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Analysis of the “Feasibility Study for a Reduction in Heating, Hot Water Supply and Catering Operating Cost at Orhei Hospital”

ENERGY AUDIT, Part I:

Heating and Hot Water

Vienna, June 2011

IMPRESSUM:

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Executive Summary

The objective of this report is an analysis of the “Orhei Feasibility Study”, which has identified a list of 4 top priority energy efficiency measures for Orhei Hospital in the Republic of Moldova. These measures include wall-insulation, replacement of windows, renovation of the hot water supply and replacement of stoves.

Two of these measures with reasonable payback time of 2,5-3,6 years will basically consist of a full switch from electricity to gas respectively gas/solar, saving 177.299 kWh/year of electricity (water heaters, electric stoves). This needs to be accounted for in the second energy audit which is conducted in parallel to the report assessed here[1]. The other two measures have payback times of 9-11 respectively 43-72 years. These to measures need to be re-evaluated according to the recommendations given in chapters 3.1 and 3.2.

The Orhei feasibility study is a good tool to assess some of the generally important saving options. Shortcomings of this feasibility study include the omission of a more detailed description of the ventilation and heating system and a description as to how the authors have chosen the measures described in the study and which alternatives they have ruled out for which reasons. Our assessment of the “Orhei Feasibility Study” is shown in table 1:

Deliverables according to TOR	Evaluation	Comments
General evaluation of heating system	Poor	Heat production & distribution is missing
Evaluation of heating losses	Incomplete	Only walls and windows are considered (production, roof, cellar, ventilation etc. missing)
Identification of opportunities to save heating energy	Incomplete	4 Basic measures described, but not the selection process
Action plan	Incomplete	4 of 8 measures not assessed. 1 measure is mentioned 2 times

Table 1: Assessment of deliverables

Our recommendations include to examine the heating system in more detail, to calculate the savings for the additional measures (3.5) and to reconfirm the details of those saving options which have already been assessed as promising.

[1] “Analysis of Orhei Hospital Complex Energy Audit”, prepared by Iurii Ghies as part of the GIZ Moldava Project

1 Background

This report is a review of the document:

“*Feasibility study regarding the efficiency of using the thermal energy in the complex of Orhei hospital buildings*” (“Orhei Feasibility Study”). Chisnau, 2011

The document was prepared by Maximuk E.P. PhD as part of the GIZ Moldava Project

This review includes:

- Recommendations regarding the reviewed study
- Recommendations for improvement

Basis for this evaluation report were the following documents:

- Orhei Feasibility Study
- Terms of reference for a short term consultancy “Feasibility Study for determining the energy efficiency measures needed to improve the situation in Orhei hospital”

2 Analysis of the current situation at the hospital

2.1 Summary of status quo analysis

2.1.1 Summary energy audit

In the “Orhei Feasibility Study” the following basic parameters concerning energy demand have been reported:

- Energy demand of Orhei Hospital for heating purposes is about 3 MW;
- Natural gas costs in 2011 of 4,782 lei/m^3;
- Electrical energy price 2011 of 1,596 lei/kWh.

2.1.2 Evaluation energy audit

The identification of the overall energy situation of the hospital is an essential step in the auditing process and the calculation of savings. This step is basically missing in the “Orhei Energy Audit”: The study focuses on saving measures but doesn’t include a basic description of the energy production facilities and the energy distribution system. The total demand of energy and natural gas per year is not reported. Since the energy audit itself suggests saving measures concerning heat production and distribution such as an insulation of pipes or a re-dimensioning of boilers (see chapter 3.5), the heating system doesn’t seem to be negligible. The energy needs for hot water are only partly available for the pediatric unit (see 3.3). The identified and described information of the energy auditor is not sufficient to deduce a comprehensive set of energy efficient measures for the Hospital.

2.1.3 Recommendations energy audit

- Add a set of data and additional information such as time series of the energy consumption in MWh/a and the energy costs for Orhei Hospital over the last 3 years (VAT incl. or not should be indicated);
- Add a description of the heat production facilities (boiler house, heat insulation, etc.) and technical standards of the facilities;
- Include a description of the heating system in the buildings (heat distribution system, heat insulation) and technical standards of the facilities;
- Add a description of energy losses apart from walls and windows (ventilation, roof, cellar);
- Add some key figures such as a calculation of total energy consumption per m^2 and per bed;

3 Analysis of Energy Efficiency Measures

In the “Orhei Feasibility Study” four measures to save energy are described. It is not clear if any other measures have been identified or examined. Neither is it clear to the reader how these four measures were chosen. Thus, on the basis of this energy audit, it cannot be ruled out that additional measures would be meaningful (see also 2.1.2).

