeseed oil was projected for 2,000 liters per bus.

Despite being fairly well developed, the public transport system is facing several issues. Although the city is the lowest in terms of energy intensity per passenger kilometer comparable to cities with similar climate within the TRACE data base, improving energy efficiency is the local government's primary concern.

RATUC and the city government are both struggling to find the most effective and least costly means to reduce fuel consumption and make the system become more efficient. However, authorities complain that old vehicles are not helping too much in this respect, and thus they need to replace the old fleet. Overall, 50% of the buses and trams have almost reached their life cycle and need to be replaced in the immediate future.

The company is even thinking of developing mini photovoltaic parks on land owned by RATUC, such as parking lots, to supply electricity for trams and trolleybuses. Another problem in connection to fleet modernization has to do with to the company's inability of applying for EU funds directly to purchase new rolling stock. Unlike Poland and Hungary, where public trasport authorities were able to access EU funds to buy new vehicles, Romania was not eligible for such expenses. According to EU regulations, aautonomous public service companies ("regii autonome") in Romania, like RATUC, are not eligible for EU structural funds. This inconvenience slowed down any investments that the municipality had in mind to modernize its public transport fleet. The actual city budget cannot meet the company's needs in this regard, and alternative funding sources must be identified.

Not in the least, traffic congestion is a problem for the city government. Because streets are quite narrow, there are only 2-3 kilometers of dedicated lanes for public transportation, therefore, all public and private vehicles crowd already busy streets. Moreover, traffic lights do not grant better access and mobility to public transportation vehicles. A lot of fuel is wasted while waiting at stop lights, particularly during rush hour traffic. In peak hours, buses get stuck in traffic in certain areas of the city.

Water Sector

Potable Water

The water sector in Cluj is well managed. Apa Someş is the water provider for Cluj and Sălaj counties, including the City of Cluj. Overall, the company is catering potable water to 400,000 people, including 4,000 residential buildings and 40,000 small households. The company sits under Cluj County Council who has 99% of shares. 1% of the shares are divided between cities in Cluj and Sălaj counties to which the company is catering water, except for Cluj-Napoca.

Primarily, the source of water comes from a nearby lake, Tarniţa, and from underground aquifers in Floreşti. The underground water is of good quality, it does not require treatment except for chlorination, so there is no need for energy consumption in this regard. Potable water is pumped gravitationally from 30 pressure points located in Cluj into a number of reservoirs. All water connections and pipes are connected to water meters. Part of the network of 600 km of pipes serving the entire county is old; some pipes are even 100 years or older. 400 km of the potable water network were modernized and upgraded with support from the Municipal Utilities Development Program II (MUDP). The rehabilitation process continued in the last couple of years with support from EU funds, and water pumps in the distribution network were replaced with energy efficient ones.

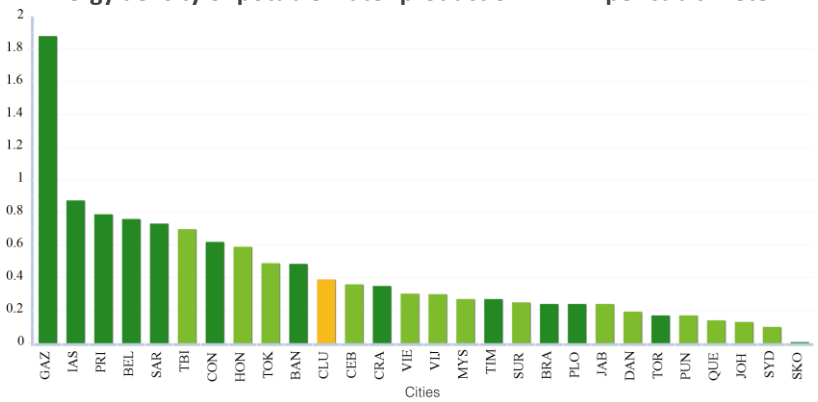
SCADA system water monitoring

Water monitoring is done through a new SCADA system that cost EUR 1.5 million. The system, designed based on the company's needs, is using Siemens high-tech equipment to monitor and record information through 300 Remote Terminal Units (RTUs) connected to all localities to which the company is catering water.

Any problems that may occur in the water system in any of these localities can be identified in real time by dispatchers sitting in the monitoring room. The new SCADA system is going to be integrated with the old one, which is currently keeping under control 30 pressure points located in Cluj city. In every city there is a dispatcher who can see in real time any activity at the water stations/pumps.

Annual water production for Cluj is approximately 40,000,000 cubic meters for which 15,000,000 kWh of electricity is used. The energy expenditure accounts for a third of the budget. On average, approximately 0.3 kWh is necessary to produce one cubic meter of drinking water. This is close to the average of most cities in the TRACE data base. Cluj needs more electricity to treat one cubic meter of potable water than some of the growth poles in Romania, such as Ploiești, Brașov or Craiova, but less than Constanța or Iași.

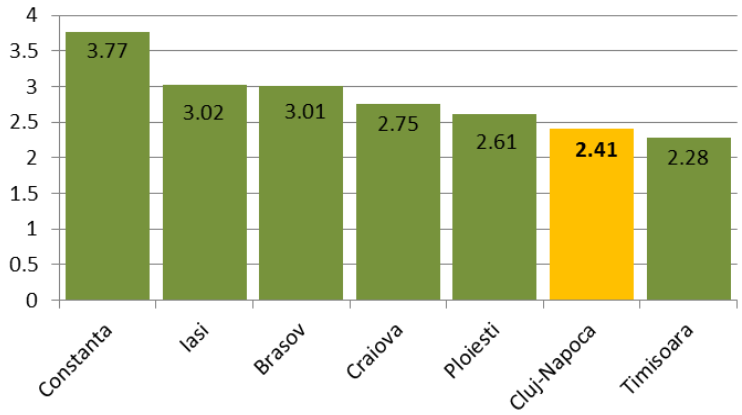
Energy density of potable water production – kWh per cubic meter



However, the efficiency of the system is low, as half of the water gets lost in the transmission and distribution network due to old, leaky pipes. Comparing to other cities in the data base, with its 48.8% losses Cluj is not doing too well in this respect. The main challenge to the system is the leakage in the distribution and transmission network due to obsolete pipelines. Despite continual upgrading of the network, the leakage rate is still high, although it dropped from 60% in early 2000s to 50% nowadays. The company is preoccupied to tackle the losses and has secured funding for additional projects aimed at reducing leakages to 25% by 2018.

As of the beginning of 2013, the water tariffs in Cluj are the second lowest among the seven growth poles, after Timișoara.

Water Tariff – RON /per cubic meter (without VAT)



source: ANRSC

In the medium to long run, the company and county authorities are aware that significant financial support is needed to further make investments aimed at reducing leakages and, thus, increase efficiency of the water system. According to a feasibility study, EUR 60 million is needed to develop a project supplying water for Slaj County from the centralized system of Cluj only. The rehabilitation process must target the remaining 200 km of the old transmission and distribution network.

Resources should be directed toward increasing efficiency of pumping stations by building three new reservoirs in areas where city is expanding, in addition to three new pumping stations soon-to-be installed. At the same time, one should have in mind some radical changes

and replace old, outdated equipment with new, modern equipment, such as devices for real-time monitoring, flow meters, pressure sensors, and electrical valves. Installation of additional 600 RTUs should allow water flow measurement at every working station/point.

Wastewater

Unlike other cities where separate operators deal with potable water and waste water, Apa Someș is also responsible for the waste water sector. The waste water is treated in a sewage treatment plant located east of Cluj, about 1 km from the airport, serving the city and five neighboring villages. The existing old plant is going to be replaced by the end of 2013 with a new one, at modern standards. The old plant was built in the 1970s and it was rehabilitated between 2000 and 2002.

The new water treatment plant, now under construction, is a EUR 35 million project funded from EU structural funds through the Environmental Operational Programme (about 75% of the money), and with support from County Council Cluj and Apa Someș, as well as small contributions from municipalities benefiting from waste water services. The waste water construction is a large project for which 80,000 cubic meters of concrete are used. The waste water treatment facility achieves a treatment ratio above the national average. However, compared to EU environmental standards, there still remains considerable need for action to reduce Phosphorus and Nitrogen from treated water before it is disposed into the river. It is expected that the new plant will be able to tackle the de-nitrification problem more efficiently. Perhaps the most noteworthy aspect about the new plant is the capacity to produce biogas and earn Green Certificates.

