Energy Efficient Cities Initiative

GOOD PRACTICES IN CITY ENERGY EFFICIENCY

Lviv, Ukraine - Energy Management Systems in Public Buildings

Project title	Energy Management Systems in Public Buildings
Sector	Public Buildings
Type of project	Energy Monitoring and Targeting
City and country	Lviv, Ukraine
City population	760,000 (in 2010)
Program costs	About 1 million UAH (US$126,550) (as of the end of 2010)
Annual % of energy reduction	10% (and 12% for water use)
Project status	Ongoing; started in December 2006

Project Summary

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.

1. Introduction

Lviv is the seventh largest city in Ukraine, with a population of 760,000 and a surface area of 171 square kilometers (km^2). Located near the border with Poland, it is the economic hub of western Ukraine and a gateway to the European Union. The city is known for its architectural monuments, cultural organizations, and institutions of higher education, which draw a considerable inflow of visitors each year. Tourism, information technology

outsourcing services, and education have led local economic growth, while traditional manufacturing industries such as chemicals and machine tools have receded. Lviv's gross domestic product (GDP) topped US$3.2 billion in 2008 and per capita GDP was about $4300.[1] Lviv ranks among the top nationally in macroeconomic stability, business sophistication, and innovation capacity thanks to its adaptive economy and strong educational basis.

Lviv's energy supply relies heavily on natural gas, which accounts for about 63 percent of the city's energy consumption and is used mostly for space heating. Liquid fuels, used primarily for transportation, contribute to 22 percent of the city's energy use, with electricity as the remaining 15 percent. From 2006 to 2010, natural gas prices rose five-fold due to a drastic reduction in the discounted price Russia, its main gas supplier, previously provided. For this reason, increasing heating costs have become a major concern of Ukrainian cities. Lviv's public sector expenditures on utility services—electricity, district heating, natural gas, water—had been managed using a fixed budgeting system (based largely on previous years' costs). As tariff adjustments and consumption-based billing schemes were introduced in the early 2000s, it became increasingly difficult to manage these expenses. By 2006, most public buildings had utility meters and the city government spent about 22.8 million UAH (US$4.5 million) on utilities, about 3.5 percent of the city's budget.

Among Ukrainian cities, Lviv has been a pioneer in promoting energy efficiency, starting with the public sector, including schools, hospitals, city administrative units and other public entities supported by the city budget. Since 1998, the city has participated in two international programs related to energy management measures in the public sector. It first participated in the Municipal Energy Efficiency Network (MUNEE) Project supported by the United States Agency for International Development (USAID).[2] The program helped to establish an energy accounting system for school buildings and used a software solution to manage the energy use information. Later in 2005 and 2006, the city administration was actively engaged with the Energy Cities- a European Association of Local Authorities - to promote energy sustainability.[3]. From this experience Lviv authorities learned how other European cities established energy management systems (EMS).[4] Both programs introduced energy management measures to the city, trained staff in energy management, and emphasized using software instruments to improve operational control of energy consumption in public buildings. Lviv was among the inaugural members of the Association of Energy Efficient Cities of Ukraine (AEECU), established in 2006 and based in the city.[5]

As a further response to the rising energy costs and budget constraints, a special energy committee was formed in 2006, following a motion of the mayor to advise the city on managing its public sector utility expenditure. The committee, comprised of a mayor's advisor, officials from the Economic Policy Department of the city administration and an external expert from the AEECU, took stock of and analyzed the utility usage and utility bills of the city's 530 public buildings. Based on the assessment, the committee proposed a monitoring and targeting (M&T) program to limit utility spending in public buildings. The

[1] The social economic figures were excerpted from the report *Municipal Energy Efficiency Market Assessment of the City of Lviv*, prepared by the Municipal Development Institute in Kyiv, Ukraine, May 2010 for ESMAP. At the end of 2008, the exchange rate was: 1 US dollar = 8 Ukrainian Hryvnia (UAH)

[2] MUNEE is implemented by the Alliance to Save Energy. See www.ase.org for more information.

