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MUNICIPAL HEATING REFORM PROJECT (MHR)

ENERGY MONITORING REPORT FOR IMPLEMENTED DEMONSTRATION PROJECTS: HEATING SEASONS 2010-2011, 2011-2012

August 2012

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Executive summary

This monitoring report is prepared as part of the implementation of the USAID Municipal Heating Reform (MHR) Project in Ukraine. The USAID MHR Project cooperates with the Government of Ukraine and local authorities on implementation of positive systemic changes in the heating sector on three relevant levels: national, regional and end-user. This promotes the creation of a financially viable and stable district heating sector that delivers reliable quality service to consumers, public institutions, and local industries and businesses, while achieving significant energy savings.

At the local level, the USAID Project cooperates with partner cities on municipal energy assessments, development of municipal energy plans, development of legal and technical specifications for metering equipment, implementation of energy efficient technologies, and monitoring results.

The USAID MHR Project and its partners, based on previously developed energy audit reports that were used as inputs for Municipal Energy Planning, selected facilities in which to implement 34 demonstration projects. Results have been measured for 20 of these projects to date.

Based on the previously developed energy monitoring methodology and the data compiled through the project to date, the USAID MHR Project prepared this monitoring report. This report provides information on the actual energy and financial savings achieved during the monitoring period, the comparison with estimated annual savings, and the calculated payback periods.

The implemented demonstration projects can be broadly grouped into four key categories based on the segment of the district heating system they cover. These are:

1. Generation systems: boilers
2. Heat distribution networks
3. Regulation and consumer interface: heat metering and control equipment
4. End-use: thermal modernization of buildings

According to the monitored energy savings, the following decreases in energy consumption were achieved:

- Generation systems: boilers – 10% of natural gas due to replacement of inefficient boilers; 31.5% of fuel from rebuilding boiler houses, replacing inefficient boilers, and switching from fuel oil to natural gas; 3.5% of boiler house's electricity consumption due to installation of variable frequency drives at ventilators.
- On the single heat distribution network activity – 8% reduction of electricity consumption for the district heating production plant from rebalancing the heat and hydraulic operating modes, which allowed switching off a system network pump during January and February 2012. Because this activity was still in its early stages and only monitored part of the heating season, these figures only reflect recorded savings starting March 2012.
- Regulation and consumer interface: heat metering and control equipment – average 16% reduction in building energy consumption.
- End-use: thermal modernization of buildings – nearly 45% reduction in building energy consumption.

Overview of District Heating System in Ukraine

In Ukraine, district heating is defined as heat produced at various heat sources (such as combined heat and power plants, hot water boilers, and industrial waste heat), transported via heat networks, and sold to third parties. When designed and operated efficiently, district heating plants can provide heat with greater efficiency and better pollution control than localized boilers.

There is huge potential for energy efficiency gains in each part of the district heating supply chain: production, transmission, distribution and end-use. The exact amount of energy loss is difficult to measure due to lack of metering equipment, but the Ministry of Regional Development, Construction, Housing and Communal Services (MinRegion) estimates that up to 60% of energy is wasted within the district heating supply chain – and that the largest losses occur at end user facilities. In addition to the boilers, circulator pumps that are common in hydraulic heating systems are large end-users of energy. The efficiency of such pumps could be an important focus going forward due to impending EU circulator pump efficiency standards.

The sharp rise in imported natural gas prices in 2011-2012 also highlighted the urgent need to modernize the country's district heating systems, to improve their energy efficiency and reduce energy losses. Improving the sector's energy efficiency can significantly reduce Ukraine's natural gas consumption and its dependence on imported natural gas. Today, heat boilers and electric power plants account for almost 40% of all natural gas consumption in Ukraine.

For all types of energy, improving efficiency at all stages – from generation to final consumption – is vitally important. Analyzing efficiencies on the end-use side is especially important, primarily because it provides the information needed to understand the true loads that need to be served. Accurate knowledge of end-use needs and detailed consumption patterns can facilitate accurate design and development of the district heating system as a whole. In turn, this supports both optimized operation and investment planning. In the case of Ukraine, lack of reliable heat consumption data presents a major problem, creating further barriers for customer orientation and optimization of service quality. Existing information is based largely on normative consumption or estimates. Thus, it is very important to meter heat consumption and to improve heating demand and supply statistics.

According to the results of almost 400 energy audits of buildings conducted in 25 partner cities during implementation of the USAID MHR Project, estimates of energy-efficiency potential in buildings vary from 30% to 60%. Most of the estimates in these audits show that 30% energy savings in buildings seems quite achievable at a relatively low cost, and that even higher energy savings are technically possible.

Lack of metering equipment in buildings is a fundamental barrier for successful reforms and improvements in energy efficiency. Without end-use metering and consumption-based billing, district heating companies have no incentive to reduce costs and end-users have little incentive for consuming less energy.

Distribution and transmission networks are in urgent need of reconstruction or improvement because energy losses in these networks are high – estimated at roughly 25% of generated heat energy. These networks offer significant potential for energy savings, but at considerable costs. Reducing

transmission losses would not only eliminate energy waste, but would also improve the reliability of heat supply and customer satisfaction, which tends to be strongly correlated with fee collection rates.

Most existing heat generation plants are old and their energy efficiency is low. Replacing or modernizing the stock of existing heat generation plants is vital to efforts aimed at reducing energy consumption in the heating sector. Based on the energy audit reports prepared for 25 partner cities during the implementation of the USAID MHR Project, district heating plants alone have the potential to achieve cost-effective reductions in energy losses of up to ten percent. Significantly greater savings would be likely if end-use (demand-side) energy efficiency measures are implemented, which would result in the opportunity to eliminate or reduce the size of a number of heating plants.

Nonetheless, despite the estimated achievable potential for reducing heat energy consumption in Ukraine, there has been limited implementation of energy efficiency measures by authorities, suppliers and consumers. One of the key barriers for accelerating implementation of energy efficiency measures is the lack of empirical evidence and awareness regarding the effectiveness of such measures. For that reason, the USAID MHR Project will implement 34 demonstration projects in 13 partner cities on both the supply and demand sides of district heating systems, in order to educate authorities, suppliers and consumers about the immediate results that energy efficiency can deliver. Twenty-one of these demonstration projects were finished before the end of heating season 2011-2012 and 20 of them are included in this monitoring report.

Overview of Implemented Demonstration Projects

The USAID MHR Project and its partners, based on previously developed energy audit reports, selected both supply- and demand-side facilities in which to implement demonstration projects. The list of all demonstration projects, which includes the completed, ongoing and monitored projects, is provided below, including information on the partners, costs, and estimated annual savings in accordance with the energy audits:

#	Project Name / Partner	Estimated Financing, USD		Estimated Annual Savings		Status of completion and monitoring for the end of heating season 2011-2012
		MHR Project Contribution, "000" USD	Partners Contribution, "000" USD	Cost "000" USD	Energy Savings, "000" m^3 of Natural Gas	
1	"Modernization of the Heating System in the 3rd and 4th Zones of Kramatorskteploenergo" and setup of heat and hydraulic operating modes", "Kramatorskteploenergo" LLC, Kramatorsk	247	281	400	1250	completed/monitored
2	"Implementation of Energy Efficiency Measures for the kindergarten "Svetlyachok" located at Ozerna St. 71", Myrhorod City Council, Myrhorod	90	72	12	20	completed/not monitored

#	Project Name / Partner	Estimated Financing, USD		Estimated Annual Savings		Status of completion and monitoring for the end of heating season 2011-2012
		MHR Project Contribution, "000" USD	Partners Contribution, "000" USD	Cost "000" USD	Energy Savings, "000" m^3 of Natural Gas	
3	"Implementation of energy-efficiency measures at kindergarten "Kazka", located at Pushkina St. 4", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove	47	37	20	24	completed/monitored
4	"Implementation of energy-efficiency measures at kindergarten "Kosmonavt", located at Chapayeva St. 18B", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove	65	37	22	26	completed/monitored
5	"Installation of network heating water meters for city blocks", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove	55	33	34	90	completed/not monitored
6	"Installation of individual heating water meters in private sector", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove					completed/not monitored
7	"Adjustment and regulation of the heating networks", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove		125	20	55	completed/not monitored
8	"Developing an energy- and environment-efficient system of heat supply for the city of Kurakhove" and "Development of design documentation for the heat substations in Kurakhove", "Skhidenergo" LLC, Kurakhove City Council, Kurakhove		42			completed/not monitored
9	"Reconstruction of a boiler room with the replacement of the "NIISTU" boilers, located at Revolutsii St. 61", "Krymteplocomunenergo" (Yevpatoria Branch), Yevpatoria	38	60	60	125	completed/monitored
10	"Automation of fuel combustion regimes for the boilers located at Internatsionalnaya St. 135a.", "Krymteplocomunenergo" (Yevpatoria Branch), Yevpatoria	31				completed/monitored
11	"Reconstruction of boiler room, including boiler replacement and gasification, located at 1\2 Tuchina St, Yevpatoria ", Yevpatoria City Council, "Krymteplocomunenergo" (Yevpatoria Branch), Yevpatoria	34	305	33	78	completed/monitored

#	Project Name / Partner	Estimated Financing, USD		Estimated Annual Savings		Status of completion and monitoring for the end of heating season 2011-2012
		MHR Project Contribution, “000” USD	Partners Contribution, “000” USD	Cost “000” USD	Energy Savings, “000” m^3 of Natural Gas	
12	“Measures aimed at improving energy efficiency in the Yevpatoria General Hospital (communal health care facility) located at the address: 39 Nekrasova St, Yevpatoria ”, Yevpatoria City Council, Yevpatoria	153	260	76	73	completed/monitored
13	“Partial Modernization of heating system and insulation of common areas”, HOA "Pokolinnya", Kramatorsk City Council, Kramatorsk	57	66	12	20	completed/monitored
14	“Modernization of multi apartment residential building using automated heating management system”, HOA "Vidrodzhenya", Lutsk City Council, Lutsk	12	12	12	36	completed/monitored
15	“Installation of weather based heating control system, insulation and replacement of pipes, energy efficient lighting”, HOA "Bilya Parku", Lviv City Council, Lviv	6	6	2	5	ongoing/not monitored
16	“Thermal insulation of external walls, automated weather based heating control system”, HOA "Mariya", Lviv City Council, Lviv	32	40	8	30	ongoing/not monitored
17	“Thermal insulation of external walls”, HOA "Kamenyar", Lviv City Council, Lviv	41	50	11	35	ongoing/not monitored
18	“Installation of heat meters and weather-based control systems in 5 typical buildings”, Yevpatoria City Council, Yevpatoria	30		8	39	completed/monitored
19	“Installation of heat meters and weather-based control systems in 5 typical buildings”, Kramatorsk City Council, Kramatorsk	26		22	62	completed/monitored
20	“Installation of heat meters and weather-based control systems in 5 typical buildings”, Lutsk City Council, Lutsk	62		20	65	completed/monitored
21	“Installation of heat meters and weather-based control systems in 5 typical buildings”, Lviv City Council, Lviv	49		14	58	completed/monitored

#	Project Name / Partner	Estimated Financing, USD		Estimated Annual Savings		Status of completion and monitoring for the end of heating season 2011-2012
		MHR Project Contribution, "000" USD	Partners Contribution, "000" USD	Cost "000" USD	Energy Savings, "000" m^3 of Natural Gas	
22	"Implementation of energy efficiency measures in HOA "Vostok-2003", HOA "Vostok 2003", Alchevsk City Development Fund, Alchevsk City Council, Alchevsk	167	85	11	38	almost completed/monitored
23	"Improvement of energy efficiency for the building of general education school #19, located at Pavlohrad, Malinovskogo St. 2", Pavlohrad City council, PJSC "DTEK Pavlohradugol", Pavlohrad	168	164	45	120	completed/monitored
24	"Thermal modernization and renovation of multistory residential building located at Peremogy St. 10, including installation of automated heating control unit" , ESCO Lutsk Communal Systems, Lutsk	50	51	12	40	completed/monitored
25	"Energy efficient renovation of the kindergarten #71 (including windows replacement, walls insulation and roof modernization) located at Chapayeva St. 6a, Chernihiv", Chernihiv City Council, Chernihiv	114	143	16	32	completed/monitored
26	"Replacement of windows with metal-plastic in educational establishments of Chernihiv", Chernihiv City Council, Chernihiv		92	8	11	ongoing/ not monitored
27	"Implementation of energy efficiency measures including insulation of external walls and installation of individual heating sub-station", HOA "Sharm-Kurakhove", Kurakhove City Council, Kurakhove	19	24	8	21	almost completed/monitored
28	"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", HOA "Almaz-Kurakhove", Kurakhove City Council, Kurakhove	21	27	13	38	almost completed /monitored
29	"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", HOA "Brigantina-Kurakhove", Kurakhove City Council, Kurakhove	20	25	4	11	almost completed /monitored

#	Project Name / Partner	Estimated Financing, USD		Estimated Annual Savings		Status of completion and monitoring for the end of heating season 2011-2012
		MHR Project Contribution, "000" USD	Partners Contribution, "000" USD	Cost "000" USD	Energy Savings, "000" m^3 of Natural Gas	
30	"Implementation of energy efficiency measures in the city of Dzhankoy", Dzhankoy City Council, Dzhankoy	38	50	12	35	ongoing/not monitored
31	"Equipping heating systems of pilot buildings in Krasnoperekopsk with metering and heat supply regulation equipment", Krasnoperekopsk City Council, Krasnoperekopsk	38	63	66	177	ongoing/not monitored
32	"Implementation of EE measures in six public buildings" , Lviv City Council, NEFCO, Lviv	88	624	100	250	ongoing/not monitored
33	"Implementation of the energy-efficiency measures in the city of Dnipropetrovsk" Dnipropetrovsk City Council, DTEK, Dnipropetrovsk	250	744	100	250	ongoing/not monitored
34	"Implementation of the energy-efficiency measures in the city of Kyiv", Kyiv City Administration, DTEK, Kyiv	250	747	88	220	ongoing/not monitored

NOTE: Monitoring of some completed projects was not provided due to lack of information.