Biogas will be produced using two old and four new digesters of 4,000 cubic meters each, with a total installed capacity of 1.16 MW. The plant is designed to produce a maximum of 23 MW. The total potential electricity that could be generated from all digesters is as high as 8.12 GWh. Old digesters are under renovation, while news ones are still under construction and will be operational by the end of the year.

New wastewater treatment plant construction site

10 km of the total length of 35 km collection pipe network is new. Once the digesters will be operational and produce electricity, the waste water treatment facility will become self-reliant. The facility will be able to supply energy to the national grid for which it can earn Green Certificates. For each MW of electric power sold to energy suppliers, the plant will earn EUR 55. Moreover, the company is hopeful that the quality of sludge needed to run the digesters stays high so the plant will be able to generate approximately 80-90% of electricity needed to operate the facility.

Solid Waste

Like most cities in the country, solid waste management in Cluj is in the hands of the private sector. Waste collection is divided between two companies, Brantner-Vereș and Rosal, which have split the city into two areas of operation. The contracts signed with the two companies are valid until 2018, with the possibility of extending them for another 4 years (with the approval of the local council). Both operators collect municipal waste and dump it into the landfill in Pata-Rât, located about 15 km from the city center. The landfill is operated by Salprest, a company whose main shareholder is the owner of Brantner-Vereș.

The Environment Law approved in 1995 declared all solid waste landfills in the country as non-compliant with EU environmental standards. During negotiations for the EU membership, Romania assumed responsibility to close all non-compliant waste deposits, and set a road map to achieve this end. According to this calendar, Pata-Rât was supposed to be shut down in 2010. However, this did not happen, and the facility is still functioning until the new landfill construction is going to be completed. The new landfill is located next to the old one, and it is expected to be operational in the fall of 2013. The initial deadline was missed by more than half a year because the construction company who won the tender declared bankruptcy and so another tender had to be organized.

The new eco-framed landfill is integrated in the Solid Waste Master Plan and will cater for the entire Cluj County. The County Council is responsible for the big project and will have to organize a tender to choose the landfill's private operator. According to the national policy on solid waste and environmental issues,[31] solid waste management is handled at the county level, and so each county had to prepare a plan in this respect.

New landfill site

[31] See the National Plan for Solid Waste Management, and the National Strategy for Solid Waste Management, available here: http://www.mmediu.ro/protectia_mediului/strategii_planuri.htm

Implementation of the master plan is done with EU structural funds through the Environmental Operational Programme and contribution from the local budgets. 85% of the money necessary to execute the master plan for Cluj County has been already secured from EU funds, and the rest should be covered by municipalities. However, until the new landfill is operational, the municipality must sort out different issues regarding the landfill, including property litigations over the facility at Pata-Rât.

Tariffs for solid waste collection and management are usually adjusted based on inflation, but they have actually changed since the contracts with the two companies were signed. As of now, domestic clients pay EUR 17 /year for waste collection, transportation, dumping, and storage, of which EUR 1.8 is the dumping fee only. Five companies participated in the tender organized for waste collection by the City Hall a few years ago. Among cost considerations, firm selection also presupposed technical and environmental considerations – e.g., EURO 4 trucks and ability to do recycling at the source. Around 50% of the operating budget of solid waste companies goes toward fuel expenses. The fuel expenditure for waste collection, transportation, and dumping at the site is USD 124,000/year.

Garbage trucks in Cluj

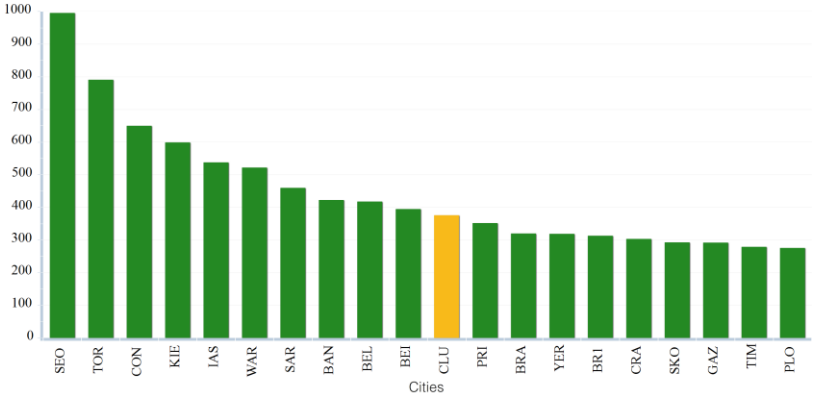
Source: ziuadeacj.relitatea.net

Both companies use 50-60 trucks to collect garbage in the city. On average, each truck makes two trips daily at the landfill to dump 25-30 cubic meters of waste for which 30 liters of diesel is used.

Pata-Rât landfill

Source: ziare.com

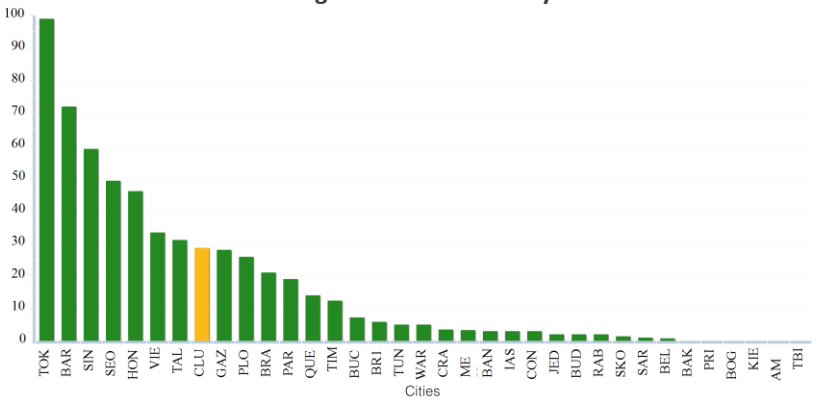
Solid waste per capita – kg/per capita



Cluj city is generating 375 kg of solid waste per capita, a figure just below Romania's average of 380 kg per capita. Romania is generating less solid waste compared to most countries in the EU, where some of them can reach as high as 800 kg/per capita. The figure for Cluj is higher than for Craiova, Ploiești or Timișoara, but it is almost twice less than in Constanța. Solid waste generation per capita in Cluj is lower than in București and other neighboring European cities like Skopje, Sarajevo, Belgrade, and also lower than in major cities like Warsaw or Kiev.

City authorities have invested aggressively in recycling in recent years and they hope to continually build up the system. Waste is sorted both at the source and at the dump site. There is a sorting facility at the dump site, and informal workers also collect a lot of recyclables. Currently, one third of residential buildings have a selective collection system through which they can separate organic waste from paper, glass, and plastic.

Percentage of solid waste recycled



People deposit recyclable waste in containers of different colors, which are available in front of their buildings or households. Despite of local authorities complaining that some of these containers were stolen, selective collection has been pretty successful so far. This explains why the city is doing quite well and has 28% rate of recycled waste, performing much better than cities with a similar Human Development Index, like Warsaw, Bratislava, Budapest, or București. In this way, the city is exceeding EU regulations requiring that at least 15% of waste be recycled. Romania has agreed with the EU to achieve a target of 60% on recycling packaging waste by 2013, otherwise the country may be penalized

severely. By 2020, the country has to be able to recycle 50% of the total waste collected. With a figure close to Ploiești, Cluj has the best performance among all growth poles in Romania. For example, the percentage of recycled waste in Cluj is 8 times higher than in Iași, Constanța, or Craiova.

Local authorities encourage selective collection, and incentives are given to those who separate organic garbage from recyclable waste. The Local Council sets the tariffs for waste collections, and they adjust them based on whether recycling is done at the collection point. For example, people who do selective collection pay RON 5/person/month, including VAT, against RON 6.25/person/month for those who do not separate the waste.

Recycling is a profitable activity. Standard rates for different types of recyclables are ranging from RON 700/ton for mixed colored plastic bottles (PET) and EUR 90 per ton of carton. (More details about tariffs for recycled waste in the table below). The bottles are usually sold to companies in Romania, while the carton collected in Cluj is sold to a company in Austria. In 2012, the selling of paper and plastic went quite well and was profitable. The tipping fee or the charge levied upon a given quantity of waste received at the waste processing facility at the dumping site is 18 RON/cubic meter.