[3] See http://www.energy-cities.eu/ for more information.

[4] These European cities include Bristol and Leicester in Great Britain, Stuttgart and Freiburg in Germany, Besancon and Montpellier in France.

[5] See http://www.enefcities.org.ua/en for more information.

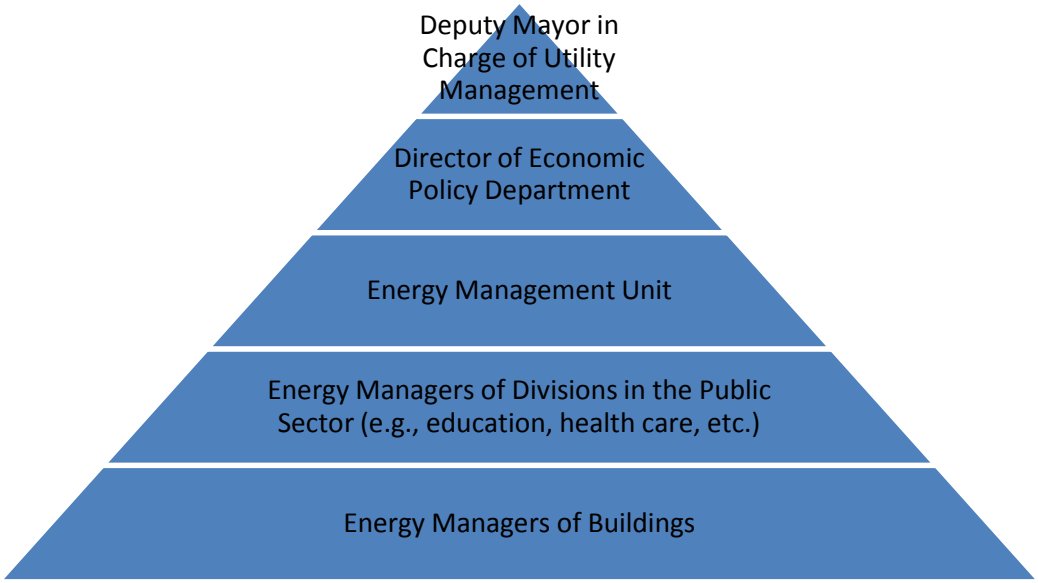
stocktaking also identified dozens of missing meters (for heating and water consumption), though at that time most of the city's buildings were equipped with meters for utility billing.[6] The mayor signed the decree on "Establishing the Monitoring and Targeting System for Utility Consumption in the Education, Health Care and Culture Institutions" in December 2006.

2. Project Description

Lviv's M&T system for public buildings consists of three key elements: regular collection of utility consumption information ("Monitoring"), defining the appropriate levels of monthly utility consumption ("Targeting"), and ensuring target achievements are met ("Controlling"). Together, these three elements form a constant feedback cycle to effectively manage utility use and control expenditure by creating transparency, establishing accountability, and identifying underperforming facilities.

While the idea of M&T is straightforward, the challenge for the city was to establish a management structure within the administration and to mobilize resources (e.g., people and software) for implementing the program. The city put in place the required personnel along a line of responsibility and accountability for controlling utility consumption of public buildings (Figure 1). This management structure was built on the existing system with a key addition: an EMU under the Economic Policy Department, a completely new unit initially staffed with two experts recruited externally. At the administrative division and the building level, existing technical and administrative support staff were trained for their new duties of reporting and controlling utility consumption, as "energy managers".

