ESMAP
Energy Sector Management Assistance Program

Energy Efficient Cities Initiative

GOOD PRACTICES IN CITY ENERGY EFFICIENCY

Kiev, Ukraine - Energy Efficiency in Public Buildings

Project title	Kiev Public Buildings Energy Efficiency Project
Sector	Public buildings and heating
Type of project	Energy efficiency in public buildings
City and country	Kiev, Ukraine
City population	2.6 million (2001)
Capital cost/initial investment	US$ 27.4 million
Annual % energy reduction	26% (333,423 Gcal)
Project status	Completed (2000-2005)

Project Summary:

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.

1. Introduction

Ukraine's economy has been one of the most energy intensive in the world. At the time the project was identified in 1996, the ratio of total primary energy supply to gross domestic product (GDP) was as high as 0.82, about four times higher than the average of Organization for Economic Cooperation and Development (OECD) countries. Low energy efficiency was primarily the result of the sharp drop in Ukraine's GDP after the break-up of the Union of Soviet Socialist Republics (USSR) in 1991, combined with low retail energy prices and a lack of energy conservation policies. A few years after the

breakup of the USSR, the price of imported energy began rising, traditional markets for Ukrainian industrial products began to shrink, and the country faced challenges from a changing market environment. Ukraine's Government recognized it needed to improve the country's energy efficiency, and in 1996 developed a Comprehensive State Energy Conservation Program.

Kiev (or *Kyiv*) is Ukraine's capital and largest city. The 2001 census listed its population at 2.6 million. It is an important East European center of industry, science, education, and culture, and home to many high-tech industries, higher education institutions and famous historical landmarks.

Before the project was identified, the city implemented tariff reforms, including better metering and consumption-based billing. This allowed heat tariffs to be set at cost-recovery levels, providing an economic incentive to consumers to conserve energy. It also improved the billing and collection of heat bills[1].

The project was designed to improve the energy efficiency of key public buildings in Kiev through technical improvements tied to supply and demand for heating services. It also sought to help develop a local energy efficiency market and related service industry capable of supplying and installing energy efficiency equipment in Kiev and other areas of Ukraine. The project also promoted public awareness of the need for more efficient use of energy.

Ukraine had experienced difficulties with infrastructure investment projects. There had also been problems with energy efficiency projects in the region. With this in mind, the project's design was simplified to reduce risks. It was limited to Kiev, which had the country's most advanced tariff reforms and payment/collection discipline, and where energy efficiency demand-side measures would be complemented with supply-side investments through the World Bank-financed Kiev District Heating Improvement Project. Investments focused on public buildings, excluding residential and industrial buildings. The industrial sector was being addressed under the complementary EBRD-supported UkrEsco Project[2], while residential energy efficiency projects in other countries in the region had been slow to get off the ground.[3]

The project included buildings owned by the City of Kiev, or its subsidiary district administrations (e.g., schools, hospitals, kindergartens, cultural centers, administration buildings). However, it did not include state-owned buildings within the city limits due to the difficulty of securing counterpart state funds. The Kiev City State Administration

[1] The heat tariffs remained at Ukrainian hrivnya or UAH57.5/Gcal (about US$10.7/Gcal, on average) during 2000-2004, but rose to UAH64.73/Gcal (about US$12.82/Gcal) at the start of 2005. It was expected that ongoing gas price increases in Ukraine, and higher heat tariffs in the future, would increase the value of conserved energy.

[2] See http://www.ebrd.com/projects/psd/psd1997/3663.htm for more information.

[3] In the late 1990s, residential energy efficiency projects in Eastern and Central Europe generally involved investments in a large number of smaller buildings, and touched on complex issues tied to privatization of buildings, formation of building management organizations, establishment of credit lines, affordability by households, etc. These factors collectively hampered program results.

(KCSA) established a Project Implementation Unit (PIU) to launch the project and monitor its progress.

2. Project Description and Design

The project's major components were:

Technical Audits and Retrofit Designs. These included (a) technical audits of the buildings to estimate energy consumption and confirm the most cost-effective energy efficiency retrofit measures; and (b) technical design of retrofit measures and provision of technical specifications and bidding documents, for equipment supply and installation contracts. During project preparation, 46 retrofit measures were evaluated and nine selected, based on their economic rates of return and ease of implementation. Systems/equipment to be installed included: (i) heat meters; (ii) substation automation; (iii) weather-stripping; (iv) radiator reflectors; (v) ceiling fans; (vi) faucet flow restrictors; (vii) low-flow shower heads; (viii) hot water heat exchangers; and (ix) riser balancing valves. All buildings would first be equipped with heat meters and new substations--it was determined that without them, the retrofitting could cause overheating of the target buildings.