Table 4: Tariffs for recycled waste

Type of recyclable waste	Tariff
Transparent PET bottles	RON 1,900/ton
Colored PET bottles	RON 1,600/ton
Mixed transparent and colored PET bottles	RON 700/ton
Carton	EUR 90/ton
Colorless foil	RON 1,200 /ton
Colored foil (plastic bags)	EUR 500 /ton

Source: Vereș - Brantner

The new landfill is designed to capture biogas. After the landfill will be operational, it is expected that the facility will be able to produce energy. Almost 50% of the waste collected is biodegradable waste, which should be a good amount of fuel to capture biogas.

Energy Efficiency Recommendations

TRACE is a tool that allows the estimation of energy savings potential in different city service areas by benchmarking the performance of a city against other cities with similar characteristics, such as climate, population, or Human Development Index. For example, energy consumption per street light pole in Cluj was compared to similar consumption of other cities within the TRACE data base, considering the climate. The energy savings potential regarding the street lighting in the city was calculated using a method that factored in the cities that performed better than Cluj, and the degree to which these cities performed better. The more information is available in the TRACE database, the better results it can provide. Currently, TRACE has data on almost 100 cities, which generally allows for good comparisons.

The energy saving potential is also determined by another key factor, i.e., the level of local control. The more control local public authorities have over a particular service area, the higher the energy saving potential. In Cluj some public utility services are managed by the city itself, whereas some others stay with the private sector or they are regulated at the national level. Solid waste, including the landfill operation, is managed by the private sector. The water and waste water sectors are managed by authorities at the county level, and so the city of Cluj does not have any saying in this matter. The city has also a very little influence over the energy sector, as policies and regulations are decided by the Government at the national level. In addition, another service area where the local level of control was considered pretty low is “Private Vehicle”. In this sector the policies and decisions are taken by the Government, with limited scope for local involvement.

After the saving potential for each sector was calculated, TRACE performed a sector prioritization automatically, based on the amount of savings potential. The sectors with the largest energy savings potential in Cluj are “District Heating”, “Private Vehicles”, and “Public Transport”. Given that district heating is a sector where local authorities allocate significant subsidies every year, and given that people have continuously de-branched themselves from the system, efficiency gains from energy efficiency investments are unclear at this point. As such, we have not considered this sector as a top priority, although an upgrade of network piping could help reduce losses, would make the system more efficient, and would lower the need for public subsidies. The first sector with the highest potential energy efficiency gains is “Private Vehicles”, even if the level of local authority control in this sector is reduced. “Public Transport” is another important sector where the municipality has already invested in recent years, and where the level of local control is quite high. The third and fourth service sectors of importance with a good potential of energy savings that have been highlighted by TRACE are “Municipal Buildings” and “Street Lighting”, both under local municipality control. “Potable Water”, “Solid Waste Management”, and “Wastewater” have a relatively reduced energy savings potential – primarily because energy efficiency improvements have already been done in recent years or are on-going, and because the level of local authority control is small.

Sector prioritization

City Authority Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	District Heating	39.4	18,165,042	0.96	6,877,094
2	Public Transportation	35.3	6,142,572	0.85	1,847,947
3	Municipal Buildings	39.2	3,777,304	0.95	1,407,094
4	Street Lighting	38.3	1,389,965	0.80	426,666

City Wide Sector Ranking

Rank	Sector	REI%	Spending (US $)	CA Control	Score
1	Private Vehicles	23.4	64,266,522	0.30	4,511,777
2	Power	32.7	75,546,821	0.10	2,473,553
3	Potable Water	43.6	1,594,512	0.25	174,181
4	Solid Waste	21.7	1,245,600	0.40	108,196
5	Wastewater	50.7	692,546	0.25	87,872

All priorities identified by TRACE were discussed with local officials to select a number of energy efficiency priorities for the municipality. Overall, a number of 11 recommendations were selected by local authorities. These recommendations will be discussed in more detail in the next sections.

From the get-go it has to be mentioned that all recommendations made in this section should be seen as indicative, not as normative. While the TRACE tool enables a quick overview of key energy efficiency issues within a municipality, it does not provide an in-depth analysis of each sector. For example, in most studied cities, the sector with the highest energy savings potential was district heating. Obviously, achieving higher savings in this sector usually also entail high costs. These costs may outweigh potential benefits, and may not warrant investments in the sector. Also, if people continue to de-branch from the system, any investments done to rehabilitate the network may be nothing more than wasted money.

Similarly, urban transport recommendations should ideally have an urban mobility plan at their foundation (EBRD is in fact supposed to prepare mobility plans for all seven growth poles and Bucharest). The recommendations made in this report are general in nature and draw on a pre-defined list of proposed interventions in the TRACE tool. These recommendations should be viewed by local authorities as an indication of what could be done to improve their city's energy performance and reduce the city's energy bill. The decision to actually implement a recommendation or not should be done only after a comprehensive feasibility study is completed. For example, the development of a bike network may have the adverse effect of reducing the share of people who use public transport instead of reducing the number of people who commute by private vehicles.

Lastly, energy efficiency interventions should not be viewed or conceived in a vacuum. Often, energy efficiency interventions have benefits that cross sectors. For example, improving the public transport network, will not only encourage a more energy efficient commuting options, but it could also improve quality of life, help boost local economies, and enable poor and marginalized communities better access to opportunities. In the same vein, interventions that aim to improve the energy efficiency of a municipal building could be done in tandem with retrofits that make these buildings more resilient to disasters.

Urban Transport

Urban transportation is the sector with the highest potential for energy efficiency gains in Cluj, and one of the priority areas of intervention for local authorities. The municipality has already a number of forward thinking initiatives in this sector, such as the development and implementation of a traffic masterplan, the development of non-motorized infrastructure (pedestrian areas and bikle paths), development of neighborhood parking structures, and improvements of the public transport system. To a large extent, the recommendations of this report fall wihin the scope of what local authorities are undertaking. The sections below will discuss each recommendation in more detail.

Non-Motorized Transport

One of the top priorities for local authorities is to continue expanding non-motorized transportation in the city. Currently, approximately one-fifth of the commuters in Cluj use non-motorized transport, but the hope is that this figure will increase in the years to come. An efficient non-motorised transportation with zero fuel consumption and low infrastructure investments is good for the enviroment, it reduces pollution, improves air quality, and is good for people's health. An initial investment of USD 1,000,000 in non-motorized means of transportation over a two-year implementation period of time can lead to energy potential savings between 100,000 and 200,000 kWh annually.

Cluj is committed to carry on with the good work that it started in the late 2000s. A project of EUR 4 mililon (of which EUR 3 million in EU grants) to build almost 20 km of bike lanes accross the city and in the wider metropolitan area, connecting Cluj to Florești and Apahida, is in execution mode. A total of 58 km of bike lanes for the entire metropolitan area, with 50 self-service bicycle docking stations, of which 43 will be located in Cluj city, will be built. Unlike other European cities where bikes are rented based on a daily, weekly, or monthly subscription, in Cluj people will be able to rent out 500 bicicles for free, except for an initial fee that they have to pay to generate a user's ID, so that city authorities can keep track of bikes and prevent theft.

Bike-share programs proved to be very successful in other cities. Washington D.C. can testify to that. The capital city has the largest bike

sharing program in the United States. A very popular program among its residents, Capital Bikeshare provides more than 1,670 bikes dispersed across 180 locations throughout Washington, D.C. and two towns in the metropolitan area, Alexandria and Arlington.

Capital Bikeshare in Washington, D.C.

Source: brokelyn.com

With the installation of bike lanes, bike signaling, and the bike-share system, the US capital is today one of the most bike friendly cities in the country. People have the option of daily, monthly or yearly subscription. The first 30 minutes of any trip is free, while usage fees will apply for longer trips. The bike-sharing system is currently implemented in 165 cities in the world, with the largest operating in City of Hangzhou in China where 61,000 bicycles and 2,400 renting stations are available.

At the same time, it is reccommended that city managers of Cluj take a look into potential private public patnerships where the branding of bicycles and renting facilities can create revenues for the local budget. This model worked out very well in Paris, the home of the Velib, the second largest bike-sharing program in the world, encompassing 20,000 bikes and 1,450 docking stations. The city launched a private partnership between the municipality and a major advertising company. The company is paying operating costs plus rights to advertising space to the City, and funds the operation from advertising revenues.

The development of pedestrian networks is another important aspect that the city government has been very pro-active about. Although local authorities in Cluj have invested significantly in improving pedestrian infrastructure in the city (Piaţa Muzeului is a well known success story), there is need for more pedestrian footpaths. And indeed, the municipality is interested in expanding the network of pedestrian areas (e.g., closing down the Mihail Kogălniceanu street, in front of the main building of Babeș-Bolyai University – see rendering below), and improving some of the existent pedestrian paths (e.g., in and around the Cetățuia area).