Figure 1 A Line of Reporting for Utility Management in Lviv



Under the utility consumption management protocol, which was established to manage utility service costs, the EMU, in consultation with the concerned energy managers, sets monthly targets for utility consumption (gas, electricity, district heating and water) for each public

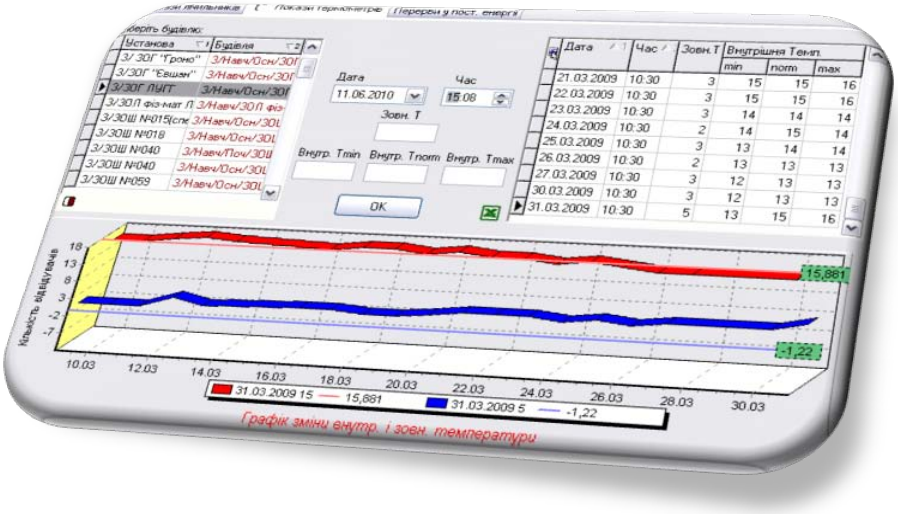
[6] In absence of heat and water metering in the buildings, the billing was based on square meters of heated space and number of water users.

building, expressed in physical units. The monthly target is determined based on the average consumption of the same months in the previous two years (the "baseline") plus an adjustment, which can either be negative (less consumption) or positive (more consumption) depending upon foreseeable changes in consumption patterns at the building level determined by the EMU and the concerned building energy manager.

On the monitoring side, building energy managers record utility consumption as well as daily indoor and outdoor temperature. They submit the data monthly to division energy managers who then compile the data and submit it to the EMU. The temperatures are monitored to ensure a reasonable comfort level and to allow normalization of weather conditions in calculating targets in the future.

On the controlling side, the EMU analyzes the monthly utility consumption against set targets, identifies excess consumption, discusses the data with the concerned facility, and agrees on a set of actions to address the situation. Public institutions are strongly encouraged to meet the agreed targets, as utility consumption levels are reviewed at the highest levels of the city administration, including the mayor. The goal of meeting these targets is also incorporated into energy manager performance evaluations, which is tied to a monthly staff award for outstanding performance.

Figure 2 Interface of the M&T Software "Energyplan"



Computerized data collection and analysis are critical to the city's M&T system, since a large amount of information needs to be assembled and examined on a regular basis. A software company that had a suitable system proposed that they could provide their "Energyplan" software to the city for free in return for fee-for-service city staff training of the software and technical support. Based on the data, the software can consolidate monthly and annual utility usage and expenditures at different levels (i.e., building, division or the public sector), compare utility consumption over multiple years and across different buildings, generate efficiency indicators (e.g., consumption per square meters, consumption per occupant) and visually present these results (Figure 2). It equipped municipal energy managers with the software record utility consumption and billing information in each public building as well as temperatures, energy-using equipment, number of occupants, and operating schedules.

The deployment of the M&T system took about six months to complete, including recruitment of EMU staff, training, and refining data collections, transfers and analyses. It was carefully monitored, controlled and aligned through weekly staff meetings of top and middle level municipal managerial personnel. Concurrently, the city installed new meters in buildings that lacked them. In May 2007, the M&T system became fully operational. Beginning in June, energy targets were developed for each public building, utility service, and each month of the year.