Full list of the agreements, including description of implemented energy efficiency measures, sources of financing, partners and other important information on the projects, is presented in Annex 1.

Hereinafter, the report will focus only on the monitored completed or partially completed demonstration projects during heating seasons 2010-2011 and 2011-2012.

These demonstration projects can be broadly grouped into four key categories based on the segment of the district heating system they cover. These are:

1. Generation systems: boilers
2. Heat transmission/distribution networks
3. Regulation and consumer interface: heat metering and control equipment
4. End-use: thermal modernization of buildings.

Generation Systems: Boilers

In the first category (generation systems), the main energy efficiency improvement measures, implemented within the framework of the USAID MHR Project, targeted the boilers. The measures included the following:

- Replacement of "NIISTU"-series boilers, which are widespread in Ukraine (with an estimated number of 100,000) and have low combustion efficiency, with high efficiency boilers. In addition, the boiler fuel combustion regimes were automated and variable frequency drives (VFDs) were installed on the dampers. Such demonstration projects were implemented in three boiler houses in Yevpatoria. Additionally, one inefficient district boiler with high emissions of pollutants that operated on mazut was replaced with a more efficient and less polluting natural gas fired boiler. The new boiler was connected to a new natural gas line.

Picture 1. Newly installed high efficiency boilers in Yevpatoria

Heat Transmission & Distribution Networks

Most district heating networks in Ukraine were built in the 1960s through 1980s without any application of thermal insulation, and have been in use far beyond their optimal operational life spans. For this reason, existing heating networks are characterized by large leak loads, high levels of heat loss, and differing pressure levels at end-use locations, e.g., buildings. This results in the total system being over-pressurized; in addition, the pumping capacity needed to convey hot water to the end-users in a given service territory is much greater than necessary. Reducing such imbalances can enable the district heating networks to take pumps off line.

The USAID MHR Project supported the modernization of the "Heating System in the 3rd and 4th Zones of Kramatorskteploenergo and setup of heat and hydraulic operating modes" with installation of dispatching systems and heat exchangers, which allowed significant reduction of the inefficient usage of this district heating system.

Another project aimed at modernization of district heating systems was implemented by DTEK Company in Kurakhove, based on the MHR Project's recommendations, which were incorporated into the Kurakhove Municipal Energy Plan.

Picture 2. Reconstructed and insulated pipes, installed heat exchangers in Kramatorsk

Regulation and Consumer Interface: Heat Metering and Control Equipment

Heat energy metering equipment is a complex combination of technical equipment and software, which measures energy consumption for heating needs, volumetric flow rates, heat carrier temperature in the supply and return pipelines, and the registration of these parameters.

A heat meter has an indicator/display that shows the following heat consumption parameters in a simple format:

- total flow in supply and return pipelines (m^3);
- temperature of heat carrier in supply and return pipelines (^oC);
- work time (hours);
- total heat consumption (Gcal); and
- cumulative data.

An automatic weather-based control system is a set of technical equipment used for controlling the heat carrier flow based on preprogrammed and measured parameters. Under the USAID MHR Project, the installed control systems replaced obsolete hydraulic elevator connections to the district heating system. The new automatic control systems provide temperature control in the internal supply pipeline of the building heating system according to the outside temperature and to the heating supply schedule. The computerized system controller stores the settings of the heat consumption schedule. The control equipment serves two main functions:

- It provides for the mixing of the heat carrier from the district heating system supply pipe and the return pipe of the building heating system using a circulator pump; and
- It controls the heat carrier flow from the district heating system using an electric control valve.

Picture 3. Installed heat metering and control equipment

End-Use: Thermal Modernization of Buildings

According to the energy audit reports, the most inefficient sector of district heating systems is end-use consumption. Categories of average annual heat consumption per square meter of buildings are presented in Chart 1:

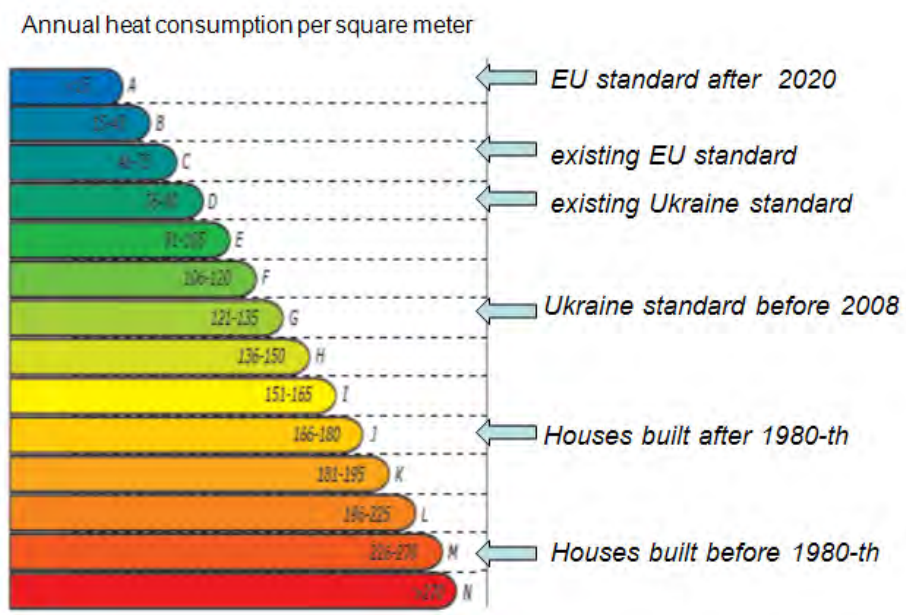
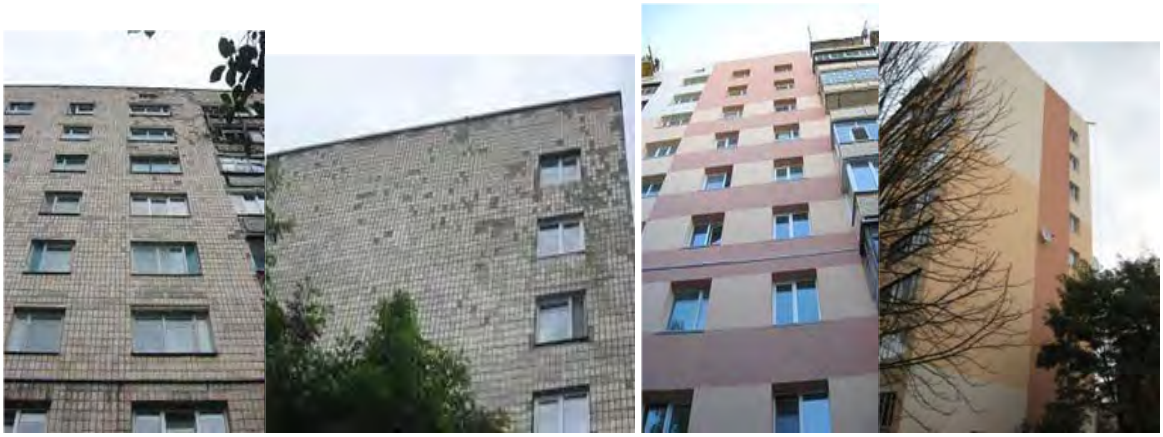


Chart 1. Comparison of energy consumption standards for constructed buildings

Additionally, the majority of buildings are characterized by failure to comply with healthy indoor temperature norms and some of the building heating systems had inconsistent pressure levels, which results in uneven temperatures throughout the building (hot and cold apartments or rooms).

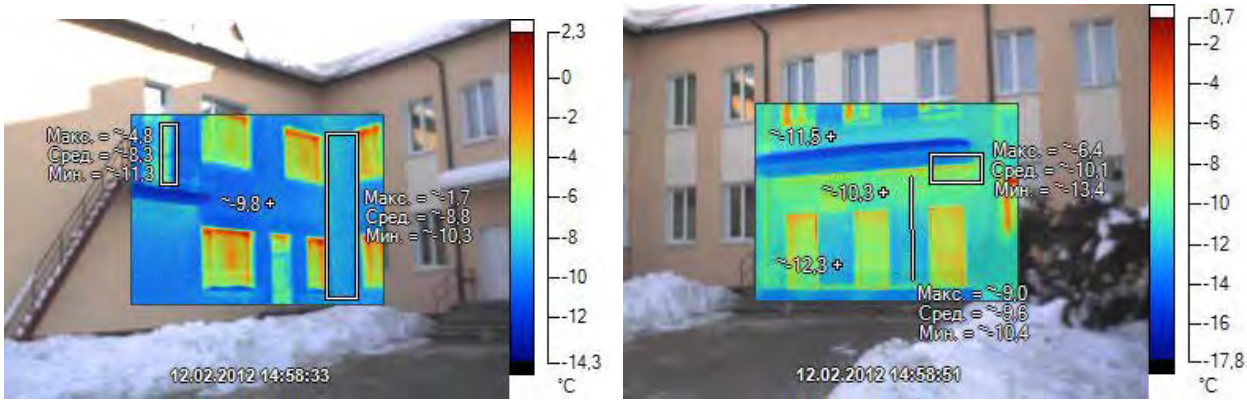
Based on previously prepared building energy audits, the USAID MHR Project, together with co-funding partners, carried out thermal modernization of eight different types of buildings, including residential buildings, kindergartens, a school, and a health care clinic. All of these buildings were additionally insulated using different materials, such as rock wool or foam blocks, and systems, such as ventilated facades or sealed insulation. Other implemented measures included rehabilitation of the ventilation systems and installation of energy efficient light bulbs in the Yevpatoria health care clinic, and installation of a hipped roof with insulation in Chernihiv kindergarten # 71.



Picture 4. Building of HOA in Lutsk before and after renovation

Picture 5. Building of HOA in Alchevsk before and after renovation

Picture 6. Building of school #19 in Pavlohrad before and after thermal renovation



Picture 7. Quality check of Kindergarten #71 additional insulation in Chernihiv

Monitoring Methodology

The USAID MHR Project prepared an energy monitoring methodology for the heat metering projects that included the use of an Excel-based tool. Based on this methodology, the project presented training sessions for city energy managers and building operators and managers on the procedures for monitoring energy savings.

In accordance with the methodology, the energy savings are calculated by comparing the calculated baseline energy consumption (heat, electricity, natural gas, oil, etc.) of each facility to its actual consumption after energy efficiency project implementation. The baseline is calculated based on two factors: the aggregate installed capacity of the boilers or building heating systems, and the average outdoor temperature for the monitoring period. Each point on the baseline graph (see Figure 1 below) corresponds to the calculated energy consumption of the facility prior to implementation of the energy efficiency project. The data for developing the baseline consumption were obtained from the owner of the facility in energy metering reports. (For sample data from the report, see Annex 6.)