Piața Muzeului, before (left) and after (right) pedestriazation

Source: http://arhitectura-1906.ro/2011/10/planwerk/

Cities in Europe, like Oxford and Ghent, developed pedestrian networks by closing temporarily or permanently the streets to vehicles, a measure that enabled good opportunities for street markets and related initiatives. Pedestrian areas not only make the city more walking-friendly, but they also increase pedestrian traffic in commercial areas, they help spur business development, and they are one of the key instruments for efficient urban regeneration projects.

All measures must be accompanied by targets that should indicate the level of expected progress over a given timeline, together with a simple but effective monitoring plan. Monitoring should have in mind, among other things, performance indicators, means of

measurement and validating measuring processes, schedule for measurement activity, and means of auditing performance.

Plans to turn Mihail Kogălniceanu Street into a pedestrian area

Source: stiridecluj.ro

City authorities could perform surveys of the number of bicycles in circulation by using traffic counters on roads and cycle lanes, determine the non-motorized transport mode, look at the number of new business created and the increase in firm revenues along and around pedestrian areas, as well as km of dedicated cycle and walking infrastructure.

Public Transport Development

Another important recommendation that came out of TRACE and discussions with local authorities are improvements and expansion of public transport system. As explained before, public transport in Cluj is quite well developed and relatively energy efficient. It is well-known that public transport has lower emissions per capita than private cars, and a great potential to provide an equitable transport network. An efficient public transport can tackle three problems at once: reduce the number of private cars in circulation, reduce energy consumption, and improve air quality.

In recent years, the city made investments in purchasing more modern and efficient rolling stock. Efforts should continue to this end, as to further improve the system to increase its accessibility and use and, most importantly, expand it to the metropolitan area. Local authorities are planning to develop a public bus system outside the city in the immediate future by linking the urban area to the neighboring communes, starting with Apahida and Florești. Such plans are considered to be an immediate priority, given that explosive growth of suburban developments in Apahida and Florești was not followed by a concomitant development of alternative transport options to private cars. As such, congestion on the access ways in and out of the city is quite frequent during rush hour.

Congestion on Calea Florești during morning rush hour

Source: http://www.facebook.com/ILoveCluj

The plan is even more ambitious when it comes to the tram network. The city government is thinking of building a tram connection from the city to the airport. As a clean, efficient means of transportation, trams remain on the top of the list, and so the local government hopes that further modernization of the network can benefit from the upcoming programming of EU structural funds, as it did in the current period (2007-2013).

In addition, local authorities have applied for a program financed by the Swiss Government to introduce electric buses in the city. If the electric bus project will go through, then Cluj will be the first city in Romania to have such means of public transportation. This premiere will be a step ahead in the grand, more ambitious plan to employ electric transportation in the wider metropolitan area, and at the same time, will get the city closer to the EU level of thinking aiming to completely take diesel-based public transport out of cities by 2050.

Another way of increasing the use of public transportation means is by making public transport better, more accessible, and attractive. Consequently, local authorities are working on introducing a single-ticket system that could be used for more trips and means of transportation within a given amount of time. Cluj is in the process of implementing the electronic-ticketing system (e-ticketing), with a tender now underway. E-ticketing will not only reduce the cost of travel and help more people ride the bus and commute, but it will also provide support for revenue collection and transfers, as well as counting passengers. E-ticketing works very well in Washington, D.C., where people use the Smartrip card for bus and metro trips.

Smartrip card in Washington, D.C.

Source: WMATA/ Larry Levine

They can put money on the card either at the metro stations or in the bus. People pay one trip (one ticket) and use it for multiple bus trips within two hours in the Metropolitan area. There is a small discount when switching from metro to bus.

In connection to the implementation of e-ticketing, the city manager and RATUC must address the lack of data regarding public transport. As of today, there is no information on transport mode split, as there is not data regarding the number of people who use public transport, who use private cars and how many walk or bike. The mere "visual based" counting of passengers cannot provide good enough estimates of the number of people who use public transport on a daily basis.

Another issue that Cluj authorities should consider is the establishment of dedicated bus lanes in addition to the few existing ones. More dedicated lanes and giving priority to buses at intersections will enable buses to bypass traffic congestion, enhancing their reliability and reducing travel times. This, of course, will be an added incentive for people to switch to using public transportation. Moreover, cities that have a good network of dedicated bus lanes have managed to tackle in a productive way bus traffic issues.

Special infrastructure for bus-priority signaling should also be considered. This system is linked to buses via transponders which use GIS information, and can help the flow of approaching buses either by extending green lights for them or by cutting down the cycle for cars. Also, passengers should be informed on trips about bus routes, and waiting times. Real-time bus countdown information displayed on screens at the waiting facilities will allow passengers to plan and better manage their trips, enhance attractiveness of the public transport, and thus increase the number of users.

City authorities may consider changing some of the current planning regulations, too. For instance, in order to obtain planning permits, developers should be able to show how a new development links to the existing or planned public transport network. At the same time, allowing higher densities of development next to well-served public transport corridors can create a good base for public transport and should be used in connection with other planning measures, such as capping parking provision to residential and office buildings. In Curitiba, Brazil,

high-density residential and commercial development is encouraged around and within walking distance of transit stops, with lower densities elsewhere in the city.

Bus lane signaling in Cluj

Not in the least, RATUC and the city government should think about organizing information campaigns to increase awareness on the benefits of the public transport. To this end, such campaigns should focus on promoting public transport as a reliable, fast, comfortable, safe, cheap, and accessible means of transportation in comparison to other transportation modes.

Traffic Flow Optimization

Improving traffic flow is another way of improving the energy efficiency performance of the Cluj urban transport system. As elsewhere in Romania, traffic congestion is creating lots of troubles for Cluj residents. Traffic management can be improved by working out solutions aimed at minimizing the distance traveled and encouraging multiple occupancy vehicle travel and, thus, reducing fuel consumption. Up to 200,000 kWh energy can be saved annually with a minimum investment of USD 100,000 to USD 1 million in changing driving patterns by technical optimization of traffic signaling or by means of information.

Information displayed through Variable Message Signing can tell drivers about route switching options, directional signing to destinations, and availability of parking spaces. Such a system was implemented successfully in Milton Keynes, UK, where transmission of data is done by using the existing TV network used by police. Over a 10-year period this measure helped reduce congestion and delays and saved motorists and bus users in the downtown area a considerable amount of money. Cluj itself developed a system of cameras throughout the city, which are used to monitor traffic in the city.

In the long run, one of the recommendations for Cluj authorities would be to build a ring road or a beltway. City authorities are aware that such solutions are very optimal, and can ease traffic congestion in the city and provide commuters with alternatives roads in the city. Municipal officials already thought about reducing the traffic by developing a beltway or a ring road to connect one side of Cluj to another, and thus prevent cars from pouring into the downtown area.

A ring road would allow the people to commute from one side of the city to another by driving their cars outside of the city, avoiding the busy urban streets. The city has prepared some ideas in this vein but no concrete steps have been taken so far, mainly due to a lack of financial resources. Such projects are very costly and require a large amount of money, either from EU funds or the state budget. Until then, the city is benefitting from the first section of the Romanian Motorway A3, also known as Transylvania Motorway (Autostrada Transylvania), which will eventually link the city with București and Romania's western border. The section between Câmpia Turzii and Cluj-Napoca Vest (Gilău) has been operational since late 2010.

Romanian Motorway A3 known as "Transylvania Motorway"

Source: buzznews.ro

Proposals for ring roads have been made both in Cluj's general urban plan and by the National Company for Highways and National Roads. These proposals come to complement the ring road built in the South-East of the city, and the Transylvania Highway, which allows the bypassing of Cluj by cars coming through Turda or Gilău.

Traffic Restraint Measures

Even though Cluj is doing well in terms of its energy consumption per car per passenger kilometer, as the number of cars will continue to rise, it is expected that fuel use will go up, and so will greenhouse emissions. City authorities should act accordingly in order to curb private vehicle usage and replace it with more sustainable, efficient, and less costly measures. Traffic restraint measures aim to discourage potential drivers from using their cars, and can lead to traffic de-congestion, less fuel consumption, and increase in use of alternative transport modes, including public transport. To this end, traffic can be restrained in many ways.

One way to do it is by imposing taxes to enter the downtown area. The city of London imposed a "congestion charge" during week days from 6 AM through 7:30 PM, and cars that want to get into the city center during these hours must pay a high fee.