At the beginning of 2008, based on utility consumption and other building data collected in 2007, the city joined the European certification for energy performance in non-residential buildings supported by the European Commission - Display Campaign, a voluntary building labeling program [7]. An online tool provided by the Campaign enables the city to calculate three performance indicators - primary energy consumption per square meter, CO_2 equivalent emissions per square meter, and water consumption per square meter. Depending on the building type, the calculated building performance is graded into a pan-European classification of six levels, from A (the most efficient) to G (the least efficient).[8] The tool can then generate a poster to present the building's performance rating (Figure 3), which is placed in a prominent place visible to the public. Lviv supported the poster display with press conferences coordinated with the mayor's office. Such a scheme was also seen as a low cost yet effective way to pressure compliance with utility consumption targets. In 2009, the city was recognized as one of the most active participants of the Display Campaign amongst some 400 participating cities across Europe.

Figure 3. Poster of the Display Campaign

[7] See http://www.display-campaign.org/ for more information.

[8] The explanation of the classification scheme is available in the Display Campaign website (http://www.display-campaign.org/doc/en/index.php/APPENDICES#The_Classification_Scheme).

Between 2006-2009, there was a positive trend of building energy performance among the 350 participating public buildings (Figure 4). Among buildings displaying the posters, average primary energy consumption was reduced by 19 percent, from 298 kWh/m^2 in 2006 to 241 kWh/m^2 in 2009; average water consumption was reduced by 20 percent, from 678 *l*/m^2 in 2006 to 543 *l*/m^2 in 2009 (Figure 5).