The baseline consumption could be calculated in two ways: according to the previously installed metering equipment, or according to the existing standard "Ukrainian Normative Value on Fuel and Heating Needs for Residential and Public Building Heating" (KTM 204 Ukraine 244–94), by using the following equation:

$Q_{period}=q_0*(t_{indoor}-t_{av.\ o.})/(t_{indoor}-t_{cold.})*n*24$, where

q_0 = heat capacity of the facility, (received from technical specifications, heat supply contracts, energy audit reports presented in Annex 1)

t_{indoor}= 18^0C – estimated indoor temperature for the residential buildings and schools, 20^0C – for kindergartens.

$t_{cold.}$=estimated minimum outdoor design temperature, depending on the city. (See Annex 3)

$t_{av.o}$ – average recorded outdoor temperature for the monitoring period

n – days in monitoring period

Two examples with different calculations of baselines are presented in Annexes 4 and 5.

The starting point of the baseline corresponds to the installed heating capacity of the facility at the minimum standard temperature for the climate zone. The minimum heat consumption point is determined by the district heating company according to settings that are specific to the district and the facility.

Figure 1 illustrates the comparison of one building's baseline heat consumption (red line) to the building's actual consumption after the control equipment installation (black trend-line). This relationship can be described by a linear regression equation.

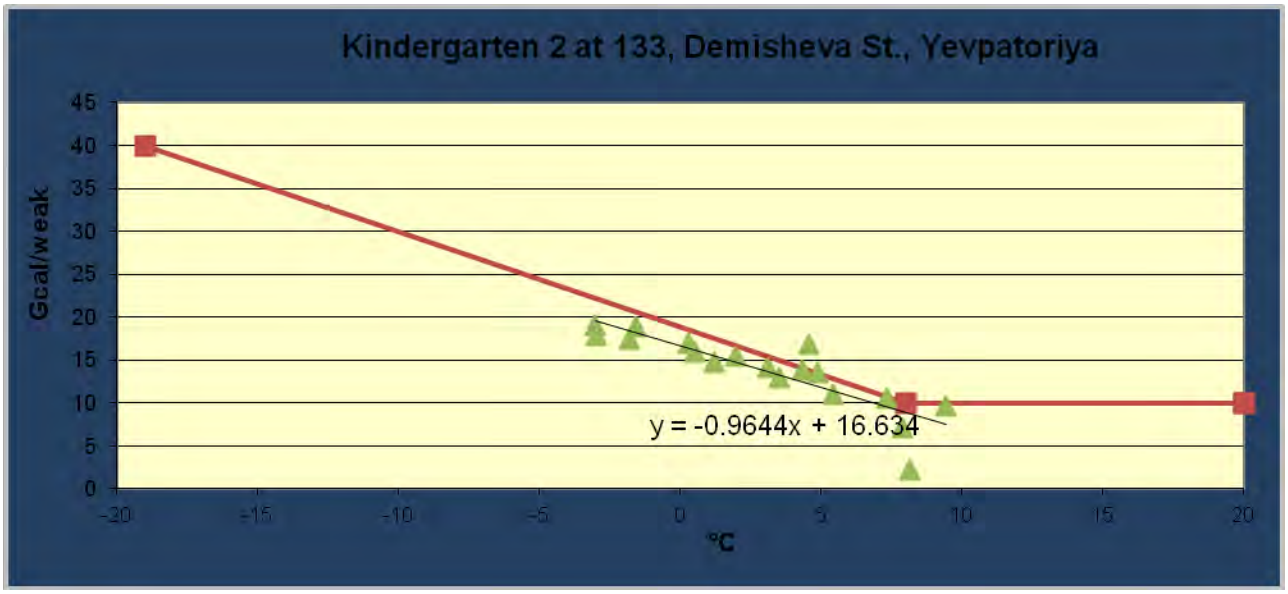


Figure 1. Sample chart: comparison of baseline and actual heat consumption

The actual heat consumption trend line corresponds to the monitoring period and can be used for operational monitoring, making prompt management decisions, and monitoring of energy savings. The actual heat consumption data points (green triangles) ideally should be located close to the trend line. The energy manager should monitor deviations and analyze their causes – e.g., equipment failure or pipeline breakage. The chart analysis provides a simple and reliable tool for addressing such issues promptly, often even before the problems become visible to the consumers. The chart also allows calculation of energy savings as the difference between the baseline and the actual heat consumption, as well as the level (percentage) of savings as a ratio of this difference and the baseline.

The detailed energy consumption monitoring methodology is available upon request from the USAID MHR Project.

Achieved Results

Generation Systems: Boilers

Project name/Partner	Monitoring period	Energy savings	Energy savings, kWh equivalent	% of base line
Reconstruction of boiler room, including boiler replacement and gasification, located at 1/2 Tuchina St., Yevpatoria *Yevpatoria City Council, "Krymteplocomunenergo" (Yevpatoria Branch)*	12/2011-3/2012	42,000 kg fuel oil	350,000	31.5
Reconstruction of a boiler room with replacement of the "NIISTU" boilers, located at 61 Revolutsii St. *"Krymteplocomunenergo" (Yevpatoria Branch)*	1/2011-3/2012	48,000 m^3 of natural gas	530,000	10
Automation of fuel combustion regimes for the boilers located at 135a Internatsionalnaya St. *"Krymteplocomunenergo" (Yevpatoria Branch)*	1/2011-3/2012	85,570 kWh	85,570	3.5*

NOTE: Level of savings, which was achieved at the dampers, where VFDs were installed was 47.5%. This saving resulted in 3.5% of total boiler house electricity consumption reduction.

Heat Distribution Networks

Project name/Partner	Monitoring period	Energy savings	Energy savings, kWh equivalent	% of base line
"Modernization of the Heating System in the 3rd and 4th Zones of Kramatorskteploenergo and setup of heat and hydraulic operating modes",*"Kramatorskteploenergo" LLC*	1/2012-3/2012	450,000 kWh	450,000	8

NOTE: Operations were intermitted during January and February 2012. Energy savings were only achieved starting March 2012.

Regulation and Consumer Interface: Heat Metering and Control Equipment

Project name/Partner	Monitoring period	Energy savings	Energy savings, kWh equivalent	% of base line
"Installation of heat meters and weather-based control systems in 5 typical buildings" *Yevpatoria City Council*	11/2010-3/2012	690 Gcal	802,500	27
"Installation of heat meters and weather-based control systems in 5 typical buildings" *Kramatorsk City Council*	1/2011-3/2012	433 Gcal	503,500	11
"Installation of heat meters and weather-based control systems in 5 typical buildings" *Lutsk City Council*	11/2010-3/2012	404 Gcal	470,00	11
"Installation of heat meters and weather-based control systems in 5 typical buildings" *Lviv City Council*	12/2010-3/2012	1187 Gcal	1,380,000	29

End-use: Thermal Modernization of Buildings*

Project name/Partner	Monitoring period	Energy savings	Energy savings, kWh equivalent	% of base line
"Measures aimed at improving energy efficiency in the Yevpatoria General Hospital (communal health care facility) located at the address: 39 Nekrasova St, Yevpatoria " *Yevpatoria City Council*	11/2011-3/2012	502 Gcal	584,000	61
"Implementation of energy efficiency measures in HOA "Vostok-2003" *Alchevsk City Council, Alchevsk City Development Fund, HOA "Vostok-2003"*	11/2011-2/2012	171 Gcal	199,000	48
"Improvement of energy efficiency for the building of general education school #19, located at Pavlohrad, 2 Malinovskogo St." *Pavlohrad City Council, PJSC "DTEK Pavlohradugol"*	12/2011-3/2012	260 Gcal	302,000	37
"Thermal modernization and renovation of a multistory residential building located at 10 Peremogy St., including installation of automated heating control unit" *ESCO Lutsk Communal Systems*	10/2011-3/2012	799 Gcal	929,000	59
"Energy efficient renovation of the kindergarten #71 (including windows	10/2011-3/2012	175 Gcal	203,000	44

replacement, walls insulation and roof repair) located at 6a Chapayeva St., Chernihiv", *Chernihiv City Council*				
"Implementation of energy efficiency measures including insulation of external walls and installation of individual heating sub-station", *HOA "Sharm-Kurakhove", Kurakhove City Council*	10/2011-3/2012	70 Gcal	81,500	47
"Partial modernization of heating system" HOA "Pokolinya", Kramatorsk City Council	12/2011-3/2012	496 Gcal	577,000	30
"Implementation of energy-efficiency measures at kindergarten "Kazka", located at 4 Pushkina St." "Skhidenergo" LLC, Kurakhove City Council	1/2011-3/2012	300 Gcal	349,000	33
"Implementation of energy-efficiency measures at kindergarten "Kosmonavt", located at 18B Chapayeva St." "Skhidenergo" LLC, Kurakhove City Council	1/2011-3/2012	183 Gcal	213,000	32
"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", *HOA "Almaz-Kurakhove", Kurakhove City Council*	10/2011-3/2012	87 Gcal	101,200	14
"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", HOA *"Brigantina-Kurakhove", Kurakhove City Council*	10/2011-3/2012	49 Gcal	57,000	16

NOTE: * - Some of the demonstration projects in end-use energy efficiency also included installation of metering and control projects and could not be separated.

** - achieved reduction of consumption highly depends on implemented measures and status of implementation. Some of the projects are in ongoing status. Full information about measures and status is presented in Annex 1.

Comparing of Achieved Results with Previously Estimated Annual Savings

Since actually achieved results after implementation of demonstration projects are measured and calculated only for short period of time with specific climatic conditions and could not demonstrate average energy savings, it is recommended to use average data for comparison of achieved and previously estimated results. Quantity of demonstration projects for comparison depends on existing information for monitoring.

Calculation of the average annual baseline consumption could be done using the same methodology for calculating the actual baseline consumption. However, according to the existing standard "Ukrainian Normative Value on Fuel and Heating Needs for Residential and Public Building Heating" (КТМ 204 Ukraine 244–94), the average baseline consumption should be calculated by using average outdoor temperature for the heating season in USAID MHR Project partner cities and the number of heating degree days in a heating season, which is defined in Annex 3.

Energy savings, in this case, could be calculated as a percentage by multiplying the average annual baseline consumption by the achieved energy savings.

Financial savings are calculated in accordance with the actual prices for energy sources.

		Cost of implementation, "000" USD	**Estimated Savings before implementation, "000" USD**	**Monitored (Calculated) Annual Savings, "000" USD**	**Simple Payback period in accordance with monitoring, years**	**Explanation of differences between estimated and calculated results**
1	"Implementation of energy-efficiency measures at kindergarten "Kazka", located at 4 Pushkina St." *"Skhidenergo" LLC, Kurakhove City Council*	84	20	11.4	7.4	Actual consumption before implementation of the project did not conform to the sanitary norms for indoor temperature (as low as +16°C in some rooms) After implementation of the measures the required temperature was achieved, but part of savings went to increasing the temperature. Therefore, monitored savings are lower than

		Cost of implementation, "000" USD	Estimated Savings before implementation, "000" USD	Monitored (Calculated) Annual Savings, "000" USD	Simple Payback period in accordance with monitoring, years	Explanation of differences between estimated and calculated results
						expected.
2	"Implementation of energy-efficiency measures at kindergarten "Kosmonavt", located at 18B Chapayeva St." *"Skhidenergo" LLC, Kurakhove City Council*	102	22	6.7	15.2	Actual consumption before implementation of the project did not conform to the sanitary norms for indoor temperature (as low as +14°C in some rooms) After implementation of the measures the required temperature was achieved, but part of savings went to increasing the temperature. Therefore, monitored savings are lower than expected.
3	"Reconstruction of a boiler room with replacement of the "NIISTU" boilers, located at 61 Revolutsii St." *"Krymteplocomunenergo" (Yevpatoria Branch)*	98	39	7.1*	13.8	Legislation on inefficient energy use, which the estimated energy savings calculated, was canceled at 2011. This resulted in lower actual savings.
4	"Automation of fuel combustion regimes for the boilers located at 135a Internatsionalnaya St." *"Krymteplocomunene*	31	21	7.6	4.1	Legislation on inefficient energy use, which the estimated energy savings calculated, was canceled at

		Cost of implementation, "000" USD	**Estimated Savings before implementation, "000" USD**	**Monitored (Calculated) Annual Savings, "000" USD**	**Simple Payback period in accordance with monitoring, years**	**Explanation of differences between estimated and calculated results**
	rgo" (Yevpatoria Branch)					2011. This resulted in lower actual savings.
5	"Reconstruction of boiler room, including boiler replacement and gasification, located at 1\2 Tuchina St., Yevpatoria " *Yevpatoria City Council, "Krymteplocomunenergo" (Yevpatoria Branch)*	339	33	57*	6	Higher monitored savings partly achieved because of tariff increasing for the energy resources after estimated savings were calculated.
6	"Measures aimed at improving energy efficiency in the Yevpatoria General Hospital (communal health care facility) located at: 39 Nekrasova St., Yevpatoria " *Yevpatoria City Council*	413	76	56.5	7.3	
7	"Partial Modernization of heating system" *HOA "Pokolinya", Kramatorsk City Council*	123	12	22.7	5.4	Obtained results are higher than expected due to implementation of additional energy efficiency measures by the owners after project was implemented
8	"Installation of heat meters and weather-based control systems in 5 typical buildings" *Yevpatoria City Council*	30	8	12.8	2.3	Higher monitored savings partly achieved because of tariff increasing for the energy resources after estimated savings were calculated.