Congestion charging in London

Source: thetelegraph.co.uk; philtaylor.org.uk

At some point, local authorities thought about introducing such a tax in Cluj, but they have pushed aside this plan for now because of economic hardship and political constraints. However, the tax option may be considered in the long run. In other cities in the world authorities established blanket bans, banning certain type of vehicles from circulation. For instance, motorcycles were completely banned in city of Guangzhou, China. However, this measure may not be acceptable to people in Cluj, as it would remind them of driving restrictions from the communist era.

A step in this direction has been nonetheless taken by the municipality. In particular, they have introduced some restrictions for private inter-regional buses. The city limited private inter-regional bus operators to only three "legal" stops in the city. Before, they used to make illegal stops in public bus stations, hampering traffic. Once "Park and Ride" facilities and intermodal terminals will be developed, inter-regional buses could be entirely banned from entering the city. Local government is

considering enforcing some reduced speed zones in the city center as an additional measure aimed at discouraging traffic in the downtown area.

At the end of the day, reducing the speed limit in some zones could be just one component of a bigger plan the city managers may take into consideration in view of restricting private car use and favor the flow of public transport, cyclists and pedestrians in designated areas, by establishing the so-called "environmental islands". The "environmental islands" may consist in few streets in certain parts of the city, and they may be the results of some measures conceived to prohibit and penalize the access of private vehicles access in designated areas, and reduce the amount of space available for private cars.

A number of civic initiatives organized by the local government may also help with easing traffic congestion. The City Hall may think about setting up "no driving days" to educate and lead by example, actions to which people could participate voluntarily. For example, the city of Puerto Princesa in the Philippines is restricting tricycles in the downtown district on a certain day of the week. (More details in Annex 2)

Parking Restraint Measures

Parking restraint measures discourage car use and provide a good incentive to alternative modes of transportation, and they also reduce fuel and traffic congestion.

Solutions may include introducing provisions for residential and corporate developments. For instance, a maximum parking allowance with low car-to-unit ratios could discourage private-car acquisition and use. The good news about this option is that it does not require immediate investments from the city budget. In London, this measure has been successfully tested, and developments where there is bus connectivity allocate less than 1 parking spot per unit. However, this practice should be coordinated with expanding public transport in the area, if necessary.

One of the best practices that have proven to be very useful in dealing with traffic congestion is the "Park and Ride" concept. Although it is quite a costly measure and involves serious capital investment, it is a very efficient way to promote multimodality by linking parking to public transport.

Generic sign for "Park and Ride"

Source: wikipedia.org

People who travel to the city drive their cars to these facilities, from where they take public transport to get to their workplace. It is crucial that such Park and Ride facilities are built in locations where public transport is available. In addition, cheap parking should not be available in center areas. The cost of transport, including parking fees, should be lower than that of the fuel used for the entire distance. City authorities looked into this option and they decided that such projects should be further developed with support from the EU. In addition, they have in mind building underground parking and hiking prices for remaining parking spaces in the city center.

Municipal Buildings

Building benchmarking

Like in many cities, gathering data on municipal buildings proved to be a challenging issue for Cluj. Some information on municipal buildings floor area and energy consumption is available, but the data are not reliable. For instance, according to the figures provided by the City Hall, in 2012, the annual electricity consumption for almost 450,000 square meters was accounted for only 8.7 million kWh. Simple math shows that the consumption was as little as 17.2 kWh per square meter. Given this figure, one may think that Cluj is the most energy efficient city in the world in terms of public buildings. However, this seems too good to be true. City

authorities should have accurate information on all energy consumption (heating, electricity, and water) for schools, kindergartens, hospitals, public offices, and monitor such information in order to identify which buildings or groups of buildings have the highest energy saving potential.

David Prodan School in Cluj (left) and Napoca Technical College (right)

Source: scoli.didactic.ro; presalocala.com

The World Bank TRACE report for Belgrade indicated that it is much more efficient to improve the energy performance of hospitals, rather than of schools and kindergartens. Education facilities are not operating during weekends and vacations, so their energy use is lower than that of hospitals which are in use 24/7 and, thus, have a much higher energy demand.

To this end, a full audit of municipal buildings in the city is required. A small team of one or two people from the City Hall or external consultants should take responsibility for this task, and various departments should be involved. Building benchmarking is based on types of construction and consumption, and should include information on electricity, natural gas, and water utility, in addition to specific data on building construction and renovation, energy bills in the past couple of years, floor area, and types of heating. At the end of the day, the analysis should be able to point to the most suitable energy saving options. Publishing the analysis and updating the data regularly may enable competitions among building managers, and, eventually, open ways for a productive exchange of data and collaboration.

Municipal buildings audit and retrofit

One of the recommendations made during the TRACE implementation process in Cluj was to perform an audit and retrofit of municipal buildings. The audit and retrofit program could enable cost savings in the official municipal buildings and the reduction of the carbon footprint of the city. The building audit is targeting specific energy consumption for end users and activities, such as computers, lighting, air conditioning and heating systems, etc. Depending on results, the city government may have to allocate money for energy efficiency upgrades, purchasing of new equipment, and some renovation of buildings.

The Local Council Cluj building

Source: wikimedia.org

The retrofit program can be executed in a cost-effective manner, by entering into agreements with Energy Service Companies (ESCOs), who will pay for the first cost of the upgrades and will share in the savings from the retrofits.

Audit and retrofit programs make a great impact on energy savings. The World Bank helped the city of Kiev audit 1,270 municipal buildings and provided support with the implementation of some measures on both the demand side (automation and control system) and the supply side (metering, tariffs). The project showed good results, as heating consumption diminished by 26% per year, with a total of 387,000 Mwh. A model pioneered by the city of Berlin in partnership with Berlin Energy Agency aimed at retrofitting public and private buildings and helping the preparation of tenders for projects that will guarantee reduction in emissions by 26%. So far 1,400 buildings have entered the program and have been upgraded and recorded more than 60,400 tons CO_2 reduction per year. (More details in Annex 7).

The good news is that the local government of Cluj is implementing an audit and retrofit program in the city. At the same time, according to the new regulations, a building can be sold provided it has an energy audit certificate, as well as an energy performance certificate.

At the same time, the local public administration is committed to continue the rehabilitation of educational units in the city to improve their energy efficiency and reduce the heating/cooling bills. Thermal insulation of buildings, in addition to replacing the old windows with double-glazed ones, is expected to reduce heating bills by at least 20%. At the same time, in order to further reduce utility bills for municipal buildings, local authorities may consider replacing the incandescent bulbs with more efficient fluorescent ones.

Street Lighting

City-Wide Integrated Public Lighting Assessment

TRACE recommendations in the field of street lighting are targeting high potential energy savings with relatively small investments. Although the energy consumption per lighting pole is among the lowest compared to other cities within the TRACE database, with similar climate, decision-makers in Cluj are looking to find appropriate ways to increase the system's efficiency.

The first step in this direction would be a full audit of the existing lighting poles, together with an assessment of running and maintenance operations. The City Hall should appoint a small team to collect key data about the street lighting system in the city. Such data should cover information on type of poles, type of lamps and wattage, inventory on park, and monument and traffic signal lamp. The analysis should compare different aspects, such as energy spent per pole, watt for different lighting sources type, money spent on initial cost, and the lifetime operational cost per lamp. At the end, the data and main findings should be published and presented to the media, citizens, and different stakeholders. The potential energy savings within a year could range between 100,000 kWh and 200,000 kWh.

Street lighting in Cluj

Source: instalfocus.ro

Municipalities across the world analyzed what solutions would work best for improving street lighting efficiency. For example, the Ciy of Gaia in Portugal conducted a four-phase study aimed at reducing energy consumption in public lighting that included an evaluation of system, a pilot project to confirm the theoretical results of flux control systems, and implementation of a financial model. The study indicated that the flux control system has a potential of 20-30% in energy savings and can increase the life cycle of lamps by up to 30%. The total capital investments

of approximately USD 225,000 can lead to a payback period of 5 years, without including savings in maintenance costs. (More details in Annex 9).

Street Lighting Audit and Retrofit

The lighting system in Cluj is doing relatively well. Overall, it performed well under normal operating conditions, and so far it did not pose serious challenges to the municipality. Minor incidents can be detected and sorted out in a timely manner. Another recommendation made to the Cluj city managers was to perform an audit of the lighting system and, subsequently, act for retrofit where appropriate. One good aspect about retrofits is that they can deliver the same lighting levels for lower energy consumption levels, reducing associated carbon emissions and the operational costs. Maintenance costs will be lowered as well, and such measures will also improve the system by reducing service interuptions.