Energy Efficiency Improvements in Buildings. The initial plan called for retrofitting 1,302 public buildings, with a total floor space of about 5.1 million square meters. However, new heat substations were installed in only 1,173 buildings, as the audits showed 129 buildings were unsuitable for modern substations as they were connected to small, isolated district heating systems, which controlled temperature at a boiler plant.

The substations were the key energy efficiency measure. Draft design principles were prepared by the Kiev Research and Design Institute for Residential and Civil Construction (KievZNIIEP). Three typical designs were made for each of seven different substations, each a different size. Designs were created with coordination from respective authorities, to ensure compatibility with the building code (SNiP), and were approved by the district heating enterprise, Kievenergo. Installation was carried out in stages, with a limited number of buildings initially to allow for adjustments and modifications as needed in subsequent phases.

During the project preparation phase, Honeywell installed substations in four typical school buildings (school buildings comprised about 30% of the buildings), with funding from the United States Department of Energy to demonstrate the measures and potential for energy savings. The substations determined the expected level of energy savings from efficiency measures, compared with estimates made in a feasibility study. This preliminary work confirmed that the study's savings estimates would likely be achieved, and also helped promote public awareness about the upcoming project itself.

Institutional Support. The project's institutional support included: (a) creation of a Project Implementation Unit (PIU), responsible for managing and monitoring the project; (b) a public awareness campaign; and (c) training of the PIU, public building managers, maintenance personnel, and local contractors.

3. Cost, Financing, Benefits, and Effects

Project Cost

The total equipment cost associated with the program, including building improvements and heat meters, was estimated at US$26.2 million when the project was appraised. An additional US$4.2 million was budgeted for audits, institutional support, and project administration. In the project's final year, about US$3 million remaining in the loan was cancelled.

Financing

The project's financing was comprised of a World Bank loan (US$18.3 million), Swedish Government grant (US$2.0 million) and KCSA funds (US$10.1 million). The World Bank loan covered most costs for supply and installation of the energy efficiency measures while institutional support was financed by the grant.

Results and Benefits

The project resulted in: (a) energy efficiency improvements in key public buildings in Kiev; (b) development of an energy efficiency market and related service industry; and (c) increased public awareness of the efficient use of energy in Kiev. Detailed results are provided below.

***Energy Efficiency Improvements in Public Buildings*:** Savings on heat consumption in public buildings reached 214,440 Gcal (normalized by degree days in base line year) by the end of 2004, or about 17% compared to heat consumption before the retrofitting. As installation of energy conservation systems and equipment intensified in the first half of 2005, heating cost savings were expected to reach about 26% (about 333,423 Gcal/year), starting in 2006, and in outer years as all of the installed energy-saving devices would be operating for a full year. Energy saving measures were selected using results of the building audits and based on specific building needs and characteristics. Besides new heat substations, other major efficiency systems and equipment included radiator reflectors, weather-stripping, improved controls for water heaters, modern shut-off valves, and modern shower units for healthcare buildings, primarily maternity hospitals and general hospitals. Table 1 provides a full description of these measures. Low-flow shower heads were deemed unacceptable, and 3,727 modern shower units were installed in healthcare buildings instead. KCSA also proposed additional measures during implementation, including improved hot water control equipment at kindergarten substations, and modernized shut-off valves and thermal insulation of heating pipes in substation rooms. In total, 2,050 water mixers were installed in kindergartens and 400 modernized shut-off valves in substations.

Table 1. Energy Efficiency Measures Implemented Under Project

Indicator	Appraisal Estimate	Actual
Number of buildings retrofitted	1,302	1,302 with heat meters 1,270 with weather stripping 1,173 with heat substations 940 with radiator reflectors 260 with 37° C water mixers

		200 with shut-off valves 14 with shower units 3 with new windows

A cash flow analysis for Kiev City was made at project completion. It showed that, under conservative assumptions, Kiev City and its district administrations would generate sufficient savings on heating bills to cover annual debt service requirements and annual operating and maintenance costs over a seven-year period after the project was completed.[4] Reductions in the city's heating bills (2005-2011) are projected at US$31.7 million.

A reduction of 110,108 tons per year of CO_2 emissions resulted from reduced natural gas consumption in district heating plants, for the same service levels provided before the project began. Other economic benefits included a positive impact on people's health and productivity; educating those using public buildings about heating service levels; improved energy security through reduced natural gas imports; and increased employment for the design, fabrication, and installation of project equipment.