		Cost of implementation, "000" USD	Estimated Savings before implementation, "000" USD	Monitored (Calculated) Annual Savings, "000" USD	Simple Payback period in accordance with monitoring, years	Explanation of differences between estimated and calculated results
9	"Installation of heat meters and weather-based control systems in 5 typical buildings" *Kramatorsk City Council*	26	22	12.5	2.1	Calculated savings are lower due to inappropriate management, maintenance and operation of equipment
10	"Installation of heat meters and weather-based control systems in 5 typical buildings" *Lutsk City Council*	62	20	46.5	1.3	Higher monitored savings partly achieved because of tariff increasing for the energy resources after estimated savings were calculated.
11	"Installation of heat meters and weather-based control systems in 5 typical buildings" *Lviv City Council*	49	14	41.8	1.2	Higher monitored savings partly achieved because of tariff increasing for the energy resources after estimated savings were calculated.
12	"Implementation of energy efficiency measures in HOA "Vostok-2003" *Alchevsk City Council, Alchevsk City Development Fund, HOA "Vostok-2003"*	252	11	7.9	23.4	Calculated savings are lower due to inappropriate management, maintenance and operation of equipment
13	"Improvement of energy efficiency for the building of general education school #19, located in Pavlohrad, 2 Malinovskogo St." *Pavlohrad City council, PJSC "DTEK Pavlohradugol"*	332	45	43.1	7.7	

		Cost of implementation, "000" USD	**Estimated Savings before implementation, "000" USD**	**Monitored (Calculated) Annual Savings, "000" USD**	**Simple Payback period in accordance with monitoring, years**	**Explanation of differences between estimated and calculated results**
14	"Thermal modernization and renovation of multistory residential building located at 10 Peremogy St., including installation of automated heating control unit" *ESCO Lutsk Communal Systems*	101	12	42.9	2.4	Obtained results are higher than expected due to implementation of additional energy efficiency measures by the owners after project was implemented
15	"Energy efficient renovation of the kindergarten #71 (including windows replacement, walls insulation and roof repair) located at 6a Chapayeva St., Chernihiv", *Chernihiv City Council*	257	16	14	16	
16	"Implementation of energy efficiency measures including insulation of external walls and installation of individual heating sub-station", *HOA "Sharm-Kurakhove", Kurakhove City Council*	43	8	7.2	6	Demonstration project was under implementation during the monitoring period, calculated savings will increase in next periods
17	"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", *HOA "Almaz-Kurakhove", Kurakhove City Council*	48	13	6.3	7.6	Demonstration project was under implementation during the monitoring period, calculated savings will increase in next periods

		Cost of implementation, "000" USD	Estimated Savings before implementation, "000" USD	Monitored (Calculated) Annual Savings, "000" USD	Simple Payback period in accordance with monitoring, years	Explanation of differences between estimated and calculated results
18	"Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station", HOA *"Brigantina-Kurakhove", Kurakhove City Council*	45	4	3.8	11.8	Demonstration project was under implementation during the monitoring period, calculated savings will increase in next periods

* - Monitored savings include decrease of the ecological tax for air pollutions

From the comparison of estimated results and calculated results achieved after implementation, the majority of demonstration projects indicate a decrease of energy consumption, which is in agreement with calculations in energy auditing reports.

Some of the objects did not achieve estimated savings due to unfinished implementation of energy efficiency measures.

Conclusions

Recommendations for heat metering, control installations and end-use in buildings projects

The results of installation of building heat meters and automatic heat controllers, and thermo-modernization of building envelope and equipment confirm the high efficiency of the implementation of these energy-saving measures in district and building heating systems.

Implementation of these energy-saving measures results in:

- achieving a significant reduction of unnecessary heat energy loss for heating of buildings during the heating season;

- improving comfort and health in the rooms of buildings and maintaining the required microclimate parameters in the premises even with changes in outdoor temperature; and

- conducting settlements with heat supply organizations for the actual amount of heat energy consumption based on the readings of heat meters, which is necessary to send factual economic signals to district heating companies and consumers to further stimulate work in the field of energy efficiency of buildings.

During the installation of building heat meters and automatic heat controllers, cases of non-compliance with normative values for performance indicators were reported. In some cases it was learned, *post facto*, that some buildings (schools, hospitals, apartment houses) had been operated at temperatures much lower than safe norms. An action sometimes undertaken by municipalities (or heating companies) to reduce the total amount of fuel purchased. However, in some instances some buildings, typically apartment buildings nearest the heat source where the tenants were billed based on norms, tenants had become comfortable with relatively high room temperatures (24 to 26C, or higher!). Some of these customers complained loudly when meters and automatic heat controllers, which were set at the normative safe heat levels of 18 to 20C were installed and they were billed by the meter readings. In some cases, the "lower than normal" historical temperature settings resulted in actual savings of fuel and energy resources (FER) that were lower than the calculated values.

In addition to the conditions above, other reasons for actual savings being different than calculated savings were the result of such things as:

- Mismatch of the heat capacity supplied to a building and the actual heat load of the building.

- Clogging in the pipes and radiators, which violated the hydraulic balance regime of the internal heating system.

- Lack of professional adjustment of the internal building heating systems.

Systemic effect from implementation of the projects on modernization of consumers' heat inputs and maximum fuel savings are possible only in case of implementation of these projects for all buildings of heat consumers that are connected to a particular source of heat generation. Otherwise, there will be an effect of heat flow from the buildings with heat controls to the buildings without them. Energy saved in retrofitted buildings will be emitted into the atmosphere through the open windows of non-retrofitted buildings. Therefore, overall system-wide savings of fuel and energy resources will be minimized.

Recommendations:

1. Projects of modernization of the consumers' heat inputs should cover all of the buildings of heat consumers that are connected to a particular source of heat generation.

2. In order to ensure and increase cost-effectiveness of the installation of building heat meters and automatic heat controllers, it is necessary to include measures aimed at improving efficiency of the connected units of the heating system such as repair/reconstruction and hydraulic and temperature re-balancing of the internal building heat systems and external networks.

3. Automatic control of heat consumption of buildings should be accompanied by mandatory equipment of the heat source with differential pressure control and automatic maintenance of the temperature schedule.

Recommendations for the district heating systems

Implementation of energy management for EFAP "Krymteplokomunenergo" according to recommendations in the Plan of Energy Efficient Improvements # 1 (PEE # 1) "Introduction of Energy Management" of the report on Yevpatoria heating system energy audit.

Conduct daily monitoring of fuel and electricity consumption by the boilers and other objects of the utility and document data using the form provided in PEEI # 1 in energy monitoring statements.

Perform analysis of efficiency of fuel and electricity use by the utility objects using the recommended Methodology for control and normalization (C&N):

– identify baselines (equations) regression for analysis of energy consumption of the utility objects.
– fix the deviation of actual expenditures from baseline values of FER (deficit/savings)
– calculate the final value of savings/excessive consumption of FER.
– document the reasons of savings/excessive consumption of energy resources and decisions adopted on elimination of the reasons for excessive consumption of energy resources or introduction of more efficient process conditions in terms of energy efficiency.

As a result of the project "Modernization of the Heating System in the 3rd and 4th Zones of Kramatorskteploenergo and setup of heat and hydraulic operating modes," the achieved economic effect with reduction of energy consumption for pumping heat carrier for the heating period 2011 to 2012 is 450,000 kWh in the 3rd CHP zone. The estimated energy savings by the 3rd CHP zone is 2,323,000 kWh.

The reasons for deviations of values of the projected and actual costs of electricity for pumping heat carrier in the heating system of the 3rd zone of LLC "Kramatorskteploenergo" is related to setup of the system for only 90% of consumers in the 3rd zone, which led to increased circulation of network water and periodic unneeded operation of an additional network pump.

Recommendations:
In order to achieve energy savings in the amounts provided by the energy audit report of Kramatorsk, it is recommended to implement the measures in line with the report:

1. Complete the set-up and conduct tuning in the 3rd zone of CHP heat supply system.

2. Install control devices on heat inputs to the buildings, which are connected to the 4th zone of CHP heat supply system to adjust the heat system hydraulic mode.

3. Establish and ensure functioning of the energy management service at the DH utility.

Annex 1. Demonstration Projects Description

Agreement # 1

Type: GDA/PPP Agreement

1. Partnership Name: "Implementation of energy efficiency measures in HOA "Vostok-2003", located at Alchevsk, 13 Gmyri St."

2. Partnership objective: "Implementation of energy efficiency measures in HOA "Vostok-2003", located at Alchevsk, 13 Gmyri St."

3. Partnership narrative:

3.1 Partners

- Alchevsk City Council
- HOA "Vostok-2003"
- Private establishment "Alchevsk city development fund"

3.2 Description

- Development of project design documentation
- Replacement of apartment windows, balcony doors, glazing of loggias (balconies), replacement of windows for common areas with energy efficient ones
- Repair of inner wall junctions and insulation of external walls, including plastering on the basement level
- Installation of two heat supply units with automated heat supply control and metering, insulation of heat supply pipes
- Insulation of ground floor
- Repair of roof and water drainage system
- Replacement of balcony parapets (5th floor), repair of entry stairs and entry areas, etc.
- Restoration of ventilation system

4. Start Date

May 2011

5. Termination Date

May 2012

6. Total Lifetime Projected Partnership Investment ("000" USD): 252

USG Funding	**167**
HOA "Vostok-2003"	**25**
Private establishment "Alchevsk city development fund"	**60**

Agreement # 2

Type: GDA/PPP Agreement

1. **Partnership Name:** "Implementation of energy efficiency measures in the city of Chernihiv"

2. **Partnership objective:** "Implementation of energy efficiency measures in the city of Chernihiv"

3. **Partnership narrative:**

3.1 Partners

- Chernihiv City Council

3.2 Description

Project "Energy efficient renovation of the kindergarten #71 (renovation including windows replacement, walls insulation and roof repair) located at 6a Chapayeva St., Chernihiv"

- Development of project design and cost documentation
- Installation of automated balancing valves and heating system regulation
- Replacement of entry doors (approximate area 58,29 sq. meters)
- Insulation of external walls (approximate area 1826.45 sq. meters)
- Replacement of wooden windows with metal-plastic (approximate area 497,98 sq. meters)
- Roof repair and insulation (approximate area 1342 sq. meters)

Project "Replacement of widows with metal-plastic in educational establishments of Chernihiv"

- General Education School of I-III levels #24
- General Education School of I-III levels #19
- General Education School of I-III levels #3

