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Use of EMESE Software to Develop Municipal Energy Plan for District XII of Budapest, Hungary

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Background

One of the most important energy related tasks of Hungarian local governments is to supply energy and heat to their public institutes (schools, kindergartens, hospitals, etc.). The energy cost is usually the single highest operating cost for these institutions. Local governments are rarely able to efficiently monitor the energy use of their buildings.

Up until 1993, there was no tool available for the local governments to monitor and evaluate the energy use of their buildings. During that year, a software program was developed by EGI, which was funded by the Dutch energy program, NOVEM. In spite of the efforts of the Dutch program and the encouragement of the ministries, less than 1% of the Hungarian local governments showed an interest in using the software and only a few of them used it properly.

At the time that the workplan for the USAID Energy Efficiency Program was developed, it was realized that lack of adequate energy management practices and tools is one of the most important barriers to energy efficiency improvement in Hungarian municipal buildings. Therefore, it was decided that some of the resources of the USAID program would be used to

a) upgrade the software by making it more user-friendly and attractive;
b) demonstrate the use of the software at two sites; and,
c) use the software to develop a municipal energy efficiency plan at one of these sites.

One of the demonstration sites was District XII in Budapest. Although traditional energy planning requires the development of a long-term comprehensive energy supply and efficiency program, the EMESE software only allows the evaluation/prioritization of energy efficiency projects. Therefore, this report summarizes the experience gained in District XII in the use of EMESE for evaluating energy efficiency projects.

The Monitoring and Targeting (M&T) method and the EMESE Software

A good energy management system relies on:

- Regular and frequent reading and logging of energy consumption;
- Setting consumption targets; and,
- Taking measures if differences between the targets and actual energy use are encountered.

One way to set targets is to compare the energy use during the current year to energy used during a previous year, adjusting for factors, such as occupancy or weather conditions that are unrelated to efficiency of energy use. Statistical analyses of historical energy data can provide a logical basis for this comparison.

The simple M&T method, however, compares the performance of the buildings to themselves only. Later, cross-sectional comparisons can be made to other similar buildings within the same city or other cities to get additional insight into energy use and efficiency of the building being studied. However, the first step in this process is to benchmark the building energy use by comparing current energy use with energy use targets for the same building.

The following benefits can be expected from this type of energy management or benchmarking system:

1. Regular energy meter readings and comparison of energy use to appropriate targets can help evaluate the performance of the individual institutions and spot technical and other faults.
2. The large database of past energy performance data form a reliable baseline for any future energy efficiency projects for the facility.

3. By comparing actual energy use with targets, it is straightforward to calculate the actual savings and cost-effectiveness of an energy efficiency project.
4. Using the benchmarking function, a priority list of energy efficiency projects can be set up. From this list, a plan can be drawn up to identify the priority order in which specific projects should be implemented.
5. This system can help these institutions to establish next year's energy budget.

With the above considerations in mind, the EMESE software was upgraded. It has the following capabilities:

- It houses general data on public buildings (identification data, type of energy supplies, heated volumes, functions, etc.).
- It stores energy meter data and/or data describing other types of energy use (electricity, district heat, fuels, water, hot tap water).
- It stores information on factors that influence energy use (ambient air temperatures, utilization indicators).
- It stores energy price information
- It generates energy use and cost targets from historical data through regression analysis.
- It compares (typically weekly) readings to the targets.
- It prepares separate reports (for the leaders of the local government, the technical manager for the local government, the individual institutions involved).
- It generates benchmarks, based on actual, normalized consumption data, in order to facilitate comparisons between institutions that perform similar functions.

The Use of the Software in District XII

General Experience District XII

This district is one of the wealthiest in the city. They operate 49 institutions. This municipality, unlike many others, has a proper organization for energy management, and has a specially appointed energy manager. The energy awareness of the city is unusually high. They have also taken part in other USAID-funded activities related to promotion of energy efficiency in schools.

The software was transferred to District XII staff in October 1997. During 1997, the entire system was set up, i.e. the institutions were designated, the model was benchmarked, and the database and information stream was organized. In January 1998, all of the institutions within District XII started to supply data for the system.