***Development of an Energy Efficiency Market and Related Service Industry*:** The project had a direct impact creating an energy efficiency market which fostered the development of an energy efficiency service industry. During the project's early years, only a few domestic suppliers of energy efficiency systems/equipment were qualified to participate in bidding for project supply and installation contracts. However, over time many more companies were established, some with foreign participation. These companies manufactured and/or assembled energy efficiency equipment in Ukraine and competed aggressively for project contracts. In the end, nearly all energy efficiency measures were implemented by domestic companies--of 29 contracts for supply and installation of energy efficiency measures, 27 were signed with 13 local companies. In addition, technical audits and designs were performed by domestic firms and design institutes, some privatized during the project period. These companies are able to provide these services to other areas of Ukraine, allowing for broader replication.

***Promoting Public Awareness of the Need for More Efficient Use of Energy in Kiev*:** The project was instrumental in building public awareness of energy efficiency in Kiev. Energy savings materials were prepared for schools and used to teach children the value of saving energy. In addition, videos shown on two local TV channels at the end of the heating season raised the level of awareness in the city regarding the benefits of energy efficiency. A public awareness campaign was launched at the end of the project, with assistance from the World Bank, to disseminate information on the project's success. As a result, the project has become well known by municipalities throughout the country, and a number of other cities have requested information about the measures implemented in Kiev and expressed interest in undertaking similar energy saving projects.

The project also helped KCSA's institutional development. It emphasized the need for "full payment" discipline and cost recovery tariffs, so energy savings from project investments could translate into real financial savings. KCSA regulated tariffs on heating

[4] For a full cash flow analysis, see Annex 3 of Project Implementation Completion Report.

utilities operating in the municipality at levels that allowed heating companies to recover operations and maintenance (O&M) costs over the project period. Delinquent heat (and other utility) bills by KCSA and its organizations were eliminated with the project's start-up, and KCSA and its district administrations have been able to maintain full payment performance of heating bills, usually with some advance payment, throughout the project period. KCSA's performance in this regard was outstanding in the Ukrainian context, and proved an excellent example for other cities in the country. The project also demonstrated that proper O&M arrangements for modern energy efficiency equipment were needed.

4. Project Innovation

Some innovative features of the project follow:

- The project integrated pricing and supply-side and demand-side efficiency improvements to ensure coordinated, effective implementation.
- The design was based on practical energy efficiency measures (e.g., high rates of return, quick and easy to implement), and targeted public end users (e.g., the ability to raise counterpart financing, exposure to cost-reflective tariffs).
- Based on the early procurement phase, the PIU determined that procurement based on the supply and installation procedure was preferable and more cost effective than separate tenders for each.
- KCSA ensured adequate O&M management by transferring ownership of heat meters to the heating utility, Kievenergo, and the heat substations to the ownership of KCSA's district administrations. The administrations held competitive tenders with service companies to ensure proper O&M of the modern equipment that had been installed.
- The PIU was transformed from a municipal budgetary organization into a municipal enterprise during the latter part of the project period, and is now a consultant to KCSA for public procurement activity, and/or to other cities interested in similar energy efficiency projects.

5. Lessons Learned

The project focused on buildings owned by a single organization (KCSA) and was implemented by a special unit (PIU) set up by KSCA. This simplified the project and allowed project leaders to meet deadlines and remain on budget, given it was much easier to make changes in buildings dealing with the same owner.

Strong project ownership, a results-oriented focus, and qualified management and staff were critical to the project's success. This somewhat mitigated the adverse effects of government bureaucratic requirements, which led to delays and poor cooperation from outside agencies. KCSA established a high bar for other Ukrainian cities in the way it managed its energy efficiency activities, including its exemplary performance in heating bill payment discipline and resolving delinquent utility bills. KCSA and its PIU have

created an outstanding example of how future projects in the country could be executed.

A few problems were encountered which delayed implementation. For example, KCSA changed PIU's legal status to a municipal enterprise during the next-to-last year of the project, causing a delay in some project work--primarily a few retrofit measures funded by the World Bank loan of which a portion had to be cancelled. A mix of supply-side and demand-side measures under the project was needed to attain optimal efficiencies, but supply-side measures were put in place first, followed by end-use upgrades, and this proved time-consuming. As a result, some demand-side measures could not be completed during the project period. Other technical issues related to installation of various equipment and systems included radiator reflectors not installed in 362 buildings due to poor baseline configurations, weather stripping not possible in 32 buildings due to poor window conditions, low-flow shower heads deemed not technically feasible, etc. The lesson learned was to keep the project design as simple and straightforward as possible, and allow a cushion in the work schedule for unforeseen circumstances that may result from changing government processes and/or requirements.