4. **Start Date**

July 2011

5. **Termination Date**

July 2012

6. **Total Lifetime Projected Partnership Investment ("000" USD): 324**

USG Funding **114**

Partner Funding 210

Agreement # 3

Type: GDA/PPP Agreement

1. Partnership Name: "Implementation of energy efficiency measures in the city of Dnipropetrovsk"

2. Partnership objective: "Implementation of energy efficiency measures in the city of Dnipropetrovsk"

3. Partnership narrative:

3.1 Partners

- Limited Liability Company DTEK
- Dnipropetrovsk City Council

3.2 Description

- Municipal educational institution "Preschool educational institution (public nursery) #2 combined type"
  - Development of project design and cost documentation (PDC)
- Restoration of the main building façade and thermal modernization of the workshop buildings of the communal educational institution "Communal Educational complex #122 "General Educational Institution – pre-school educational institution" of Dnipropetrovsk City Council, located at 49 Kozheduba St., Dnipropetrovsk (capital repair)
  - Development of project design and cost documentation (PDC)
  - Examination of PDC, technical, and architectural supervision
  - Installation of heat radiator screens, replacement of incandescent lamps and outdoor lighting
  - Installation of automatic weather based heat supply unit and automatic regulators of the heat flow (balancing of the heating system), insulation of heating system and hot water supply pipes
  - Heat insulation of roof
  - Windows replacement with metal plastic ones and replacement of entry doors
  - Thermal insulation of external walls of workshop and related insulation works
  - Repair of the building facade
  - Reconstruction of the building ventilation system
- Energy efficient renovation of communal educational institution "Specialized Secondary General Education School № 53 with advanced study of German language" of Dnipropetrovsk City Council, located at 35 Topolina St., Dnipropetrovsk (including windows replacement and façade insulation (capital renovation)
  - Development of project design and cost documentation (PDC)
  - Examination of PDC, technical, and architectural supervision
  - Installation of heat radiator screens, replacement of incandescent lamps
  - Insulation of heating system pipes, installation of automatic heat supply unit and automatic heat flow regulators (balancing of the heating system)
  - Thermal insulation of external walls and related insulation works

    - Windows replacement with metal plastic ones
- Façade restoration for the main building of communal educational institution "Pre-school educational establishment (kindergarten-nursery) #299" of Dnipropetrovsk City Council, located at 10 Korobova St., Dnipropetrovsk (design and capital renovation)
    - Development of project design and cost documentation (PDC)
    - Examination of PDC, technical, and architectural supervision
    - Façade restoration and Windows replacement with metal plastic ones

4. Start Date

July 2011

5. Termination Date
Being implemented (completion – December 2012)

6. Total Lifetime Projected Partnership Investment ("000" USD): 639

USG Funding	**250**
Limited Liability Company DTEK	**350**
Dnipropetrovsk City Council	**394**

Agreement # 4

Type: GDA/PPP Agreement

1. **Partnership Name:** "Implementation of energy efficiency measures in the city of Dzhankoy"

2. **Partnership objective:** "Implementation of energy efficiency measures in the city of Dzhankoy"

3. **Partnership narrative:**

3.1 Partners

- Executive Committee of Dzhankoy City Council

3.2 Description

- Dzhankoi Children Music School
    - Repair and heat insulation of the roof
    - Installation of automatics and admixture pumps, adjustment
- Kindergarten # 5
    - Current repair of internal building heating piping with replacement of certain parts of pipes, welding of corroded spots in the heating system
    - Installation of automatics and admixture pumps, adjustment
    - Development of the executive building heating scheme
    - Calculation of hydraulic and heat regime of the building
    - Preparation of recommendations on bringing the heating system in order
    - Assembly works according to the provided recommendations

    - Inspection of operation regimes for the heating systems and control of hydraulic regime
    - Hydro-pneumatic flushing
- Kindergarten # 16
    - Replacement of internal building heating piping and air heater batteries
    - Installation of automatics and admixture pumps, adjustment
    - Development of the executive building heating scheme
    - Calculation of hydraulic and heat regime of the building
    - Preparation of recommendations on bringing the heating system in order
    - Assembly works according to the provided recommendations
    - Inspection of operation regimes for the heating systems and control of hydraulic regime
    - Hydro-pneumatic flushing
- Secondary School - Complex # 2, building 2
    - Current repair of internal building heating piping with replacement of certain parts of pipes, welding of corroded spots in the heating system
    - Installation of automatics and admixture pumps, adjustment
    - Development of the executive building heating scheme
    - Calculation of hydraulic and heat regime of the building
    - Preparation of recommendations on bringing the heating system in order
    - Assembly works according to the provided recommendations
    - Inspection of operation regimes for the heating systems and control of hydraulic regime
    - Hydro-pneumatic flushing
- Children Sports School
    - Hydro-pneumatic flushing
    - Installation of automatics and admixture pumps, adjustment

4. Start Date

September 2011

5. Termination Date
Being implemented (Completion – September 2012)

6. Total Lifetime Projected Partnership Investment ("000" USD): 88

USG Funding	**38**
Partner Funding	**50**

Agreement # 5

Type: GRANT

1. Partnership Name: "Modernization of the Heating System in the 3rd and 4th Zones of "Kramatorskteploenergo" LLC and setup of heat and hydraulic operating modes"

2. Partnership objective: "Modernization of the Heating System in the 3rd and 4th Zones of "Kramatorskteploenergo" LLC and setup of heat and hydraulic operating modes"

3. Partnership narrative:

3.1 Partners

"Kramatorskteploenergo" LLC

3.2 Description

- Task 1: Fulfillment of hydraulic calculation, with development of measures to set up networks of Zones 3 & 4
- Task 2: Repair works on the main of Zone 3 to ensure work under increased temperature schedule
- Task 3: Development of the project for reconstruction of the central heat sub-station, with connection of sub-main networks on the independent scheme
- Task 4: Preliminary regulation of heat network of Zones 3 & 4. Instrumental measurements.
- Task 5: Procurement of equipment for the central heat sub-station of Zone 3, including
    - heat exchangers for the central heat sub-station of Zone 3
    - other equipment for reconstruction of the central heat sub-station of Zone 3
- Task 6: Assembly work on reconstruction for the central heat sub-station
- Task 7: Procurement of equipment for automation of the central heat sub-stations of Zones 3 & 4
- Task 8: Assembling and set up of the automation system for the central heat sub-stations of Zones 3 & 4
- Task 9: Measures on set up of elevation units in Zones 3 & 4
- Task 10: Regulation of heat network of Zone 3

4. Start Date

July 2010

5. Termination Date

November 2011 (Completed)

6. Total Lifetime Projected Partnership Investment ("000" USD): 528

USG Funding	**247**
Partner Funding	**281**

Agreement # 6

Type: GDA/PPP Agreement

1. Partnership Name: "Equipping heating systems of pilot buildings in Krasnoperekopsk with metering and heat supply control equipment"

2. Partnership objective: "Equipping heating systems of pilot buildings in Krasnoperekopsk with metering and heat supply control equipment"

3. Partnership narrative:

3.1 Partners

Executive Committee of Krasnoperekopsk City Council

3.2 Description

Equipping heating systems of pilot buildings in Krasnoperekopsk with metering and heat supply regulation equipment, including:

1. Training and educational school "School-lyceum" #2, 3, Mendeleeva St.;
2. Training and educational school "School-lyceum" #3, 4, district 1;
3. Secondary school №4, 22, Kalinina St.;
4. Secondary school №5, 21, district 10;
5. Clinic central hospital, 7, 50 years Peremogu St.

4. Start Date

September 2011

5. Termination Date
Being implemented (Completion – September 2012)

6. Total Lifetime Projected Partnership Investment ("000" USD): 101

USG Funding 38

Partner Funding 63

Agreement # 7

Type: GDA/PPP Agreement

1. Partnership Name: "Implementation of the energy-efficiency measures in the town of Kurakhove"

2. Partnership objective: "Implementation of the energy-efficiency measures in the town of Kurakhove"

3. Partnership narrative:

3.1 Partners

Skhidenergo Limited-Liability Company

Kurakhove City Council

3.2 Description

- Implementation of energy-efficiency measures at kindergarten “Kazka”, located at Pushkina St., Kurakhove
- Implementation of energy-efficiency measures at kindergarten “Kosmonavt”, located at 18B Chapayeva St., Kurakhove
- Installing network heating water meters for city blocks
- Installing individual heating water meters in private houses
- Adjustment and regulations of the heating networks
- Developing an energy- and environment-efficient system of heat supply for the city of Kurakhove

4. Start Date

September 2010

5. Termination Date

September 2011

6. Total Lifetime Projected Partnership Investment (“000” USD):

USG Funding 167

Partner Funding 274

Agreement # 8

Type: GDA/PPP Agreement

1. **Partnership Name:** “Implementation of the energy-efficiency measures in the city of Kyiv”
2. **Partnership objective:** “Implementation of the energy-efficiency measures in the city of Kyiv”

3. **Partnership narrative:**

3.1 Partners

Limited Liability Company DTEK

Executive body of Kyiv City Council – Kyiv City State Administration

3.2 Description

- General Education school № 233, Kyiv, 20-A, Layosha Gavro St.
    - Development of project design and cost documentation (PCD)
    - Examination of PCD, technical and architectural supervision
    - Installation of electric stoves with energy saving taps
    - Introduction of remote automatic energy consumption data collection system
    - Reconstruction of internal heating system for the building
    - Roof thermal insulation
    - Replacement of wooden windows with metal plastic ones
    - Thermal insulation of external walls

    - Restoration of supply-and-exhaust mechanical ventilation in the building (phase one)
- Child educational establishment № 573, Kyiv, 27-G, Marshala Malynovskogo St.
    - Development of project design and cost documentation (PCD)
    - Examination of PCD, technical and architectural supervision
    - Replacing existing incandescent lamps to compact fluorescent lamps
    - Introduction of remote automatic energy consumption data collection system
    - Modernization of internal heating system for the building
    - Insulation of pipes and valves of the heating system and regulation of automatic control of heating and hot water supply systems in the building
    - Installation of heat pump for hot water supply
    - Replacement of wooden windows and entrance doors with metal plastics ones
    - Thermal insulation of external walls
    - Restoration of supply-and-exhaust mechanical ventilation in the building (phase one)
    - Roof thermal insulation
    - Installation of electric stoves with energy saving taps

4. Start Date

April 2012

5. Termination Date

Being implemented (Completion – December 2012)

6. Total Lifetime Projected Partnership Investment ("000" USD): 998

USG Funding	**250**
Limited Liability Company DTEK	**375**
Kyiv City State Administration	**373**

Agreement # 9

Type: GRANT

1. Partnership Name: "Thermal modernization and renovation of multistory residential building located at 10 Peremogy St., including installation of automated heating control unit"

2. Partnership objective: "Thermal modernization and renovation of multistory residential building located at 10 Peremogy St., including installation of automated heating control unit"

3. Partnership narrative:

3.1 Partners

“Energy Service Company “Lutsk Communal Systems” LLC

3.2 Description

- Organization and holding of the promotion campaign
- Conducting of the initial research on the level of residents’ satisfaction with the rendered
- communal services
- Installation of energy saving PVC windows
- Modernization of the heating and hot water supply systems – installation of IHS
- Introduction of the monitoring system and analysis of change of the efficient energy consumption in the building after modernization

4. Start Date

March 2011

5. Termination Date
August 2011

6. Total Lifetime Projected Partnership Investment (“000” USD): 101

USG Funding **50**

Partner Funding **51**

Agreement # 10

Type: GRANT

1. Partnership Name: “Implementation of energy efficiency measures in the residential building of HOA “Bilya Parku””

2. Partnership objective: “Implementation of energy efficiency measures in the residential building of HOA “Bilya Parku””

3. Partnership narrative:

3.1 Partners

HOA “Bilya Parku”

Lviv City Council – Co-financing

3.2 Description

- Task 1: Organizing a system of water consumption, replacing damaged sections of pipelines

- Task 2: Installing a weather-dependent automatic heating control unit at building entry

- Task 3: Heat insulating the pipes and valves, replacing damaged section of pipelines, flushing the heating system

- Task 4: Energy-efficient lighting

4. Start Date

September 2010

5. Termination Date
December 2011

6. Total Lifetime Projected Partnership Investment ("000" USD): 12

USG Funding **6**

Partner Funding **6**

Agreement # 11

Type: GDA/PPP Agreement

1. Partnership Name: "Implementation of the energy-efficiency measures in the city of Myrhorod"

2. Partnership objective: "Implementation of the energy-efficiency measures in the city of Myrhorod"

3. Partnership narrative:

3.1 Partners

Myrhorod City Council

3.2 Description

Project to implement the activities aimed at improving the energy-efficiency of the #12 Svitlyachok

Kindergarten located at 71, Ozerna St. in Myrhorod

- Implementing work of heat-insulating the building façade and basement
- Implementing work of heat-insulating the heating and hot water supply pipelines, which pass through unheated premises
- Replacing wood windows with metal-plastic ones with energy-saving insulated glass units

4. Start Date

September 2010

5. Termination Date
December 2011

6. Total Lifetime Projected Partnership Investment ("000" USD): 162

USG Funding	**90**
Partner Funding	**72**

Agreement # 12

Type: GDA/PPP Agreement

1. Partnership Name: "Improvement of energy efficiency for the building of general education school #19, located at Pavlohrad, 2 Malinovskogo St."