The municipality has been using EMESE since it was introduced. Unfortunately, after the initial zeal, the regular evaluation of data has stopped. In part, this was because the energy manager has been overloaded with other tasks. Now, data are entered sporadically, perhaps once a month or once every two months. Because of this, one function of the system, i.e. the close monitoring of the institutions' performance, is not utilized to its full potential.

The municipality, however, makes use of the other features of the EMESE software. They have used it to quantify the results of their energy efficiency projects that were recommended through the USAID energy audits, and subsequently implemented. They have also used it in their energy planning and budgeting process.

Project Evaluation

District XII has implemented several energy efficiency projects during the past two years. Some of these were recommended through the USAID-funded energy audits and the municipality on its own initiative undertook others. It is very important for the technical department to quantify and document the results of these projects, in order to:

a) draw conclusions regarding the feasibility and economics of the types of measures that were installed;
b) justify the investments to the Board of Representatives.

EMESE has proved to be a very useful and easy-to-use tool for evaluating these projects. Both the data and the well-defined target functions in the software allow the actual savings to be easily identified in the examples below.

The following projects were implemented in District XII:

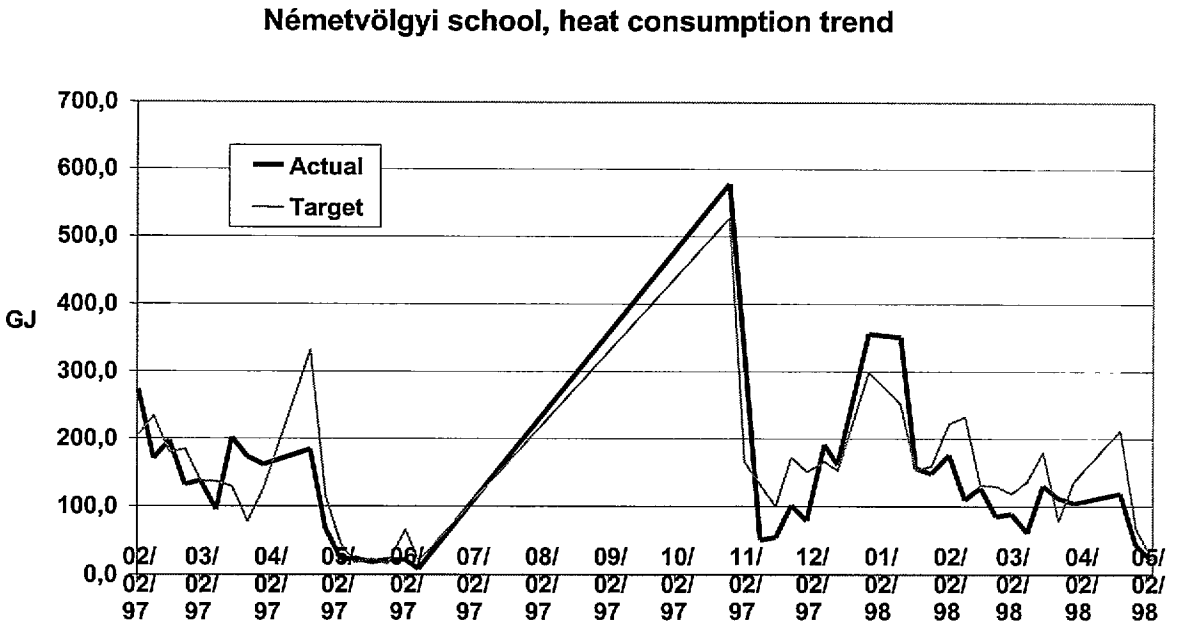
Institution	Projects	Date of project implementation
Németvölgyi school	Detaching the caretaker's flat from the main heating system	09/01/97
Tallya kindergarten	Thermostatic valves, draftproofing	09/01/97
Kiss János kindergarten	Thermostatic valves, draftproofing	09/01/97
Virányos school	Detaching the caretaker's flat, improved heating control thermostatic valves	09/01/97
Ózike kindergarten	Thermostatic valves, draftproofing	09/01/97
Sports Center	Boiler modernization, thermostatic valves	01/10/98
Normafa kindergarten	Boiler modernization, thermostatic valves, insulation	12/22/98
Municipality building	Boilerhouse modernization	01/10/98

Fortunately, some of these institutions started to collect data early, and historical weather data were available from the Institute of Meteorology. Therefore, the municipality energy manager had good baseline energy data to work with. This made it relatively easy to calculate the energy savings associated with each of the above projects.