3.1 WALL INSULATION:

3.1.1 Summary wall insulation

In the present state of the buildings the walls consist of shell limestone or reinforced concrete walls. The walls are not isolated. The proposed efficiency measure is to insulate some 13.118 m^2 of these walls with 100 x 50 cm stone wool insulation panels with a thickness of 7 cm and a value for the thermal conductivity (λ-value) of 0,04 W/(m·K). The heat transfer factor (U-value) of the non insulated wall is 1,3 W/(m^2·K). The insulated wall heat transfer factor U is 0,44 W/(m^2·K). Rated outdoor temperature is -16 ℃. Savings in natural gas are calculated to be 113.696 m^3/year or 543.690 lei per year. At prices for the insulation of 370 to 450 lei/m^2, total insulation costs would be in the range of 4,85 to 5,90 million lei. The resulting pay back period would be of the order of 9 to 11 years.

3.1.2 Evaluation wall insulation

The calculations presented are stated as to being in accordance with national standards. Prices are said to be commercial prices valid for the moment of this study.

- We can confirm that the above calculation method is correct and sufficiently detailed[2] for this evaluation;
- Concerning the heat transfer factor of the given walls, it is reasonable to consider an insulation of the walls as an energy saving measure at Orhei Hospital;
- Only one scenario for the wall insulation is described and calculated. It is not clear why this scenario is chosen[3];
- VAT incl. or not should be indicated;

[2] We used the following formula: Energy Saving [m^3 gas/y] = ΔU x 10 x Wall Area

[3] For example: Increasing the thickness of the insulation with the same λ-value of 0.04 W/(m^2*K) to 20 cm would result in additional savings of approximately 35.000 m^3 of gas or 170.000 lei.

3.1.3 Recommendations KPC

- We recommend to include in the report an explanation why a thickness of the insulation plates of 7 cm has been chosen as the optimum;
- For the calculation of energy reduction a boiler efficiency of η = 92% was assumed. This seems rather high for a boiler system which is described as being potentially over dimensioned (2.1.2). Effective energy savings could thus be higher. Actually this value should be known exactly;
- Improving the thermal insulation of the buildings at Orhei Hospital could have beneficial effects on the need for cooling;

3.2 REPLACEMENT OF THE OLD WINDOWS

3.2.1 Summary window replacement

The existing windows heat transfer coefficient (U-value) is 2,15 W/(m^2·K). By replacing 2.746 m^2 of existing glazing with PVC windows with a heat transfer factor of 1,8 W/(m^2·K), energy demand could be reduced by 35,6 kW. Thus an amount of 9.696 m^3/year of natural gas could be saved. As a side effect, the author of the Orhei Feasibility Study mentions that PVC windows will considerably reduce the inflow of the outdoor air and thus affect the ventilation of the premises. However, the costs for these PVC windows are of the order of 733 to 1.221 lei per m^2 leading to total costs for the replacement of all windows of 2.012.820 to 3.352.870 lei. The payback time for this measure thus lies between 43 and 72 years.

3.2.2 Evaluation window replacement

- We cannot confirm the payback time for this measure;
- The calculation method that was chosen is basically correct, but the assumptions for the heat transfer coefficient (U-value), which were used in this calculation, needs to be reconfirmed: For the existing windows we assume an U-value of more than 3 W/(m^2·K) (instead of 2,15) and for the new PVC windows we assume the U-value to be smaller than 1,5 W/(m^2·K) (instead of 1,8). Assuming a ΔU of 1,5 W/(m^2·K) some 41.200 m^3 of gas could be saved. At a price of 4,782 lei/m^3 about 200.000 lei could be saved, which is more than 4 times the savings calculated in the audit (46.385 lei/year). The corresponding payback time would be 10 to 17 years.

3.2.3 Recommendations windows replacement

- Reconfirm the calculation;
- According to the Orhei Feasibility Study the installation of better windows would imply a need to renovate the obsolete hospital ventilation system (see Orhei Feasibility Study 3.2). Since ventilation systems generally are an important aspect in hospitals we recommend a more detailed assessment of this topic at Orhei hospital including the aspect of waste heat recovery (see also 2.1.2).