2. Partnership objective: "Improvement of energy efficiency for the building of general education school #19, located at Pavlohrad, 2 Malinovskogo St."

3. Partnership narrative:

3.1 Partners

Pavlohrad City Council

PJSC "DTEK PAVLOHRADUGOL"

3.2 Description

- Modernization of the heating system
- Replacement of windows with energy efficient and related works
- Replacement of entrance doors and related works
- Development of project design documentation
- Technical supervision
- Insulation of external walls - facade
- Production and installation of external slopes and sills
- Insulation of external walls - basement
- Other renovation (repair) activities: repair of water supply and sewage system, roof and other

4. Start Date

June 2011

5. Termination Date
Completed

6. Total Lifetime Projected Partnership Investment ("000" USD): 332

USG Funding	**168**
Pavlohrad City Council	**14**
PJSC "DTEK PAVLOHRADUGOL"	**150**

Agreement # 13

Type: GDA/PPP Agreement

1. **Partnership Name:** "Implementation of energy efficiency measures in the city of Yevpatoria "

2. **Partnership objective:** "Implementation of energy efficiency measures in the city of Yevpatoria "

3. **Partnership narrative:**

3.1 Partners

Yevpatoria City Council

3.2 Description

- Measures aimed at improving energy efficiency in the Yevpatoria City Policlinics communal health care facility located at the address: 39 Nekrasova St., Yevpatoria .
    - Operation and maintenance manuals
    - Installation of energy efficient lighting system
    - Additional thermal insulation on external walls
    - Restoration of the exhaust ventilation system, including installation of a new energy efficient driver
    - Additional thermal insulating roofing
    - Installation of automated individual boiler room equipment with high efficiency rate and tentative capacity of 500 KW
    - Restoration of hot tap water supply system and installation of .
    - water saving caps and thermostatic mixers
    - Modernization of internal heating system including switching over to a two-pipe system and replacement of pipelines
    - Other energy efficiency measures
    - Windows replacement
- Reconstruction of boiler room, including boiler replacement and gasification, located at 1/2 Tuchina St., Yevpatoria .
    - Main equipment supply in accordance with the specification

4. **Start Date**

August 2010

5. **Termination Date**

Completed (November 2011)

6. **Total Lifetime Projected Partnership Investment ("000" USD): 752**

USG Funding	**187**
Partner Funding	**565**

Agreement # 14

Type: GRANT

1. Partnership Name: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"
2. Partnership objective: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"

3. Partnership narrative:

3.1 Partners

HOA "Almaz-Kurakhove"

Kurakhove City Council (DTEK Funding)

3.2 Description

- Reconstruction of the heating system with change of the scheme and replacement of radiators and pipelines
- Installation of the individual heat sub-station

4. Start Date

30 June, 2011

5. Termination Date
June 2012

6. Total Lifetime Projected Partnership Investment ("000" USD): 48

USG Funding	**21**
Partner Funding	**27**

Agreement # 15

Type: GRANT

1. Partnership Name: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"

HOA "Brigantina-Kurakhove"

2. Partnership objective: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"

HOA "Brigantina-Kurakhove"

3. Partnership narrative:

3.1 Partners

HOA "Brigantina-Kurakhove"

Kurakhove City Council (DTEK Funding)

3.2 Description

- Reconstruction of the heating system with change of the scheme and replacement of radiators and pipelines
- Installation of the individual heat sub-station

4. Start Date

30 June, 2011

5. Termination Date
Completed

6. Total Lifetime Projected Partnership Investment ("000" USD): 45

USG Funding	**20**
Partner Funding	**25**

Agreement # 16

Type: GRANT

1. **Partnership Name:** "Implementation of energy efficiency measures in the residential building of HOA "MZHK Kamenyar""

2. **Partnership objective:** "Implementation of energy efficiency measures in the residential building of HOA "MZHK Kamenyar""

3. Partnership narrative:

3.1 Partners

"MZHK Kamenyar"

Co-financing from Lviv City Council

3.2 Description

Thermal Insulation of external walls

4. Start Date

November, 2010

5. Termination Date
Completed – April 2012

6. Total Lifetime Projected Partnership Investment ("000" USD): 82

USG Funding **41**

Partner Funding **41**

Agreement # 17

Type: GDA/PPP Agreement

1. **Partnership Name:** "Implementation of energy efficiency measures in the residential building of HOA "Mariya""
2. **Partnership objective:** "Implementation of energy efficiency measures in the residential building of HOA "Mariya""

3. Partnership narrative:

3.1 Partners

HOA "Mariya"

Lviv City Administration

3.2 Description

- Installation of energy efficient lighting
- Installation of automated whether based heating control system
- Thermal insulation and repair of external walls of the building with the total volume of up to 1657 square meters

4. Start Date

May, 2011

5. Termination Date
May 2012

6. Total Lifetime Projected Partnership Investment ("000" USD): 74

USG Funding **32**

HOA "Mariya" **8**

Lviv City Administration **34**

Agreement # 18

Type: GRANT

1. **Partnership Name:** "Partial Modernization of heating system and thermal insulation of common areas"

2. **Partnership objective:** "Partial Modernization of heating system and thermal insulation of common areas"

3. Partnership narrative:

3.1 Partners

HOA "Pokolinya"

Kramatorsk City Council – co-financing

3.2 Description

- Installation of heat flow controllers
- Installation of windows and doors in lobbies
- Replacing the heating main in basement
- Switching over, testing, and putting into operation

4. Start Date

September 2010

5. Termination Date
September 2011

6. Total Lifetime Projected Partnership Investment ("000" USD): 112

USG Funding	**56**
Partner Funding	**56**

Agreement # 19

Type: GRANT

1. Partnership Name: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"

HOA "Sharm-Kurakhove"

2. Partnership objective: "Implementation of energy efficiency measures including reconstruction of heating system and installation of individual heating sub-station"

HOA "Sharm-Kurakhove"

3. Partnership narrative:

3.1 Partners

HOA "Sharm-Kurakhove"

Kurakhove City Council (DTEK Funding)

3.2 Description

- Façade Insulation
- Installation of the individual heat sub-station

4. Start Date

June, 2011

5. Termination Date
Completed (June 2012)

6. Total Lifetime Projected Partnership Investment ("000" USD): 42

USG Funding **19**

Partner Funding **23**

Agreement # 20

Type: GRANT

1. **Partnership Name:** "Modernization of multi apartment residential building using automated heating management system". HOA "Vidrodzhenya"

2. **Partnership objective:** "Modernization of multi apartment residential building using automated heating management system". HOA "Vidrodzhenya"

3. Partnership narrative:

3.1 Partners

HOA "Vidrodzhenya"

Lutsk City Council – co-financing

3.2 Description

- Organizing and conducting a promotional campaign
- Ongoing dissemination of information and promotion of the project in the media
- Conducting a baseline survey of the residents' level of satisfaction with
- the quality of communal services provided
- Modernizing the heating and hot water supply system
- Implementing a monitoring system and analyzing changes in building's energy consumption efficiency after the modernization
- Analyzing the effect of the implemented measures and preparing the reports
- Conducting the final survey of the residents' level of satisfaction with the quality of communal services provided

4. Start Date

September 2010

5. Termination Date
September 2011

6. Total Lifetime Projected Partnership Investment ("000" USD): 24

USG Funding **12**

Partner Funding **12**

Agreement # 21

Type: GRANT

1. **Partnership Name:** "Reconstruction of a boiler room with the replacement of the "NIISTU" boilers, located at 61 Revolutsii St." and "Automation of fuel combustion regimes for the boilers located at 135a Internatsionalnaya St."
2. **Partnership objective:** "Reconstruction of a boiler room with the replacement of the "NIISTU" boilers, located at 61 Revolutsii St." and "Automation of fuel combustion regimes for the boilers located at 135a Internatsionalnaya St."
3. **Partnership narrative:**

3.1 Partners

Leased enterprise "KRYMTEPLOCOMUNENERGO"

3.2 Description

1. Dismantling of old boilers (NIISTU-5)
2. Design work, including approval of projects by the inspection bodies
3. Installation of new RTQ-600 boilers
4. Commissioning, including approval of reports by the inspection bodie

4. **Start Date**

June 2010

5. **Termination Date**

June 2011

6. **Total Lifetime Projected Partnership Investment ("000" USD): 122**

USG Funding **62**

Partner Funding **60**

Agreement # 22

Type: GDA/PPP Agreement (MOU)

1. **Partnership Name:** "Implementation of energy efficient measures in six public buildings of Lviv"

2. **Partnership objective:** "Implementation of energy efficient measures in six public buildings of Lviv"

3. **Partnership narrative:**

3.1 Partners

Lviv City Council

3.2 Description

- Polyclinic #5 Modernization of the building's heating system, with installation of the automatic weather-based controls
- Polyclinic #5 Heat insulation of pipes and switches on heat supply pipes in the non-heated premises
- Polyclinic #4 - child care Improving heat release and installation of heat reflectors
- Polyclinic #4 - child care Window replacement
- Polyclinic #4 - child care Modernization of the building's heating system, with installation of the automatic weather-based controls
- Polyclinic #4- child care Heat insulation of pipes and switches on heat supply pipes in the non-heated premises
- Polyclinic #4 - adult care External insulation of walls
- Polyclinic #4 - adult care Window replacement
- Pre-school #169 Window replacement
- Pre-school #169 Replacement of incandescent light bulbs with energy-saving CFL bulbs
- Pre-school #169 Modernization of the building's heating system, with installation of the automatic weather-based controls
- Pre-school #169 External insulation of walls
- Pre-school #129 Improving heat release and installation of heat reflectors
- Pre-school #129 Replacement of incandescent light bulbs with energy-saving CFL bulbs
- Pre-school #129 Modernization of the building's heating system, with installation of the automatic weather-based controls
- Pre-school #129 Heat insulation of pipes and switches on heat supply pipes in the non-heated premises
- Pre-school #129 Insulation of the roof
- Pre-school #129 External insulation of walls
- School # 84 Improving heat release and installation of heat reflectors
- School # 84 Window replacement
- School # 84 Modernization of the building's heating system, with installation of the automatic weather-based controls
- School # 84 Heat insulation of pipes and switches on heat supply pipes in the non-heated premises

4. Start Date

October 2011

5. Termination Date
Being implemented

6. Total Lifetime Projected Partnership Investment (“000” USD): 708

USG Funding	**88**
Partner Funding	**620**

Annex 2. Heat Load of the Building Heating Systems

#	Name	Address	Installed capacity, Gcal/h
Alchevsk			
1	HOA “Vostok-2003”	Hmyri, 13	0.230
Chernihiv			
2	Kindergarten #71	Chapayeva, 6A	0.140
Yevpatoria			
3	Kindergarten №2	Demisheva, 133	0.1580
4	Residential Building HOA “Parus”	9 Maya, 39-B	0.2121
5	Residential Building HOA “Parus”	9 Maya, 39-V	0.1570
6	Residential Building ME “Gilichnik-4”	Sovetskiy, 3	0.2712
7	Residential Building ME “Gilichnik-4”	Polupanova, 38	0.1136
8	City polyclinic	Nekrasova, 39	0.493
Kramatorsk			
9	Residential Building	19 Partsyezda, 57	0.287
10	Residential Building	Kramatorskiy, 7	0.438
11	Residential Building	Dvorcovaya, 42	0.601
12	Residential Building	Lenina, 7	0.106
13	Residential Building	Lenina, 16	0.227
14	HOA Pokolinya	Parkova, 95	1.115
Kurakhove			
15	Kindergarten ‘Kosmonavt”	Chapaeva, 18-B	0.157
16	Kindergarten “Skazka”	Pushkina, 4	0.261
17	HOA “Almaz-Kurakhove”	Marksa, 10	0.067
18	HOA “Brigantina-Kurakhove”	Mechnikova, 18	0.212