As highlighted earlier, Cluj had replaced a large number of vapor-sodium lamps, and the city government is planning to carry on with this process.

Sodium vapor-based street lighting in Cluj

Although it is widely acknoweldeged that environmentally friendly LED lamps are more efficient than vapor-sodium ones, it is also very true that they are a very costly solution for which large investments are needed. However, this option could work better if there is a partnership or a joint-venture between the city government and a private entity, as is the case in Los Angeles. Under a partnership between the Clinton Climate Initiative and the municipality, Los Angeles is developing the largest streetlight retrofit undertaken by a city to date, replacing traditional streetlights with environmentally friendly LED lights. The project is estimated to reduce reduce CO2 emissions by 40,500 tons and save USD 10 million annually through reduced maintenance costs and 40% energy savings.

However, LED-based street lighting is considered not to be an immediate priority for Cluj, but it can become so in the long run. As of now, the city government and the street lighting contractor, Siemens, will have to continue replacing the inefficient bulbs and upgrade the old lighting infrastructure.

Lighting Retrofit example, Oslo

Lighting Retrofit, City of Oslo

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. 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.

Street Lighting Timing Program

The street lighting timing program is a simple, inexpensive method of reducing electricity consumption for city streets. An initial capital investment of USD 100,000 over a year can prompt between 100,000 and 200,000 kWh in energy savings.

The attractive aspect of this program is that it can be tailored for the specific needs for lighting in a particular area. The level of lighting can be adjusted through a monitoring system, according to varying weather and activity levels. Usually, light systems have astronomic timers with geographic designations, and allow for adjusting the light according to the season and time of day. More light is used during winters when days are shorter and it gets dark early, whereas less light is required in the summer time. The lighting and its intensity may vary based on demand on a particular time of the day.

LED Street Light Timer

Source: ledoes.com

For instance, at midnight, when only few people and cars are out on the streets, the light is reduced automatically from a command center. By dimming the lights gradually, eyes are able to adjust to lower lighting levels, and the dimming is barely noticeable. The city of Kirklees, UK, chose to dim lights to varying levels throughout the day, instead of turning off the lights at certain times of the day. The municipality installed retrofit systems on each existing lighting pole and used wireless technology to monitor and dim the street lights. The retrofitting process simply required to add a small antenna to the lamp heads, which plugged into the electronic ballast with no need for additional wiring. The lights are switched on 100% at 7PM, after that 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. (More details in Annex 10). Light dimming programs are very efficient because they save both energy and money, reduce the brightness of bulbs at times of low road or street usage, and vary bulb brightness at varying times.

At the same time, city authorities in Cluj should consider implementing an automatic lighting system for certain city areas (e.g. areas with little pedestrian traffic, such as parking lots). Using a motion-sensor, the light turns on only when someone is walking by, and it stays off when nobody is there. Such systems are implemented in some neighborhoods in București, along small alleys and paths around residential buildings.

District Heating

District Heating Maintenance and Upgrade

The last recommendation made to the city managers in Cluj is related to the district heating sector. The heating district system of Cluj is operating since the 1960s. In its good times, in the mid-1990, it used to distribute over 1.2 million Gcal heat to 84,000 apartments in the city. However, RATCJ, the district heating company, lost 50,000 clients (apartments) following massive disconnections in the 2000s, as people switched to cheaper and more efficient individual heating units operating on natural gas. The remaining 34,000 clients receive hot water and heat produced by a thermal plant connected to several sub-plants and by a co-generation facility. According to city authorities, RATCJ received perhaps one of the largest funding in the country to modernize the network. Rehabilitation work on some of the old pipelines was performed, a number of the old boilers were replaced, and new pumps were purchased. However, the

system needs more money to continue network upgrading in order to reduce the 27% heat loss. The network is not very efficient because of its poor insulation, and so loses water through leakage. One recommendation made to the city managers is to continue maintenance and upgrading of the system. The rehabilitation of the network should include further upgrading of boiler pumps, pipelines, and insulation. It is expected that the primary network can deliver more heat to the end users once the network pipelines are repaired and better insulated. Good quality materials, improved heat exchange, and implementation of methods to detect leaks in the pipelines can also help reduce heat losses.

Modernized thermal plant in Cluj

Source: casa-construct.ro

In parallel, the thermal rehabilitation and insulation of old, poorly-built communist residential buildings should continue through government programs or loans. RATCJ argues that besides investments, policies at the national level and local initiatives are needed in order to further sustain the system. For instance, the city should not allow installation of micro-heating units in new residential complexes where a district heating connection is available. The company believes that authorities should not encourage disconnection from the systems, as individual micro-heating units are not very safe and are not the most environmentally friendly devices. Moreover, the chimneys sticking out of the buildings walls look unaesthetic.

RATCJ has taken some steps to counter disconnection from the district heating system. The company approached some schools and kindergartens in the city to jointly develop thermal rehabilitation projects and, thus, improve heating efficiency. The energy efficiency results are better if, in addition to replacing old pipes, thermal rehabilitation is performed. RATCJ is planning to take up a few school rehabilitation projects to demonstrate the increased efficiency of the system after completion of thermal insulation work. The district heating company also offers its expertise to those who would like to connect or reconnect to the system, as well as to those interested in rehabilitation work. In an initial stage, some thermostatic faucets have already been installed in a few kindergartens.

It is expected that following rehabilitation work the energy efficiency of buildings will go up, and so people will acknowledge the positive change. RATCJ hopes that by promoting the good results and organizing educational campaigns for raising awareness, some people may end up reconnecting to the heating network, the number of customers could go up, and so the company may regain some of lost market.

Not in the least, RATCJ should continue to expand the co-generation system and install combined heat and power facilities in all areas where it would be possible to run engines producing more than 1 MW of electricity. The co-generation system is environmentally friendly, makes better use of fuel, and has small production costs.

EUROPEAN UNION

GOVERNMENT OF ROMANIA

MINISTRY OF REGIONAL DEVELOPMENT AND PUBLIC ADMINISTRATION

CLUJ-NAPOCA

Instrumente Structurale 2007 - 2013

Annexes

Improving Energy Efficiency in CLUJ-NAPOCA Romania

ROMANIA REGIONAL DEVELOPMENT PROGRAM

TRACE City Energy Efficiency Diagnostic Study


Municipal Buildings


Water and Wastewater


Solid Waste Management


Public Transport


Public Lighting


Power and Heat

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Detailed Recommendations from TRACE

Improving Energy Efficiency in Cluj-Napoca, Romania

ANNEX 1: 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

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

	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.
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-motorized transport mode, modal shift, km of dedicated cycle/walking infrastructure, take-up of cycle promotion schemes by analyzing 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 2: 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.
Signaling	The City Authority invests in the necessary infrastructure for bus-priority signaling. Such systems are linked to buses via transponders which use GIS information, and favor 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	The City Authority links development densities to public transport

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

regulations & guidelines	availability and funding and 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 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 new developments link to the existing or planned public transport network in order to gain planning permission. See the Curitiba case study for 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 totaled 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 high density 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

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 3: Traffic Flow Optimization

DESCRIPTION

Traffic can be positively managed to ensure the most efficient operation of the transport system. Management techniques will seek to minimize distance travelled between origin and destination, ensure the efficient flow of traffic and encourage multiple occupancy vehicle travel.

Encourage the efficient use of vehicles and minimize journey lengths, reducing fuel use.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Flow optimization	The City Authority changes driving patterns either by technical optimization of traffic signaling, or by means of the provision of information. Real-time information can be provided by means of Variable Message Signing (VMS) or telecommunication where drivers are provided with route switching options, clear directional signing to destinations, and directions to nearest available car parks. This minimizes journey length and reduces congestion. Messaging systems have also been used to counter crime by providing information on e.g. kidnappings and terrorist attacks. See Portland and Milton Keynes case studies for further details.
Regulatory	The City Authority establishes high-occupancy vehicle lanes (HOV), producing an incentive for car sharing. The pairing of users can be left to civic initiatives, or driven by city authorities either separately or in combination with its other initiatives (in the latter case initiatives can be communicated to users using the same platform). Achieving a minimum number of users is crucial, as insufficient use results in reduced available road space and increased congestion. The implementation of an effective enforcement and penalties system are equally important, as the lane will otherwise attract an unacceptably high level of non-HOVs, which also reduces effectiveness. See Madrid case study for further details.