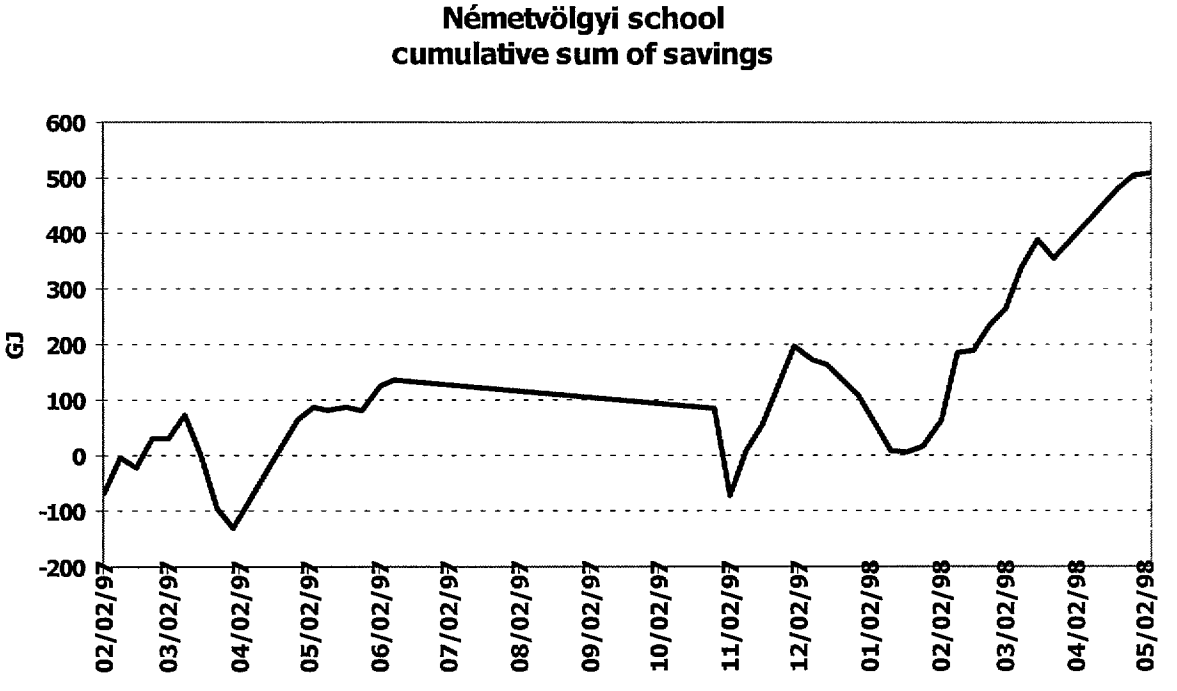
In the cases presented below, a target function was determined using the 'before the project' data. This target function depends on the outdoor temperature (i.e., the degree-days) and occupancy data. It estimates how much the energy use should be based on the specific temperatures and occupancy levels being experienced. These estimated values are then compared to actual consumption levels. In the examples below, first the target and actual energy uses are presented and compared. This provides useful insight into how the projects influence energy consumption. The second chart in each case is very useful in quantifying the energy saved. This chart plots the accumulated differences between the target and actual values ("CUSUM" curve).

Németvölgyi school:

The peak in the curve below reflects missing data experienced between the summer and project implementation period. However, the segments of the graph before (until 06/02/97) and after (from 11/2/97on) the peak should be compared. This comparison demonstrates that before the project was implemented, actual consumption was close to the target values, while after the project was implemented, actual comsumption is falling below the targets and is well below previous usage levels. The trend curve demonstrates the actual savings that have been achieved.