Proper O&M of heat substations and energy measuring equipment is essential to ensure energy savings will continue in the future. KCSA acknowledged the importance of monitoring to ensure meters are properly functioning and track energy savings, and it continues to call on the PIU to perform this task. Also, KCSA required that its district administrations enter into contracts with competent energy service companies to ensure proper O&M of installed equipment. Future energy efficiency projects should include a system allowing for the operation of equipment and benefits achieved to be monitored, during project implementation and after completion.

The project was built on a Ukraine Government policy framework which called for cost-reflective tariffs at the municipal level. The tariff level during the project moved toward full recovery of heating services costs. The idea was to ensure that energy consumers were sent the right signal to encourage energy conservation. Maintaining cost-recovery heat tariffs was required under the complementary Kiev District Heating Improvement Project and reinforced under this project. Proper billing and payment discipline was further supported under the parallel district heating program, which provided heat meters to consumers and supported billing of heat services based on meter readings instead of norms. (Consumption-based billing was introduced only after installation of heat meters to ensure an effective reduction in heating bills.) This project further supported better payment discipline of heating bills by requiring that delinquent bills be eliminated and future heating bills be settled by Kiev City. This kind of billing and collection is essential to provide adequate incentives for energy efficiency measures to be adopted and maintained.

6. Financial Sustainability, Transferability, and Scalability

Heat tariffs on public buildings and other heat consumers allowed the major heat utility, Kyivenergo, to cover O&M costs during the project period. Tariffs remained at Ukrainian hrivnya or UAH57.5/Gcal (on average about US$10.7/Gcal) during 2000-04, but rose to UAH 64.73/Gcal (about US$12.82/Gcal) at the start of 2005. Heat tariffs fell

by 40-50% during the project period, primarily from the sharp drop in the price of fuel used to produce heat shortly after start-up--from about US$80/1,000 cubic meters for gas at the time of the project's appraisal. Thus, heat costs savings were less than originally estimated. Nevertheless, Ukraine's ongoing gas price increases and an expected rise in future heat tariffs will amplify the value of energy conservation as a result of the project. The energy savings generated have lowered heating bills for owners of the public buildings. To continue benefitting from this, the owners are ensuring proper O&M of key energy-saving equipment, e.g., heat substations and heat meters. KCSA has retained staff from the PIU to keep track of the energy savings benefits. With gas prices expected to rise in the future, resulting in higher heating tariffs, cost savings on energy will grow more valuable than ever, and provide further incentives for building owners to properly maintain their energy-saving equipment.

The project investments generated robust economic benefits with an economic net present value (ENPV) of US$11.2 million and an economic internal rate of return (EIRR) of 26.6%, which compare favorably to estimates made during the project appraisal of US$6.2 million and 20.2%, respectively. This performance is due to a rise in consumer surplus, a result of improvements in service and inclusion of environmental benefits in the post-project evaluation, namely CO_2 emissions trading, for which there was no market at the time of appraisal (making it impossible to estimate this economic value.)[5]

The project has served as a positive demonstration for other Ukrainian cities with district heating systems servicing public buildings. Many of these buildings are plagued with substantial heating loss and have no means of regulating heat consumption. A number of other cities in Ukraine have made requests for information about the energy efficiency measures implemented in Kiev, and expressed interest in undertaking similar energy saving projects. The project has also had a wider impact throughout the country by helping develop a domestic energy efficiency service market, with a number of companies now able to compete for technical audit contracts covering buildings and installation of energy efficiency measures.

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[5] Environmental benefits from the lower emissions were calculated based on a conservative price of US$5/ton of CO_2 emissions, as applied by the World Bank Carbon Fund in 2005.

ANNEX: CITY AND PROJECT PROFILE

CITY PROFILE

1. Name of the City	**Kiev**
2. Area	**Ukraine**
3. Population	**2.6 million (2001)**
4. Population Growth Rate	**-0.675%**
5. GDP of the City	**US$9.2 Billion**
6. GDP Growth Rate	**7.7%**
7. GDP per Capita	**US$3,408**

PROJECT PROFILE

1. Project Title	**Kiev Public Buildings Energy Efficiency Project**
2. Sector	**Public buildings**
3. Project Type	**District heating and energy efficiency services**
4. Total Project Capital Cost	**US$27.4 million**
5. Energy/Cost Savings	**333,423 Gcal by 2006 (26%)**
6. Internal Rate of Return	**26.6%**
7. Project Start Date	**27-JAN-2000**
8. Project End Date	**30-JUN-2005**
9. % of Project Completed	**Completed**

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