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum

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

Speed of Implementation
> 2 years

Co-Benefits
Reduced carbon emissions
Enhanced public health & safety

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 number of vehicles in circulation by using traffic counters.
- Determine mode share of people travelling in the area or city.

CASE STUDIES

Arterial 'green wave' traffic flow optimisation, Portland, USA C40 Cities (2010). "Portland, USA: Optimizing traffic signal timing significantly reduces the consumption of fuel", available online from http://www.c40cities.org/bestpractices/transport/portland_traffic.jsp The City Authority optimized traffic signal timing at 135 intersections on 16 of some of Portland's most congested thoroughfares. 'Optimization' of traffic signals consists of re-timing the traffic signals to improve their synchronization across a road traffic network. The cost of an intersection synchronization varied USD 1,000-3,000. The resulting reductions in the frequency by which vehicles accelerate and decelerate, as well as the reductions in the time vehicles spend with idling engines, yielded annual fuel savings of 1,750,000 gallons of gas. This is the equivalent of removing 30,000 passenger vehicles from the road for an entire year. The city went a further step by measuring and eliminating CO2 through the purchase of carbon credits.
Variable Message Signs, Milton Keynes, UK Department for Transport (2010). "Case Study: Milton Keynes Integrated Traffic Management", available online from: http://www.dft.gov.uk/itstoolkit/CaseStudies/milton-keynes-integrated-traffic-management.htm In order to achieve a more efficient usage of car parks and encourage shoppers into the central retail area of Milton Keynes, as well as reduce congestion caused by cars looking for parking, the city administration invested in Variable Message Signs which display the location and availability of parking spaces to road users. Installation costs were lowered by making use of existing ducted network in Milton Keynes used by the Police for CCTV. This created the added benefit of providing a large capacity network for future growth in data transmissions. The reduction in congestion and delays resulting from the system are estimated to save motorists and bus passengers in the central area

more than GBP 3 million over a 10-year period.
High-Occupancy Vehicle lane, Madrid, Spain Monzon, A. (1999) "Managing long term congestion in HOV lanes. Effect of 2+ vs 3+ limit on the Madrid N-VI corridor", paper presented at the European Transport Conference, Cambridge, Jan 1st 1999, available online fromhttp://www.etcproceedings.org/paper/download/2493 High environmental standards, low housing density, and high motorization rates influenced the decision of implementing an HOV lane scheme on the median of the N-VI motorway into Madrid. The cut off limit for the lane is 2+ passengers and the facility is separated from the mix-flow lanes by a concrete barrier along the whole length of it. A successful design aspect is the reversible basis on which the system operates to match peak flows, serving the inbound trips during the morning peak, and the outbound trips during the evening peak. Rather than increase ridesharing, the lanes have attracted a growth in public transport mode share (40% in the period 0700-1000 in the year following implementation), resulting in increased frequencies of services.

TOOLS & GUIDANCE

Tools & Guidance
Colorado Department of Transportation (2005). "CDOT Guidelines on Variable Message Signs (VMS)", A guidance document for the design of Variable Message Sign (VMS) messages. Available online from http://www.cotrip.org/its/whitepapers/VMSGUIDE-rev-2005.pdf
Alabama Department of Transportation (2007). "Traffic Signal Design Guide & Timing Manual" A guidance document with detailed guidelines and recommendations for the designing and timing of traffic signals in the State of Alabama. Available online from http://www.dot.state.al.us/dsweb/Traffic/pdf/AldotTrafficSignalManual122007.pdf

ANNEX 4: 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.

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.

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

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 license, 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 5: Parking Restraint Measures

DESCRIPTION Restricting parking availability discourages car use and provides an incentive to use more sustainable modes of transport, including public transport. Removing vehicles from circulation reduces fuel use and reduces congestion effects.

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Planning measures	The City Authority introduces planning measures which determine car parking provision for residential and office developments. Introducing maximum parking allowances with low car-to-unit ratios discourages private-car acquisition and use. Such measures do not affect the existing parking provision, however, and so need to be supported by additional measures. While areas of intervention can be defined, larger coverage is more effective as it has less potential to overwhelm surrounding areas. A gradient approach solves this by making requirements less stringent from the centre to the periphery. These measures safeguard energy use and efficiency in design and thereby bear no immediate cost to the city authority. See London case study for further details.
Parking fees	The City Authority charges for on-street parking. Implementing a charging regime for car parking and formalizing parking arrangements will enable the parking stock to be controlled and generate a revenue stream for sustainable transport measures. This type of approach requires a supporting system for enforcement, e.g. traffic wardens who issue fines to perpetrators, and are politically very sensitive measures. See San Francisco case study for further details.
Park & Ride facilities	The City Authority promotes multimodality by providing Park & Ride locations at key interchanges. By linking parking to public transport

ATTRIBUTES

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

First Cost
< US$100,000

Speed of Implementation
> 2 years

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

	use, the necessities of non-inner city residents are considered. The success of Park & Ride is linked to availability of public transport and unavailability of cheap parking in central locations. The perceived cost should be lower than that of driving the entire way. Measures of this kind often require major capital investment in infrastructure by the city authority with respect to 'Park & Ride' locations on the periphery of the city, bus terminals and additional buses. See Oxford case study for further details. Complementary implementation activity: Planning measures

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 parking stock and usage.
- Perform traffic surveys of number of vehicles in circulation by using traffic counters.
- Determine the average travelling speeds on the main transport corridors.
- Determine the mode share of people travelling in the area or city.
- Perform statistical analysis of rate of growth of car registration data.

CASE STUDIES

Parking standards, London Plan, London, UK London (2010). "Chapter 6: Transport" in The London Plan, available from http://www.london.gov.uk/shaping-london/london-plan/docs/chapter6.pdf pp.160-161.
The London Plan establishes maximum parking guidelines for residential development. It stipulates that all developments in areas of good public transport accessibility should aim for significantly less than 1 parking space per unit. The main challenge continues to consist of

ensuring that these standards are supported other measures which reduce car dependency, both within the development and in the surrounding area, e.g. improved and increased public transportation accessibility.

SF park curbside parking, San Francisco, USA
Institute for Transportation and Development Policy (2010) "U.S. Parking Policies: An Overview of Management Strategies", available online from http://www.itdp.org/documents/ITDP_US_Parking_Report.pdf
San Francisco Municipal Transit Agency's (SFMTA) installed new electronic, multi-space meters in 2009 and will activate parking spot sensors attached to the pavement sometime in 2010. The aim is to use pricing to help redistribute the demand for parking. The heart of SFpark is a Data Management System which sorts a tremendous amount of data collected from the networked array of remote sensors in all 6,000 parking spots. These wireless sensors can detect whether a spot is occupied by a vehicle and report parking occupancy information in real time to a central computer. The project will produce valuable data about the effect of meter pricing on occupancy. By 2010 the project will encompass 6,000 of San Francisco's 25,000 metered curbside parking spots in seven pilot neighborhoods.

Parking fees, Aspen, US
Source: Victoria Transport Policy Institute (2010). "Parking Pricing Implementation Guidelines", available online from http://www.vtpi.org/parkpricing.pdf
The city used to suffer from high levels of congested on-street parking. In order to reduce the effects of the "ninety-minute shuffle" (where locals and downtown commuters moved their vehicles every 90 minutes to avoid a parking ticket), the city introduced charges for on-street parking using multi-space meters. Parking fees are highest in the center and decline with distance from the core. The city had a marketing campaign to let motorists know about the meters, including distribution of one free prepaid parking meter card to each resident to help familiarize them with the system. Motorists were allowed one free parking violation, and parking control officers provide an hour of free parking to drivers confused by the meters.

Park-and-Ride, Oxford, United Kingdom
Oxford City Council (2009). "Park and Ride Transfer", available online from http://www.oxford.gov.uk/PageRender/decTS/Park_and_Ride_occw.htm
Oxford city has five Park-and-Ride sites serving the city's shoppers, visitors and commuters. These sites used to charge for parking to provide income to cover operational costs, but were not able to generate additional money for repairs or improvement. In order to achieve savings, the management of the Park-and-Ride sites was transferred to Oxfordshire county, resulting in efficiency savings of 250,000 GBP per year for the city administration. These savings were achieved primarily through economies of scale, and by sharing the cost of providing the service with taxpayers across the County, and not just those in the city - both of which used the facilities.