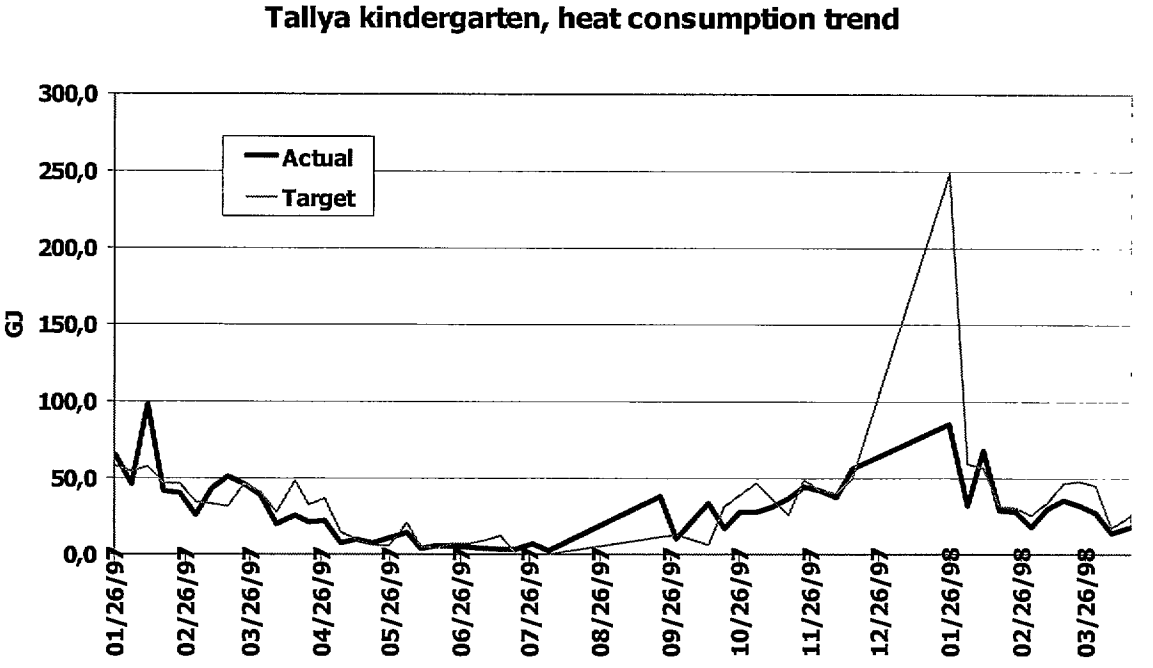


The achieved savings can easily be identified by the CUSUM graph (below):