Figure 4. Improved Grading of Building Energy and Water Consumption

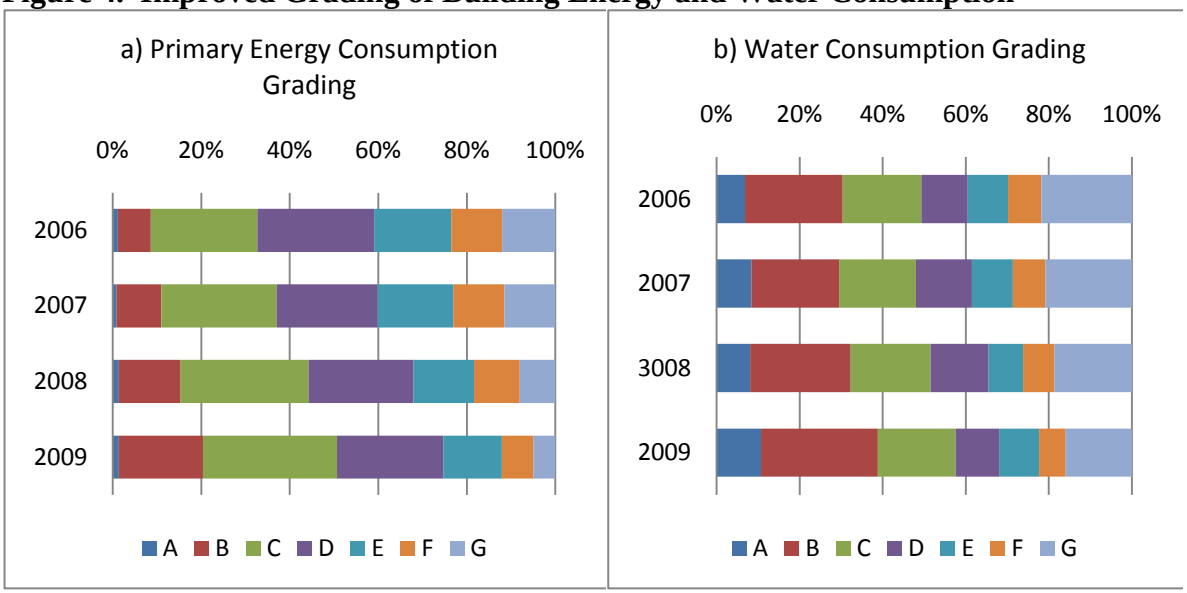
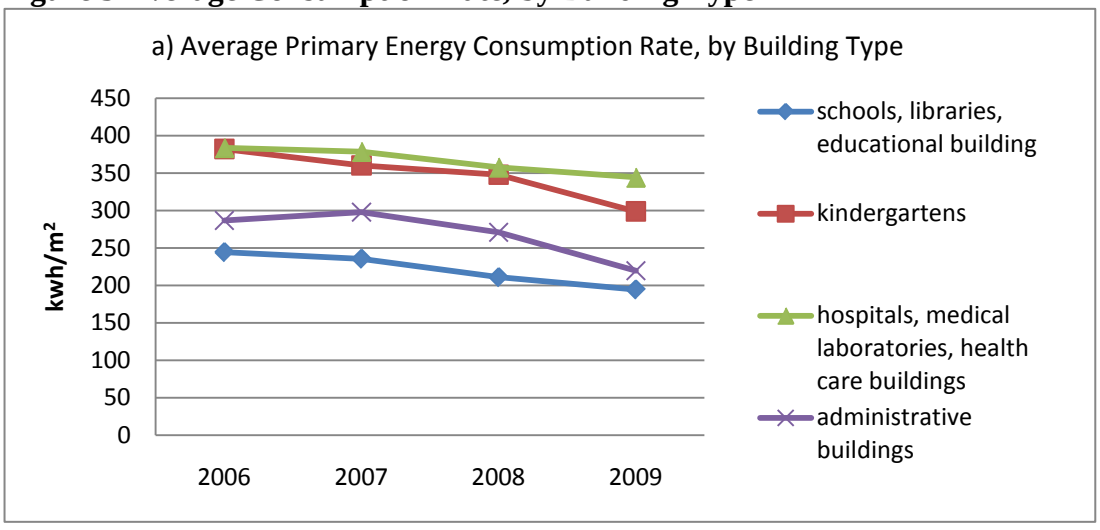
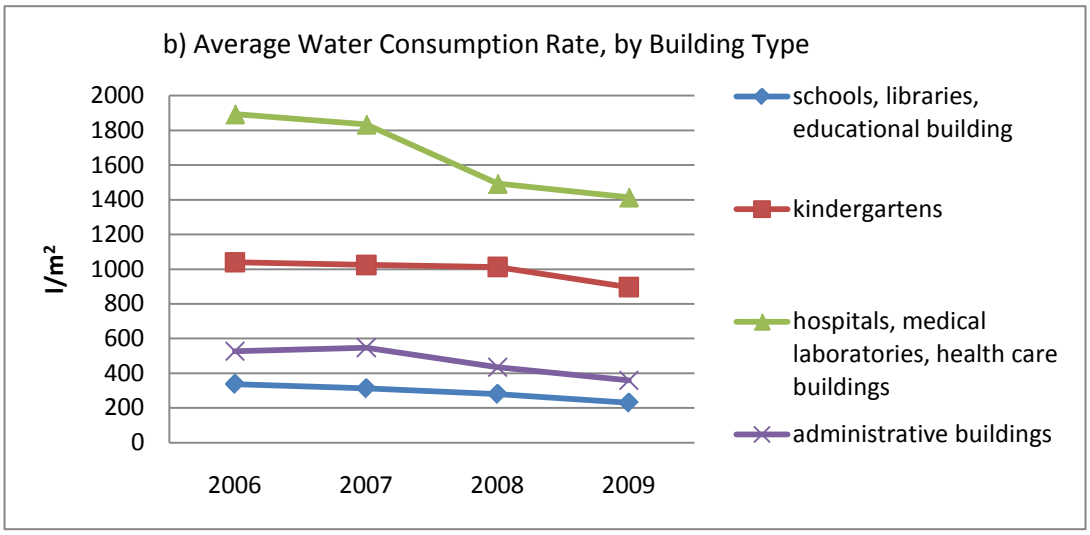


Figure 5 Average Consumption Rate, by Building Type





The city management viewed the Display Campaign as very effective in helping its citizens understand the program and see the results. Increasing public awareness and interest encouraged energy managers and building occupants to reduce energy and water waste.

