Technical Study of Energy Efficiency Opportunities in the District Heating System in Oradea, Romania

Background

The City of Oradea and the Municipal "Regia" responsible for heat delivery (APATERM) are considering an investment to improve the system reliability and energy efficiency of district heating substations and the secondary side piping network. The US Agency for International Development (USAID) contracted with E^3 International staff for a technical and economic assessment of alternatives to the system upgrade.

The City of Oradea is in the Northwest part of the country near the border with Hungary. The population is about 228,000 people. Two cogeneration power plants generate 1830 tons of steam per hour (t/hr) with an installed electrical capacity of 208 megawatts (MWe). The plants supply hot water for heating to substations through seven main primary side distribution heat pipes. This primary pipe network, owned by Termoelectrica, S.A. is 74 kilometers long and feeds 197 substations. APATERM operates 143 of the substations, as well as a secondary district-heating network of about 550 kilometers to service 57,000 apartments and 2,800 family houses. The industrial thermal energy demand has continually decreased since 1990 to a current level that is 10% of the original level.

Objective

To determine the least cost alternative to upgrade the heat supply system and answer two principal questions for the city:

- Should the Oradea district heating system remain centralized with combined heat and power plants (CHP) supplying the heat, or should APATERM build new, small, distributed natural gas-fired boilers at substations?
- Should APATERM invest in a total upgrade of substations, or accept increasing repair and maintenance cost and losses by continuing to operate the existing system?

Town Hall, Oradea

Approach

E^3 International's technical approach consisted of seven factors:

- Equipment upgrades to co-generation plants CHP1 and CHP2 were evaluated in three main alternatives based on different fuels and emissions controls.
- The distributed gas-fired boilers in substations were evaluated as a primary side heat supply alternative to the central primary side system. The natural gas supply network cost was included in the total investment.
- The primary side distribution (pipe) network was evaluated with emphasis on the available transportation capacity delivered from either CHP1 or CHP2.
- The substations, secondary distribution (pipe) system, and municipal buildings demand were assessed assuming proper and balanced system operation that results in a

supply capacity and consumption required for comfortable living conditions.

- Replacement of some secondary pipes was considered as a "necessary cost." A limited amount of replacement was evaluated based on the age of the pipe.
- Economic evaluation of the APATERM investment in substations and the secondary pipe network was based on the cost of delivered heat and on the economic impact on the APATERM operation.
- Assessment of municipal buildings was based on general building characteristics of four selected building types and a comparison and extrapolation of results of energy savings from various energy conservation measures implemented in similar buildings in similar environments.

Task 1: Energy Efficiency Measures in the District Heating System

Substations and Secondary Distribution Network

E^3 International staff's assessment of the system substations and the secondary distribution network:

- Evaluated current conditions and the operation of the substation equipment.
- Evaluated the energy saving potential and proposed upgrades for improvement of the substations.
- Suggested ways for more effective operation of substations and secondary pipe distribution system.

Power Plants and Primary Distribution Network

E^3 International staff's assessment to identify the least cost alternatives for the supply side of the district heating system included:

- Three alternatives for retrofit of the primary system, or its replacement by new, decentralized small natural gas- fired boilers at substations;
- The potential for energy saving in production, distribution and use of heat and the possible use of renewable energy; and
- The cost of delivered heat to the users.

Task 2: Energy Efficiency Measures in Municipally Owned End-use Facilities.

E^3 International staff's assessment of heat consumption in municipal buildings determined the most cost-effective energy savings using combinations of energy conservation measures (ECMs) evaluated by computer simulation of heat supply and losses. The ECMs were:

- **Building Envelope:** window caulking and replacement, exterior wall insulation, and roof insulation.
- **Building Heating System:** building level control and installation of thermostatic radiator valves.
- **Domestic Hot Water:** installation of low-flow shower heads and flow restrictors.

Task 3: Prioritized List of Least Cost Investment Opportunities

E^3 International staff analyzed results of Task 1 and Task 2 to:

- Perform a heat balance of the system given current and expected future loads
- Develop a preliminary design of designated energy savings strategies and analyze the impact on system demand and energy requirements
- Estimate the energy savings for each strategy.

Results

The original substation equipment and design is obsolete. In 1998, about 60% of the substations were equipped with modern, compact plate heat exchangers, but other parts are in very poor condition. The installed heating capacity of 705.4 Gcal/hr is oversized by 33 percent. In addition, the system has a 19.4% heat loss.

Energy savings can be realized by improved hardware and control equipment, and a change in system operation and management. It is most economical to replace the substation equipment, including the recently installed compact heat exchangers in all substations by factory pre-assembled, modular substations. APATERM needs to upgrade substations and the secondary network pipes, and perform hydraulic balancing of the secondary network loops at the user side.

For municipal buildings, two combinations of ECMs were the most cost-effective for acceptable simple payback in a combined project with other demand side upgrades:

- **Window weatherization, building level heat control, radiator thermostatic valves, and hydraulic balancing of the system** - yield a project simple payback of 2.7 years for high schools ($239,000 USD investment), 2.7 years for technical schools ($132,000 USD investment) and 3.4 years for kindergartens ($88,000 USD investment).

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