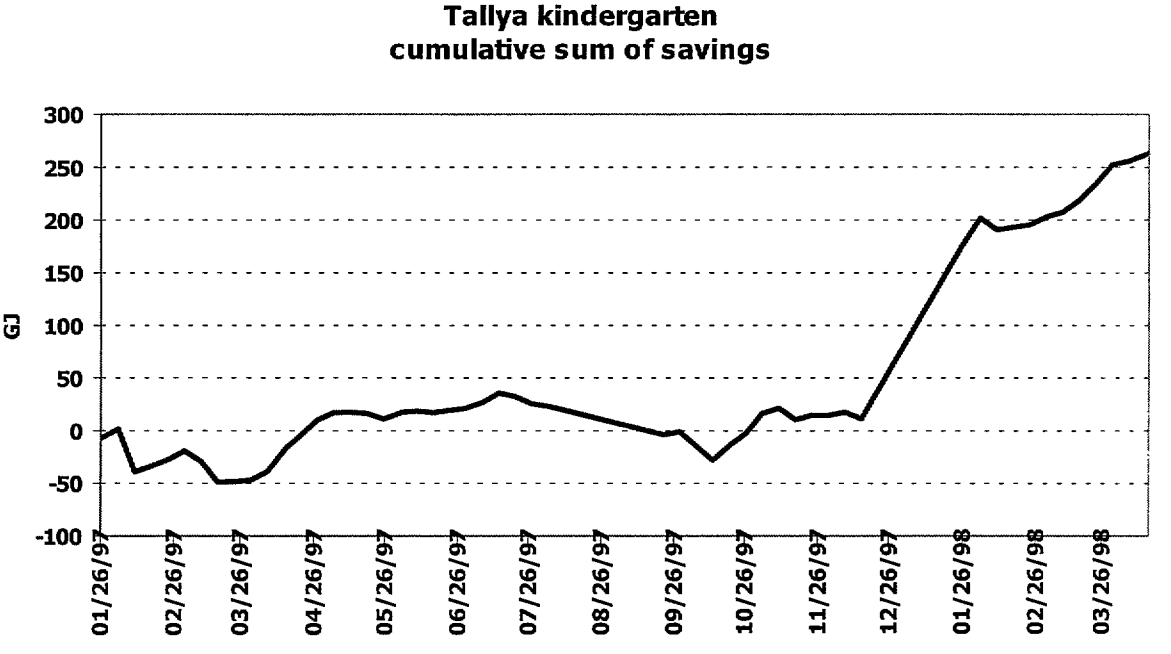


As the chart shows, before the project, the differences between the actual and target values were not significant and certainly did not show any trends: Over a 9 month period, the accumulated difference value did not exceed 100 GJ. After the project was implemented, however, the cumulative savings is significant and there is an upward trend in the chart, indicating continued savings. The drop December 97 - January 98 may be due to some system problems. After that, there is a constant increasing trend in the savings. In summary, the school has saved some 500 GJ since the project was implemented.

Tallya kindergarten



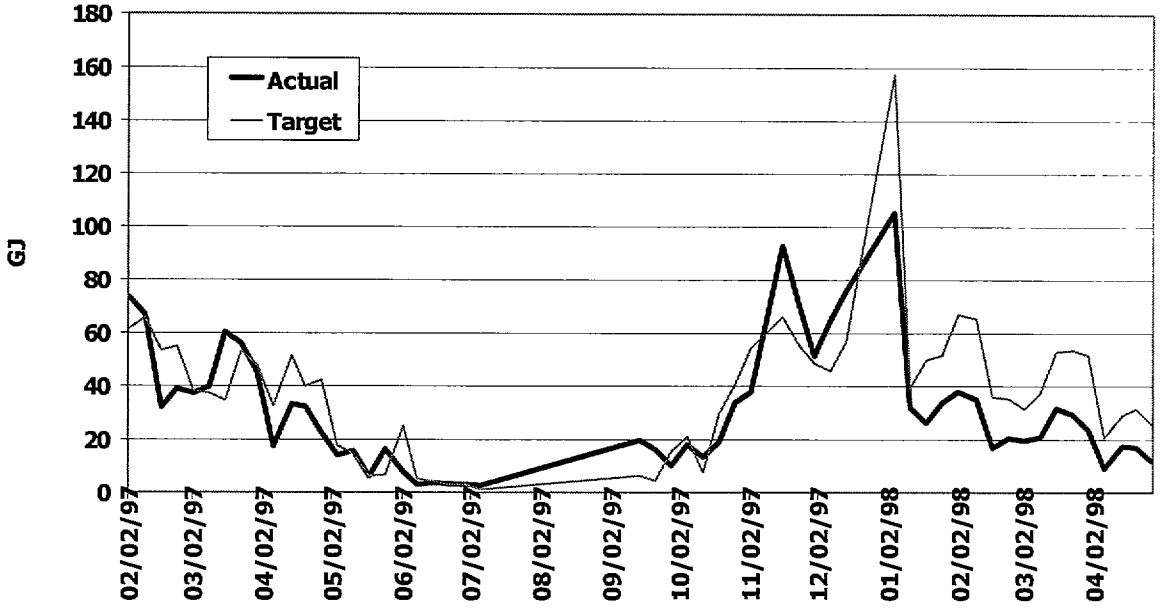
The peak in January is due to the winter break in the kindergarten. During that time, no readings were made and a high number of degree days was accumulated (hence the high target), however, only minimum heating was on (hence the difference). In this case, the achieved savings are not that apparent from the trend graph. However, if the CUSUM graph is plotted, then the effect of the project becomes apparent. From December 97 onwards, the savings are continuous and amount to more than 250 GJ by April 98.