3. Costs, financing, benefits and results

The costs of the program have been modest.[9] The initial and recurring costs of the M&T program have resulted from the establishment and operation of the EMU. Staffing represented about 75 percent of these operational costs, the remainder was office facilities and poster printing. Capital costs included office equipment (47,300 UAH), software (40,000 UAH) and training of software users (35,589 UAH) (Table 1).[10]

At of the end of 2010, the implementation of the utility consumption M&T system in public buildings had generated about 9.5 million UAH (about US$1.2 million) of estimated net savings for Lviv, representing a highly cost-effective program. The evaluation of the cost and benefit of the program is complicated by the annual fluctuation of climate conditions (a cold and prolonged winter will have a significant impact on district heat and natural gas consumption), addition or removal of users and equipment, and increased comfort requirements. This case study analysis did not attempt to control these factors. Since 2008 was the first year when all public buildings were metered and consumptions recorded, it is used as the baseline year for comparison. The cost of additional metering was not included in the investment cost of the M&T program since it was considered a precondition on the end-use side.[11] The direct benefit of the M&T program included calculated utility expenditure savings in 2009 and 2010 based on 2008 consumption levels.

[9] As indicated previously, the cost of installing the remaining heat/water meters (at 240,000 UAH) is not considered part of the program costs.

[10] The market price of the software, which would have been paid by the city, was included in the cost to make a conservative calculation of the net savings.

[11] Metering at connection points is a basic condition for commercially operated utility supply. For internal energy management purpose, end users may decide to install their own meters and sub-meters. In Lviv's case, some connection meters were not installed when the M&T program started and were quickly remediated. Although these meters are crucial to the M&T program they were owned by the utility companies and were thus not included in the cost of the M&T program itself.

Physical reduction of energy and water consumption accounted for the majority of cost savings. Rising utility tariffs also made the physical savings more valuable.[12] Table 2 provides a more detailed account of the reported utility savings and tariff levels for the evaluated period (2008-2010).

Table 1. Cost and Benefit Analysis

	2007	2008	2009	2010
Cost (in current '000 UAH)				
Capital Cost				
Software	40.0			
Computer and devices	47.3			
Training of software users	35.6			
Operational Cost				
Salary (newly employed staff)	171.6	184.8	191.4	198
Office facilities (e.g., rent, utilities and stationary)	44.6	44.6	44.6	44.6
Display posters printing	10.7	10.8	10.9	10.9
Total Cost (in current '000 UAH)	**226.9**	**240.2**	**246.9**	**253.5**
Savings of Utility Spending (in current '000 UAH)				
Electricity			1,250.7	1,239.4
District heat			3,547.2	1,447.1
Natural gas			1,389.3	1,219.2
Water			413.8	572.8
Total Savings of Utility Spending (in current '000UAH)			**6,601.0**	**4,478.5**
Net Savings (in current UAH '000)	-226.9	-240.2	6354.1	4225.0
Net Savings (in 2008 UAH '000)	-238.0	-240.2	6919.9	4788.9
Net present value of M&T program in 2008 (UAH '000)		9489.4		
Net Present Value in 2008 (USD '000)		**1186.2**		

Note 1: The current UAH is converted to 2008 constant UAH, by adjusting inflation rates[13].
Note 2: An annual discount rate of 12% is applied when calculating the net present value of the program in 2008.
Note 3: Exchange rate of 8 UAH per USD is used when converting the net present value in UAH to USD.