19	HOA “Sharm-Kurakhove”	Lenina,117	0.038
Lviv			
20	School №77	Vigovskogo, 7A	0.268
21	Kindergarten "1,2,3"	Lyubinska, 89V	0.112
22	Residential Building HOA “Syhivchani”	Antonicha,4	0.712
23	Residential Building	Petluri, 2A	0.6671
24	Residential Building	Kitayska, 6	0.3681
Lutsk			
25	Residential Building	Gordiyuk, 43	0.420
26	Residential Building	Sobornosti, 24	0.646
27	Residential Building	Kravchuka, 20	0.356
28	Kindergarten #13	Stanislavskogo, 50A	0.178
29	Kindergarten #27	Konovaltsa, 10A	0.136
30	HOA Binom	Peremogi,10	0.92
Myrhorod			
31	Kindergarten “Svitlyachok”	Ozerna, 71	0.155
Pavlohrad			
32	School #19	Malinovskogo, 2	0.718

Annex 3. Outdoor Temperature in MHR Partner Cities

City	Estimated outdoor temperature for the coldest 3 day period, ^{0}C	Average outdoor temperature for the heating season, ^{0}C	Days in a heating season	Degree Days (for indoor temperature +18°C)
Alchevsk	-25	-1.6	180	3528
Chernihiv	-23	-1.7	191	3763
Kurakhove	-25	-1.8	183	3623
Kramatorsk	-26	-1.9	185	3682
Lutsk	-20	-0.2	187	3403
Lviv	-19	-0.2	191	3476
Myrhorod	-22	-1.5	188	3666
Pavlohrad	-24	-1.1	180	3438
Yevpatoria	-16	+2.4	149	2324

Annex 4. Example of Energy Savings Calculation for the Boiler Plant at 1/2 Tuchina Street in Yevpatoria Based on Previously Measured Consumption

Based on previously developed energy audit reports prepared by Optimenergo during implementation of the USAID MHR Project, and data on fuel oil consumption (see Figure 2), the monthly baseline can be described by the following equation:

У = -1733.94X + 31338, where

X – average outdoor temperature of the monitoring month

Y – consumption of the fuel during monitoring month

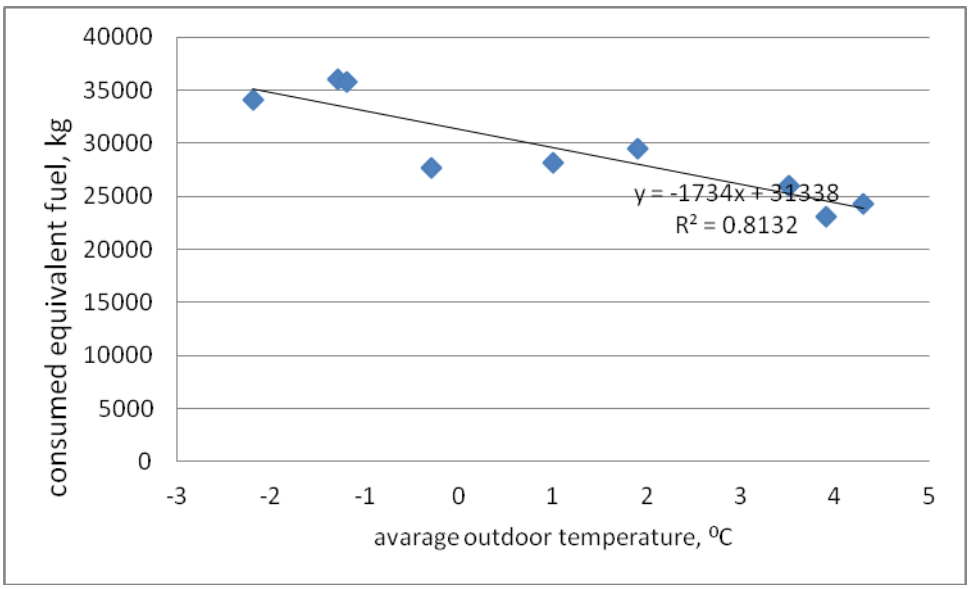


Figure 2. Baseline of heat consumption of the boiler plant at 1/2 Tuchina Street in Yevpatoria

Initial data for the baseline were collected before replacement of the boiler on a monthly basis only. After installation of the new high efficiency boiler with fuel switching to natural gas, data were collected on a daily basis. For the monitoring of energy and financial savings, it is appropriate to convert the coefficient in the equation to a daily basis, by dividing by the pre-installation data by 30 (average number of days in a month). The daily baseline equation for the district heating boiler at Tuchina Street 1/2 will thus be:

У = -57.8X + 1044.6

Calculations of fuel and financial savings as a result of modernization and boiler conversion from fuel oil to natural gas are presented below:

Energy and cost savings calculations of the modernized boiler plant at 1/2 Tuchina Street in Yevpatoria

Date	Outdoor temperature, ^{0}C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, m^{3}of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
10.11.2011	2.3	536	694	912	218	4.27	3895	1.40	974	2921
11.11.2011	-0.7	585	758	1085	328	4.27	4636	1.40	1063	3572
12.11.2011	-0.5	635	822	1074	251	4.27	4586	1.40	1154	3432
13.11.2011	1.3	582	754	970	216	4.27	4141	1.40	1058	3084
14.11.2011	1	612	793	987	194	4.27	4216	1.40	1112	3103
15.11.2011	1.1	619	802	981	179	4.27	4192	1.40	1126	3066
16.11.2011	2.1	397	514	923	409	4.27	3944	1.40	722	3222
17.11.2011	-2.1	450	583	1166	583	4.27	4981	1.40	818	4163
18.11.2011	-0.4	598	774	1068	293	4.27	4561	1.40	1087	3474
19.11.2011	5.1	485	628	750	122	4.27	3204	1.40	882	2322
20.11.2011	0.4	437	566	1022	456	4.27	4364	1.40	794	3569
21.11.2011	3.3	341	442	854	412	4.27	3648	1.40	620	3028
22.11.2011	3.7	512	663	831	168	4.27	3550	1.40	931	2618
23.11.2011	4.1	380	492	808	316	4.27	3450	1.40	691	2760
24.11.2011	-2.8	373	483	1206	723	4.27	5154	1.40	678	4476
25.11.2011	-3	625	809	1218	409	4.27	5203	1.40	1136	4067
26.11.2011	-3.3	666	862	1235	373	4.27	5278	1.40	1211	4067
27.11.2011	2.6	587	760	894	134	4.27	3821	1.40	1067	2754
28.11.2011	6	540	699	698	-1	4.27	2981	1.40	982	1999
29.11.2011	4.3	467	605	796	191	4.27	3401	1.40	850	2552
30.11.2011	3.5	987	1278	842	-436	4.27	3599	1.40	1794	1804
01.12.2011*	2.5	0	0	0	0	4.27	0	1.42	0	0
02.12.2011	2.7	0	0	0	0	4.27	0	1.42	0	0

Date	Outdoor temperature, ^{0}C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, $m^3$of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
03.12.2011	3.6	0	0	0	0	4.27	0	1.42	0	0
04.12.2011	7.5	0	0	0	0	4.27	0	1.42	0	0
05.12.2011	8.6	0	0	0	0	4.27	0	1.42	0	0
06.12.2011	9.5	0	0	0	0	4.27	0	1.42	0	0
07.12.2011	4.8	0	0	0	0	4.27	0	1.42	0	0
08.12.2011	2.9	0	0	0	0	4.27	0	1.42	0	0
09.12.2011	2.8	0	0	0	0	4.27	0	1.42	0	0
10.12.2011	5.2	0	0	0	0	4.27	0	1.42	0	0
11.12.2011	7.6	0	0	0	0	4.27	0	1.42	0	0
12.12.2011	2.2	0	0	0	0	4.27	0	1.42	0	0
13.12.2011	3.8	0	0	0	0	4.27	0	1.42	0	0
14.12.2011	6.8	0	0	0	0	4.27	0	1.42	0	0
15.12.2011	6.4	0	0	0	0	4.27	0	1.42	0	0
16.12.2011	6.2	0	0	0	0	4.27	0	1.42	0	0
17.12.2011	8	0	0	0	0	4.27	0	1.42	0	0
18.12.2011	8.1	0	0	0	0	4.27	0	1.42	0	0
19.12.2011	4.7	0	0	0	0	4.27	0	1.42	0	0
20.12.2011	7.5	0	0	0	0	4.27	0	1.42	0	0
21.12.2011	7.3	0	0	0	0	4.27	0	1.42	0	0
22.12.2011	3.6	415	537	837	299	4.27	3574	1.42	764	2809
23.12.2011	-0.5	544	704	1074	369	4.27	4586	1.42	1002	3584
24.12.2011	-2.7	634	821	1201	380	4.27	5129	1.42	1168	3962
25.12.2011	-2.7	456	591	1201	610	4.27	5129	1.42	840	4290
26.12.2011	-1.2	586	759	1114	355	4.27	4759	1.42	1079	3680
27.12.2011	4.1	442	572	808	235	4.27	3450	1.42	814	2636
28.12.2011	4.9	395	512	761	250	4.27	3253	1.42	727	2525

Date	Outdoor temperature, ^0C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, $m^3$of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
29.12.2011	2.3	413	535	912	377	4.27	3895	1.42	761	3134
30.12.2011	4.3	423	548	796	248	4.27	3401	1.42	779	2622
31.12.2011	5.6	392	508	721	213	4.27	3080	1.42	722	2358
01.01.2012	1.2	486	629	975	346	4.33	4225	1.42	895	3330
02.01.2012	0.3	605	783	1027	244	4.33	4451	1.42	1114	3336
03.01.2012	6	369	478	698	220	4.33	3023	1.42	679	2344
04.01.2012	6.2	361	467	686	219	4.33	2972	1.42	665	2308
05.01.2012	6.4	377	488	675	187	4.33	2923	1.42	695	2228
06.01.2012	7.4	375	486	617	131	4.33	2672	1.42	690	1982
07.01.2012	5.9	383	496	704	208	4.33	3048	1.42	706	2342
08.01.2012	6.4	335	434	675	241	4.33	2923	1.42	617	2306
09.01.2012	6	390	505	698	193	4.33	3023	1.42	718	2305
10.01.2012	4.1	379	491	808	317	4.33	3499	1.42	698	2801
11.01.2012	1.1	476	616	981	365	4.33	4250	1.42	876	3373
12.01.2012	0.4	539	698	1022	324	4.33	4426	1.42	992	3433
13.01.2012	3.8	465	602	825	223	4.33	3574	1.42	857	2718
14.01.2012	1.1	474	614	981	367	4.33	4250	1.42	872	3377
15.01.2012	-0.1	553	716	1050	334	4.33	4550	1.42	1019	3532
16.01.2012	-1.7	591	765	1143	378	4.33	4951	1.42	1088	3863
17.01.2012	-3.4	654	847	1241	394	4.33	5377	1.42	1205	4172
18.01.2012	-3.6	646	837	1253	416	4.33	5426	1.42	1189	4237
19.01.2012	-6	699	905	1391	486	4.33	6028	1.42	1288	4740
20.01.2012	-0.8	595	771	1091	320	4.33	4726	1.42	1096	3630
21.01.2012	3	490	635	871	237	4.33	3774	1.42	902	2872
22.01.2012	2.6	492	637	894	257	4.33	3875	1.42	906	2969
23.01.2012	2	477	618	929	311	4.33	4025	1.42	878	3146

Date	Outdoor temperature, ^0C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, $m^3$of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
24.01.2012	3.7	482	624	831	207	4.33	3599	1.42	888	2711
25.01.2012	-1.3	609	789	1120	331	4.33	4850	1.42	1122	3730
26.01.2012	-4.9	747	967	1328	360	4.33	5753	1.42	1375	4376
27.01.2012	-6	771	998	1391	393	4.33	6028	1.42	1420	4608
28.01.2012	-10.9	796	1031	1675	644	4.33	7255	1.42	1466	5789
29.01.2012	-12.3	783	1014	1756	742	4.33	7606	1.42	1442	6163
30.01.2012	-12.7	792	1026	1779	753	4.33	7705	1.42	1458	6247
31.01.2012	-11	808	1046	1680	634	4.33	7279	1.42	1488	5791
01.02.2012	-17.7	858	1111	2068	957	4.33	8957	1.42	1580	7378
02.02.2012	-19	868	1124	2143	1019	4.33	9283	1.42	1598	7685
03.02.2012	-14.2	825	1068	1865	797	4.33	8081	1.42	1519	6562
04.02.2012	-10.4	825	1068	1646	577	4.33	7129	1.42	1519	5610
05.02.2012	-8.7	822	1064	1548	483	4.33	6703	1.42	1513	5190
06.02.2012	-9.4	800	1036	1588	552	4.33	6880	1.42	1474	5406
07.02.2012	-13.1	826	1070	1802	732	4.33	7806	1.42	1522	6284
08.02.2012	-15.6	862	1116	1946	830	4.33	8431	1.42	1588	6844
09.02.2012	-14.6	847	1097	1889	792	4.33	8182	1.42	1560	6622
10.02.2012	-14.4	841	1089	1877	788	4.33	8131	1.42	1549	6582
11.02.2012	-12.4	829	1074	1761	688	4.33	7631	1.42	1526	6103
12.02.2012	-10.6	822	1064	1657	593	4.33	7180	1.42	1513	5666
13.02.2012	-7	795	1030	1449	420	4.33	6278	1.42	1464	4814
14.02.2012	-4.1	781	1011	1282	270	4.33	5552	1.42	1439	4114
15.02.2012	-2.7	667	864	1201	337	4.33	5202	1.42	1229	3973
16.02.2012	-0.9	699	905	1097	191	4.33	4751	1.42	1288	3463
17.02.2012	-3.8	672	870	1264	394	4.33	5477	1.42	1237	4240
18.02.2012	-6.1	754	976	1397	421	4.33	6053	1.42	1388	4664