Normafa kindergarten

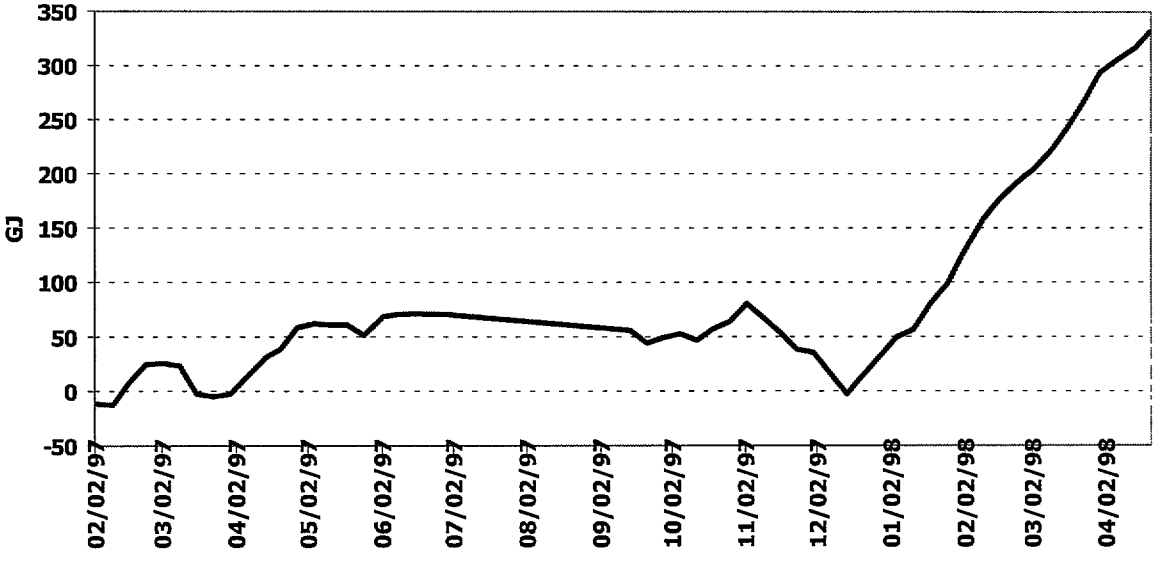
The savings achieved due to the new boilers are already apparent from the energy consumption trend graphs.

Normafa kindergarten, heat consumption trend



The peak is also explained by the winter break. After the project, the curve of actual consumption follows the trend of the target curve, but on a lower level. This clearly indicates the improved efficiency of the new equipment. The achieved savings are the easiest to quantify using the CUSUM curve.

Normafa kindergarten
cumulative sum of savings



The sudden change in December 97 evidently shows that a serious change occurred, i.e. the project was implemented. From then onwards there is a continuously increasing trend indicating the almost constant savings, which accrued to almost 350 GJ in four months.

Municipal energy planning

As stated earlier, EMESE can be used in the planning process in two ways: to prioritize energy efficiency projects, and to plan the annual energy budget.