TOOLS & GUIDANCE

Tools & Guidance
Victoria Transport Policy Institute (2010). "Parking Management: Strategies, Evaluation and Planning" A comprehensive guidance document for planning and implementation of parking management strategies. Available online from http://www.vtpi.org/park_man.pdf
Victoria Transport Policy Institute (2010). "Parking Pricing Implementation Guidelines" A guidance document for implementation of parking pricing with details on overcoming common obstacles. Available online from http://www.vtpi.org/parkpricing.pdf
Spillar, R. (1997). "A Comprehensive Planning and Design Manual for Park-and-Ride Facilities" A guidance document for the planning and design of Park-and-Ride facilities. Available online from http://www.pbworld.com/library/fellowship/spillar

ANNEX 6: Municipal 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 meter).

IMPLEMENTATION OPTIONS

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

ATTRIBUTES

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

First Cost
< US$100,000

Speed of Implementation
1-2 years

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

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

	between different buildings. These factors could include: • types of tenants • occupancy density (persons/m2) • building energy management This benchmarking is usually does for the purposes of building labeling. See Singapore case study for further details.
Present Benchmarking Internally	One of the most significant motivators for energy efficiency in building operations is peer pressure as no building owners or operators want to be seen as having the worst performing buildings. So sharing building energy intensity internally across departments and operators will inherently improve energy consumption. This will also allow operators to share experiences to allow knowledge sharing across the CA.
Publish Benchmarking Publically	The boldest statement to show leadership in building energy efficiency is to publish energy performance data to the public, press, voters, and potential political opponents. This last stage of the benchmarking program may be many years after the commencement of the program when the data shows improvements and tells a good story of progress toward efficiency in government operations. The CA could then challenge (or require as some cities have begun to do) private building owners to benchmark their buildings and publish their results.

MONITORING

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

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

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

CASE STUDIES

Energy Efficiency in Public Buildings, Kiev, Ukraine
Source: ESMAP (2010). "Good Practices in City Energy Efficiency: Kiev, Ukraine - Energy Efficiency in Public Buildings", available online from http://www.esmap.org/esmap/node/656
Under the Kiev Public Buildings Energy Efficiency Project, 1,270 public buildings in the city of Kiev--including healthcare, educational and cultural facilities—were retrofitted with cost-effective, energy-efficiency systems and equipment. The project focused on the supply-side, such as automation and control systems, and demand-side measures, including installation of metering and weatherization, as well as a sound heating tariff policy. The project was undertaken by the Kiev City State Administration (KCSA). Savings from the retrofitting were estimated at 333,423 Gigacalories (Gcal)/year by 2006--normalized by degree/days in the base-line year--or about a 26% 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: Municipal Buildings Audit and Retrofit

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

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

	• server rooms and cooling of servers • appliances (water cooler, fridge, vending machines) The Municipal Offices EE Spreadsheet includes estimation methods for energy efficiency potential for offices which includes equipment retrofits, 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:

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

CASE STUDIES

Model for Improving Energy Efficiency in Buildings, Berlin, Germany http://www.c40cities.org/bestpractices/buildings/berlin_efficiency.jsp The City of Berlin in partnership with Berlin Energy Agency (BEA) has pioneered an excellent model for improving energy efficiency in buildings. They project manage the retrofit of public and private buildings, preparing tenders for work that will guarantee reductions in emissions. 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) signed 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 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/ year. To reach these savings an investment of 1 Million DM for control equipment was needed. 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 8: City-wide integrated lighting assessment

DESCRIPTION

Existing public lighting is often highly inefficient, using high energy consumption technologies, and lacking the strategic coordination of placement and operation of lighting. An audit of the existing stock as well as assessing running and maintenance operations, will help identify appropriate measures to significantly increase energy efficiency. Interventions that include new technologies and retrofitting will also increase the design life of luminaires, which reduces both the requirements and costs of maintenance. The aim of this recommendation is to enable a holistic assessment of the lighting system as a whole to identify areas for improvement across the network.

ATTRIBUTES

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

IMPLEMENTATION OPTIONS

Implementation Activity	Methodology
Appoint Inventory Leader	Hire, or allocate 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 Inventory Requirements	Define essential and desirable information useful for a street lighting inventory database. Key data points are required to contextualize the information. Data may include: • Street Name and Pole Number • Pole types and Luminaries types • Lamp type and wattage and lumen output • Park lighting lamp type inventory • Monument lighting lamp type inventory • Traffic Signal lamp type inventory • Street Signage lamp type inventory
Collect Data	Hire staff positions to begin the arduous process of requesting data,

	receiving data, checking data, and collecting primary data by visiting street lights and other lighting features. Alternatively write an RFP and award a contract with a specific scope of work to gather energy benchmarking data for all municipal buildings.
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/ pole • compare lumens / Watt for different lighting source types • compare $ / Watt for initial cost • compare $ of lifetime operational cost per lamp
Publish Inventory Publically	The boldest statement to show leadership in Public Lighting energy efficiency is to publish energy performance data to the public, press, voters, and potential political opponents. This last stage of the 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 owners to benchmark their lighting installations 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:

- % street lights inventoried for luminaries type and lamp type.

- % public parks and monuments lighting inventoried for luminaries type and lamp type.
- % traffic lights inventoried for luminaries type and lamp type.
- % signage lighting inventoried for luminaries type and lamp type.

CASE STUDIES

Energy Efficiency Public Lighting Project, Vietnam http://www.gefonline.org/projectDetails.cfm?projID=1106; http://www.c40cities.org/bestpractices/lighting/vietnam_lighting.jsp The Vietnam Energy Efficiency Public Lighting Project (VEEPL) is a national 10-year program which audits, installs and promotes the use of energy efficient lighting in streets, schools and hospitals, where all costs from installation, operation, maintenance, and electricity are covered by the national government. At a capital cost of US$ 15 million, the program is projected to yield annual financial savings of about US$ 13 million (based on an electricity tariff of US$ 0.056/kWh). By means of strengthening both the technical and policy support for a transition to more energy efficient public lighting in Vietnam, the authorities are looking to set up a sustainable long-term lighting industry. Measures which have been introduced to remove barriers have included the establishing of standards which define energy-efficient public lighting and building policies; improvements made in testing capabilities of the local lighting laboratories; the education of the public about the benefits of energy efficient public lighting; and having brought private and public industry and stakeholders around the table to agree on minimum standards of energy efficiency in lighting.
Energy efficient public lighting, Gaia, Portugal http://www.managenergy.net/download/nr20.pdf Gaia Municipality enacted a study with the main objective of reducing energy consumption in public lighting across the municipal area. The project was divided into four phases. The first phase evaluated existing public lighting conditions and available energy efficient technologies. The second phase developed a pilot project to confirm the theoretical results of flux control systems. This was followed by a third phase, where a financial model for project implementation was developed. Finally the project was implemented using a third party financing model. A communication campaign was then enacted in order to disseminate the information on the project. The preliminary study found that the best technical solution was the installation of flux control systems. These typically save 20-30% of energy and increase the life span of lamps by up to 30%. The first stage of the project saw the installation of 30 flux control equipments inducing energy savings of up to US$ 45,000. The total investment was approx. US$ 225,000, which will lead to payback period of 5 years, not considering savings in maintenance costs.
Tools & Guidance
"Lighting the Way": A Local Government Guide to Energy Efficient Public Lighting on Minor Roads, Australian Government, Department of Environment and Water Resources. http://www.iclei.org/fileadmin/user_upload/documents/ANZ/CCP/CCP-AU/EnergyToolbox/lightingtheway.pdf

ANNEX 9: Street Lighting Audit and Retrofit

DESCRIPTION

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

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

IMPLEMENTATION OPTIONS

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

ATTRIBUTES

Energy Savings Potential
> 200,000 kWh/annum

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

Speed of Implementation
1-2 years

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

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

MONITORING

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

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

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

CASE STUDIES

ESCO street light retrofit, Akola, India

Source: Energy Sector Management Assistance Program (ESMAP) (2009). "Good Practices in City Energy Efficiency: Akola Municipal Corporation, India - Performance Contracting for Street Lighting Energy Efficiency"

The Akola CA enlisted an ESCO to replace over 11,500 existing street lights (standard fluorescent, mercury vapor, sodium vapor) with efficient T5 fluorescent lamps. The selected contractor financed 100% 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 latest technology, financing strategies, and public-prive implementation models for LED retrofits. CCI's modelling and technology analysis, as well as its financial advisory, serves as key reference sources for the development of this comprehensive retrofit plan.

The phased nature of the project allows the city to re-evaluate its approach on 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

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 10: Street 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.

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.

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

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.

ANNEX 11: District Heating Network Maintenance and 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.

ATRIBUTES

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

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.

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 12: List of abbreviations for cities in the TRACE database

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

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