Date	Outdoor temperature, ^0C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, $m^3$of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
19.02.2012	-7.7	764	989	1490	500	4.33	6454	1.42	1406	5046
20.02.2012	-2.8	691	895	1206	312	4.33	5226	1.42	1272	3954
21.02.2012	-2.2	713	923	1172	248	4.33	5076	1.42	1313	3763
22.02.2012	-0.5	629	815	1074	259	4.33	4650	1.42	1158	3492
23.02.2012	-0.5	636	824	1074	250	4.33	4650	1.42	1171	3479
24.02.2012	2.9	527	682	877	195	4.33	3799	1.42	971	2828
25.02.2012	4	600	777	813	36	4.33	3524	1.42	1105	2419
26.02.2012	2.8	504	653	883	230	4.33	3824	1.42	928	2896
27.02.2012	-0.3	586	759	1062	303	4.33	4601	1.42	1079	3521
28.02.2012	-2	649	840	1160	320	4.33	5026	1.42	1195	3832
29.02.2012	-2.6	689	892	1195	303	4.33	5177	1.42	1268	3907
01.03.2012	-2.2	668	865	1172	307	4.33	5076	1.42	1230	3846
02.03.2012	-3.5	671	869	1247	378	4.33	5401	1.42	1236	4166
03.03.2012	-0.1	623	807	1050	244	4.33	4550	1.42	1147	3403
04.03.2012	-1.5	641	830	1131	301	4.33	4901	1.42	1181	3720
05.03.2012	-1.4	595	771	1126	355	4.33	4876	1.42	1096	3780
06.03.2012	-2.9	635	822	1212	390	4.33	5251	1.42	1169	4082
07.03.2012	-3.3	676	875	1235	360	4.33	5352	1.42	1244	4106
08.03.2012	-2.2	660	855	1172	317	4.33	5076	1.42	1216	3860
09.03.2012	-2.3	605	783	1178	394	4.33	5101	1.42	1114	3988
10.03.2012	-2.6	624	808	1195	387	4.33	5177	1.42	1150	4027
11.03.2012	-1.4	621	804	1126	321	4.33	4876	1.42	1144	3732
12.03.2012	-0.6	624	808	1079	271	4.33	4675	1.42	1150	3527
13.03.2012	-0.9	594	769	1097	327	4.33	4751	1.42	1094	3656
14.03.2012	1.8	512	663	941	278	4.33	4075	1.42	943	3132
15.03.2012	0.3	612	793	1027	235	4.33	4451	1.42	1127	3323

Date	Outdoor temperature, ^{0}C	Consumed fuel				Oil fuel cost		Natural gas cost		Savings, UAH
		Recorded, m^{3}of natural gas	Recorded kg of fuel oil equivalent	Baseline kg of fuel oil equiv.	Difference kg of fuel oil equivalent	Tariff, UAH/ kg of fuel oil equivalent	Cost, UAH	Tariff, UAH/ kg of fuel oil equiv.	Cost, UAH	
16.03.2012	-0.9	644	834	1097	263	4.33	4751	1.42	1186	3565
17.03.2012	2.7	521	675	889	214	4.33	3850	1.42	960	2890
18.03.2012	5.5	426	552	727	175	4.33	3149	1.42	785	2364
19.03.2012	6.4	370	479	675	196	4.33	2923	1.42	682	2242
20.03.2012	7.5	296	383	611	228	4.33	2647	1.42	545	2102
21.03.2012	6.9	312	404	646	242	4.33	2797	1.42	575	2224
22.03.2012	7	329	426	640	214	4.33	2773	1.42	606	2167
23.03.2012	5.5	299	387	727	340	4.33	3149	1.42	551	2598
24.03.2012	7.4	337	436	617	181	4.33	2672	1.42	620	2052
25.03.2012	4.3	320	414	796	382	4.33	3449	1.42	589	2860
26.03.2012	5.1	332	430	750	320	4.33	3248	1.42	611	2638
27.03.2012	1.3	538	697	970	273	4.33	4200	1.42	991	3209
28.03.2012	3.1	508	658	865	208	4.33	3749	1.42	936	2814
29.03.2012	5	443	574	756	182	4.33	3274	1.42	816	2458
30.03.2012	6	330	427	698	270	4.33	3023	1.42	607	2416
31.03.2012	4.8	568	736	767	32	4.33	3324	1.42	1046	2278
Total			**91,204**	**133,238**	**42,033**		**575,401**		**129,426**	**445,974**

*Due to high outdoor temperatures, the boiler house was not used from 1.12.2011 through 21.12.2011.

Thus, for the period November 2011 – March 2012, fuel savings in fuel oil equivalent were 42,000 kg, which equals 32,000 m^3 of natural gas. The average reduction in fuel consumption for this period was **31.5%** from the baseline. Total financial savings for this period are based on existing tariffs and were nearly **UAH 446,000**, which is roughly equal to **$55,000**.

Annex 5. Example of Energy Savings Calculation for the HOA "Vostok-2003" at 13 Hmyri Street in Alchevsk, Based on Calculated Previous Consumption

Based on the existing "Ukrainian Normative Value on Fuel and Heating Needs for Residential and Public Building Heating" standard (КТМ 204 Ukraine 244–94), heat consumption was calculated using the following equation:

$Q_{period}=q_0*(t_{indoor}-t_{av.\ o.})/(t_{indoor}-t_{cold.})*n*24$, where

q_0 = 0, 230 Gcal/h heat capacity of the object, (received from technical specification)

t_{indoor}= 18^0C – estimated indoor temperature for the residential.

$t_{cold.}$= - 25 estimated minimum outdoor design temperature.

$t_{av.o.}$- average recorded outdoor temperature for the monitoring period

n – days in monitoring period

Based on data received from the heat metering equipment and outdoor temperatures recorded from the nearest meteorological station, input data for calculation of energy savings are presented in the following table:

Month	Average recorded outdoor temperature for the monitoring period, ^{0}C	Recorded consumption of heat energy using installed heat meters, Gcal	Days in monitoring period
November 2011	-1.72773	35.8440	30
December 2011	0.133198	44.2020	31
January 2012	-6.27295	46.7340	31
February 2012	-11.2624	54.8850	29

The following table shows base heat energy consumption, based on initial data and the baseline equation:

Month	Base heat consumption, Gcal
November 2011	75.9747
December 2011	71.10156
January 2012	96.59505
February 2012	108.9378

Energy savings for the period November 2011 – February 2012 were:

Month	Base heat	Recorded	Energy Savings,	Energy

	consumption, Gcal	consumption of the heat energy due to installed heat meters, Gcal	Gcal	Savings,%
November 2011	75.9747	35.8440	40.13	53
December 2011	71.10156	44.2020	26.90	38
January 2012	96.59505	46.7340	49.86	52
February 2012	108.9378	54.8850	54.05	50
Total			170.94	48

Total energy savings for the period of November 2011 – February 2012 were 170.94 Gcal (48% of the baseline). The financial savings were calculated by multiplying energy savings by the existing heat energy tariff for residential buildings in Alchevsk (292.45 UAH Gcal). Thus, financial savings for the period November 2011 – February 2012 were nearly 50,000 UAH, which equals $6,250.

Annex 6. Sample of Data from Heat Meter Report

Date	Kindergarten "Kazka" in Kurakhove city, February 2012									
	Q1, Gcal	Q1av. hour, Gcal/h	G1, т	G1av, т/h	t1, °C	P1, kg/cm^2	T1, hh:mm	t2, °C	P2, kg/ cm^2	dt12, °C
01.02.2012	3,345	0,139	96,900	4,037	94,60	7,0	24:00	60,10	4,0	34,50
02.02.2012	3,457	0,144	97,550	4,065	94,60	7,0	24:00	59,20	4,0	35,40
03.02.2012	3,618	0,151	97,074	4,045	94,50	7,0	24:00	57,30	4,0	37,20
04.02.2012	3,433	0,143	96,018	4,001	93,20	7,0	24:00	57,50	4,0	35,70
05.02.2012	3,413	0,142	95,406	3,975	92,90	7,0	24:00	57,20	4,0	35,70
06.02.2012	3,517	0,147	96,639	4,027	92,50	7,0	24:00	56,20	4,0	36,30
07.02.2012	3,594	0,150	95,214	3,967	94,40	7,0	24:00	56,80	4,0	37,60
08.02.2012	3,568	0,149	95,358	3,973	94,30	7,0	24:00	57,00	4,0	37,30
09.02.2012	3,554	0,148	95,753	3,990	94,10	7,0	24:00	57,10	4,0	37,00
10.02.2012	3,557	0,148	94,674	3,945	95,30	7,0	24:00	57,90	4,0	37,40
11.02.2012	3,467	0,144	93,452	3,894	95,90	7,0	24:00	58,90	4,0	37,00
12.02.2012	3,441	0,143	92,755	3,865	95,60	7,0	24:00	58,60	4,0	37,00
13.02.2012	3,423	0,143	93,782	3,908	93,00	7,0	24:00	56,60	4,0	36,40
14.02.2012	2,919	0,122	92,343	3,848	85,30	7,0	24:00	53,80	4,0	31,50
15.02.2012	2,733	0,114	93,028	3,876	82,30	7,0	24:00	53,00	4,0	29,30
16.02.2012	2,958	0,123	94,420	3,934	86,10	7,0	24:00	54,80	4,0	31,30
17.02.2012	2,896	0,121	94,255	3,927	85,60	7,0	24:00	55,00	4,0	30,60
18.02.2012	2,976	0,124	91,507	3,813	89,70	7,0	24:00	57,20	4,0	32,50
19.02.2012	3,064	0,128	92,286	3,845	91,10	7,0	24:00	58,00	4,0	33,10
20.02.2012	3,302	0,138	93,314	3,888	92,80	7,0	24:00	57,60	4,0	35,20
21.02.2012	3,004	0,125	88,695	3,696	88,70	7,0	24:00	55,00	4,0	33,70
22.02.2012	2,888	0,120	88,769	3,699	86,90	7,0	24:00	54,40	4,0	32,50
23.02.2012	2,656	0,111	93,941	3,914	80,80	7,0	24:00	52,60	4,0	28,20
24.02.2012	2,464	0,103	94,550	3,940	77,10	7,0	24:00	51,20	4,0	25,90
25.02.2012	2,410	0,100	90,884	3,787	79,70	7,0	24:00	53,10	4,0	26,60
26.02.2012	2,169	0,090	90,894	3,787	74,60	7,0	24:00	50,70	4,0	23,90
27.02.2012	2,418	0,101	95,176	3,966	76,20	7,0	24:00	50,90	4,0	25,30
28.02.2012	2,521	0,105	93,872	3,911	79,00	7,0	24:00	52,20	4,0	26,80

Q1 – consumed heat during day, Gcal

Q1av – average hour consumption during day, Gcal/h

G1 – measured flow of heat career through heat meter, ton

G1av – average hour measured flow of heat career, ton/h

t1 - temperature of heat carrier in supply pipeline, °C

P1 – pressure of heat carrier in supply pipeline, kg/cm^2

T1 –work time during day, hh:mm

T2 - temperature of heat carrier in return pipeline, °C

P1 – pressure of heat carrier in return pipeline, kg/cm^2

dt12 – temperature difference between supply and return pipeline, °C