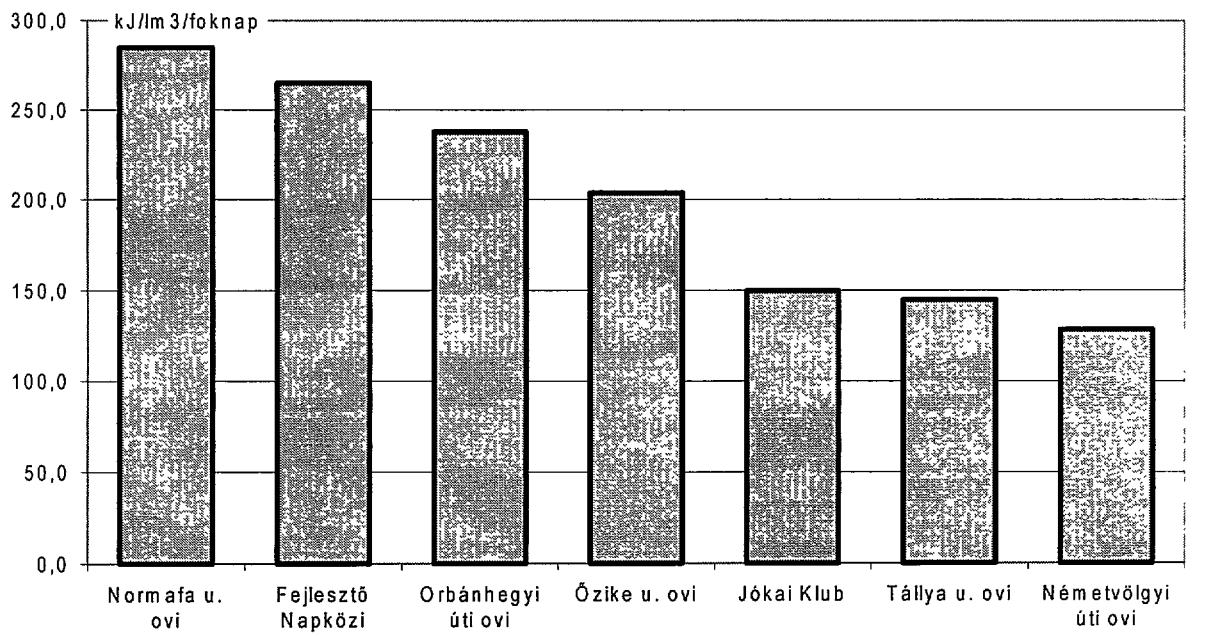
The latter is currently done on the basis of the last five years' average values in District XII. A more accurate method would be to use the target functions provided by EMESE and substitute average degree-day and occupancy data to compute the annual expected energy use for each of the individual institutions. This method takes into account the technical parameters of the building, their energy infrastructure, and their operating practices.

Although the software is in place, the municipality is not yet able to use it to generate their energy budget, since not enough data have been gathered. In addition, those members of the Board of Representatives without technical background need to be educated on the benefits of the method. This education also requires that a few years' data be available to document the superiority of the EMESE estimates versus the simple trend estimates used previously.

However, the municipality has used the EMESE software for their energy efficiency project planning to prioritize potential projects. Based on their experiences from previously implemented projects, the municipality has decided to concentrate their efforts on heating system upgrades and building envelope improvement projects focused on window and door replacement. Kindergartens have priority for political and other reasons. The District has decided that the next projects will involve heating system improvements in the kindergartens. The priority, size and quantity of the projects were identified with the help of the benchmark values provided by EMESE.

For heating energy, EMESE provides a benchmark figure that is calculated by dividing the total heating energy by the number of degree days and the heated volume of the buildings. Obviously, only similar institutions can be compared using this benchmark, as it does not take into account occupancy patterns.

This figure was calculated for all the kindergartens in question and the results were presented in the following chart. The calculation was made for the first six months of 1998.



The chart demonstrates the effects of the project implemented in the Tállya kindergarten in 1997 described above. After the project was implemented there, energy consumption is significantly lower.

On the other hand, the calculation revealed the poor condition of the Normafa kindergarten. That was one of the reasons it was the first to undergo the energy efficiency improvements. (The results of this project were discussed in the previous chapter.)

Based on the EMESE ranking and other considerations the municipality developed the following energy efficiency plan:

Institution	**Projects**	**Planned project implementation**
Normafa kindergarten	Boiler modernization, thermostatic valves, insulation	12/22/98 (already finished)
"Fejlesztő" kindergarten	New boilers, thermostatic valves, building envelope improvements	02/99 (delayed)
Németvölgyi kindergarten	New boilers, thermostatic valves, building envelope improvements	06/99
Orbánhegyi kindergarten	New boilers, thermostatic valves, building envelope improvements	07/99
Jókai Klub	New boilers, thermostatic valves, building envelope improvements, heat and water meters	06/99