Table 2. Lviv: Results of Public Buildings Utility Consumption M&T Program. 2008-2010

	Utility Consumption	Physical Unit	Tariff (UAH per unit)
2008			
Electricity	17205.80	thousand kWh	587.83
Heat	92434.00	Giga calorie	270.20
Natural Gas	4186.35	thousand cubic meters	1529.70
Water	656.28	thousand cubic meters	4960.00

[12] For example, the physical savings in 2009 is valued at 6.6 million UAH using 2009 tariffs, but would be valued at 4.8 million UAH at 2008 tariff levels.
[13] Inflation rates are sourced from the website: (http://www.prostobankir.com.ua/spravochniki/indikatory_rynka/indeks_inflyatsii/indeksy_inflyatsii_za_2000_2011_goda).

2009

Electricity	15451.69	thousand kWh	713.00
Heat	83129.00	Giga calorie	381.22
Natural Gas	3631.57	thousand cubic meters	2504.30
Water	580.08	thousand cubic meters	5430.00

2010

Electricity	15,659.80	thousand kWh	801.70
Heat	89,209.00	Giga calorie	448.70
Natural Gas	3,783.30	thousand cubic meters	3025.00
Water	550.80	thousand cubic meters	5430.00

Source: Lviv City Energy Management Unit

Besides utility bill savings, there were also other unaccounted co-benefits resulting from the program. The program reduced greenhouse gas (GHG) emissions and achieved a greater degree of energy security for the country. More important and beneficial to the city, the M&T program and the display campaign established a transparent and accountable energy and water management system for the public sector. It not only enabled the city to actively manage utility consumption and expenditure but also demonstrated the leadership of the city administration in pursuing sustainable actions. The M&T system is only a starting point for managing energy and water use in public buildings. While maintaining the gains already achieved, Lviv is well-positioned to work with financial institutions and energy service companies (ESCOs) on potential investments to further improve energy efficiency in public buildings.

4. Lessons Learned

City leadership, commitment, and support were critical to the success of the M&T program. The deployment of the M&T system required considerable organizational support on the part of the city administration, including establishing a new EMU with newly recruited and technically-competent staff. In addition, a number of new duties and functions had to be included into the daily routine of existing technical and administrative support staff of the city's public buildings. With his strong and careful leadership, Oleg Synyutka, then the deputy mayor and the M&T program's organizational leader, guided the program through its deployment. Notably, the city took actions to ensure the people and software required to implement the program were put in place. In addition, the city's decision to participate in the EC's Display Campaign helped to communicate the results of the program, increase public awareness on building energy efficiency and reinforce the improved behaviors of building managers and occupants.

The prudent planning and preparation of the city also contributed to the success. The stocktaking prior to the program launch helped establish a concrete baseline for setting the targets and drafting the policy concept which led to the program. Also, installation of missing meters ensured that the measure of utility use in all public buildings–a pre-condition for M&T--was in place. Despite all virtues of the program, the city would have benefited from open and competitive bidding for software and related support.

5. Project Innovation

Energy monitoring and targeting is an established technique that has proved its effectiveness in other cities around the world. The city of Lviv managed to build on this global experience, knowledge exchanges, and capacity building organized by NGOs in the field, adapting these lessons and techniques into its own organizational structure and operational process. The city also proved its resourcefulness by taking advantage of the readily available communication tool, the Display Campaign, to compliment its M&T program. And, rather than seek to mobilize large sums of funding to support a major investment program for municipal energy efficiency, the city started with simpler, less investment-oriented measures first.

6. Financial Sustainability, Transferability, and Scalability

The economical M&T program in Lviv successfully generated significant reductions in utility bills at a time of tariff escalations and budget constraints. The program will continue to ensure that utility consumption in public buildings is carefully managed. Further reduction of utility consumption is likely to result from more capital-intensive energy efficiency investments in the future.

The transferability of the program is strong. The city has learned from the early experiences of implementing energy management measures in other cities and several cities in Ukraine, such as Lutsk, Kamyanets-Podilsky, Kovel and Dolyna, are now following suit. Lviv's experience demonstrates that by implementing low-cost managerial measures a city could achieve significant utility bill savings, easing fiscal pressures and helping the environment.

The program also had good coverage: All public buildings in the city participated in the M&T program. It represents initial efforts of the city to manage resources more efficiently. In the future, the program could improve the rigor of target setting, such as correcting influence factors that drive utility use and benchmarking utility consumption against that of similar types of best-performing buildings. Currently, the city is considering providing financial incentives (e.g., grants, benefit-sharing) to encourage public entities to further improve energy efficiency.

References

1. *Agnieszka Schirru-Nowicka, Antoliy Kopets and Oleh Herasevych, 2011. The Value of the Display® Campaign as a Voluntary Energy and Environmental Performance Certification System of Buildings to the Sustainable Municipal Energy Management in Ukraine. Innovation: The European Journal of Social Science Research, Vol. 24, No. 1, March 2011, Routledge.*
2. *Anatoliy Kopets, 2010. Energy Management Systems and Energy Monitoring for Public Buildings in Ukrainian Cities. Presentation made at the workshop Energy Efficient City in Russia: Preparing, Financing and Implementing Municipal Energy Efficiency Programs, June 29-30, 2010, Kazan, Russia.*
3. *Anatoliy Kopets, 2009. Experience in using the software of the European campaign Display® for the Preparation of Energy Certificates for Buildings in Ukraine. Presentation made in working group meeting of the Ministry of Housing and Municipal Economy, Ukraine, in August 2009.*
4. *Anatoliy Kopets, 2007. Managing Energy Use in Cities (in Ukrainian). Communal Economy Magazine, No. 2, pp. 26-29, 2007.*
5. *Anatoliy Kopets and Roman Kyshkan (Editor), 2007. Practical Guide for Increasing Energy Efficiency in Municipal Systems (in Ukrainian). Downloaded at: http://climategroup.org.ua/upl/Energy_Book.pdf*
6. *Bärbel Schwaiger and Anatoliy Kopets, 2009. First Steps towards Energy-Efficient Cities in Ukraine. Paper submitted for 5th Urban Research Symposium, June 2009, Marseille, France.*
7. *California Energy Commission, 2000. Energy Accounting: A Key Tool in Managing Energy Costs. Downloaded at: http://www.energy.ca.gov/reports/efficiency_handbooks/400-00-001B.PDF*
8. *Display Campaign Website, http://www.display-campaign.org/example830, accessed in February, 2011.*
9. *Halyna Kopets and Taras Kopets, 2008. Results of Implementation of Software "Energyplan" in Energy Management System of Lviv. Modern Problems of Radio Engineering, Telecommunications and Computer Science, 2008 Proceedings of International Conference, February 19-23, 2008, p.656.*
10. *Municipal Development Institute in Kyiv, Ukraine, 2010. Municipal Energy Efficiency Market Assessment of the City of Lviv, consultant report prepared for ESMAP.*

ANNEX: CITY AND PROJECT PROFILE

CITY PROFILE

1. Name of the City	**Lviv, Ukraine**
2. Area	**171 km^2**
3. Population	**760,000 (in 2010)**
4. Population Growth Rate	**n.a.**
5. GDP of the City	**US$3.2 billion (in 2008)**
6. GDP Growth Rate	**n.a.**
7. GDP per Capita	**US$4,300**

PROJECT PROFILE

1. Project Title	**Energy Monitoring and Targeting in Public Buildings**
2. Sector	**Public Buildings**
3. Project Type	**Energy Monitoring and Targeting**
4. Total Program Costs	**US$ 126,550 (as of end 2010)**
5. Net Energy/Cost Savings	**US$ 1.2 million (as of the end of 2010)**
6. Simple Payback	**n.a.**
7. Project Start Date	**December 2006**
8. Project End Date	**Ongoing**
9. % of Project Completed	**Ongoing**

Project contacts:

Anatoliy Kopets
Executive Director
Association of Energy Efficient Cities of Ukraine
Lviv, Ukraine
Tel: +380-67-342-2610
E-mail: akopets@enefcities.org.ua