3.3 REPLACEMENT OF THE ELECTRIC BOILERS

3.3.1 Summary window replacement

According to the “Orhei Feasibility Study”, the pediatric unit at Orhei Hospital uses eight electric boilers to heat water. The total capacity for all water heaters in the building is 12 kW – the total need for the heating of water is calculated to be 55.980 kWh. As the measure of choice for improvements of this system, the “Orhei Feasibility Study” has looked into a replacement of these boilers with heat exchangers equipped with solar collectors (15 m^2). To determine the configuration of this solar water heating system and price a preliminary project study has – reportedly – been conducted. The price for the equipment and components amounts to 191.150 lei. The total investment in hot water supply system renovation, design and installation is estimated to be 268.500 lei. The contribution of the solar units is expected to reduce the necessary gas consumption by 40%. With these parameters the saving will be about 3.924 m^3/year. To compare with the existing costs of 94.046 lei/year, the saving amounts to 75.280 lei/year. This results in a payback period of 3,6 years.

3.3.2 Evaluation electric boilers

- Indicate the area of solar panels needed: A 40% contribution from solar heating is generally possible. However, in this case 40% of the demand would be 22.392 kWh/year, which is not feasible with 15 m^2 of panels (we assume 200-600 kWh/year·m^2)[4].

3.3.3 Recommendations electric boilers

- Describe the size of the solar panels used in the calculation and the factor for the solar gains per m^2 and year;

3.4 REPLACEMENT OF ELECTRIC STOVES WITH GAS STOVES

3.4.1 Summary gas stoves

According to the Orhei Feasibility Study the annual electrical energy consumption for catering is 118.368 kWh/year. At a price of 1,596 lei/kWh, the total costs are about 190.000 lei/year. The calculations reveal that the replacement of the existing electric stoves with gas stoves will reduce operating costs by 108.900 lei/year. The stove investment payback requires up to 2,5 years.

3.4.2 Evaluation gas stoves

- The Orhei Energy Audit estimates the power consumption at the kitchen[5] to be 102.470 kWh/y which is about 13% lower than the value used in this calculation;

3.4.3 Recommendations gas stoves

- None;

[4] Arbeitsgemeinschaft ERNEUERBARE ENERGIE NÖ.Wien on behalf of Arsenal Research, EU – INTERREG Project Solar Net I

[5] See Orhei Feasibility Study, table.2: 2 Electric stoves, 1 Electric boiler, 1 Electric frying pan, 3 Electric pans

3.5 ADDITONAL MEASURES

3.5.1 Summary additional measures

In the final action plan of the Orhei Feasibility Study, four additional measures are mentioned, which are:

- To install heat meters in heat supply stations separate for each building;
- To mount balanced valves in heat supply stations separate for each building to equalize the heating supply systems hydraulic pressure;
- To insulate the pipelines of the heating systems, which pass through the unheated cellars and service floors;
- To install boilers with lower heat capacity, which will ensure an effective operation in off-peak conditions and use backup alternative fuel;

3.5.2 Evaluation additional measures

- An assessment of the effectiveness of these measures in terms of energy savings or cost and benefit ratios has not been reported;

3.5.3 Recommendations additional measures

- The above measures seem very reasonable and would be worth looking into more closely (especially balanced valves and the insulation of pipelines);

4 Analysis of action plan

The action plan mentions 9 activites or measures to save energy. 1 measure is mentioned 2 times. Only 4 out of these 89 measures have been analysed in a comprehensive way. For the other 4 activities no data has been reported, nor investment costs and saving. An implementation plan has not been reported.

5 Final recommendations

The “Orhei Feasibility Study” found some promising options to save money and energy (wall insulation, replacing electric stoves, electric boilers), which greatly impact the electricity needs of the Hospital and need to be taken into account in the energy audit that focuses on electricity[6].

The other saving options need to be reconfirmed (windows) or specified (additional measures) and discussed with the hospital administration (wall insulation with payback time of 9-11 years).

Some commonly analysed efficiency measures for hospitals have not been described in the “Orhei Feasibility Study”. These are:

- For buildings with high energy and electricity demand a co-generation system for producing heat and electricity could be examined;

[6] “Analysis of Orhei Hospital Complex Energy Audit”, prepared by Iurii Ghies as part of the GIZ Moldava Project

- The topic of heat recovery has not been described. As hospitals typically use a lot of energy for laundry services[7] some “low hanging fruits” might be collectable in this field (e.g. heat recovery from waste water at laundry station).

[7] According to the Orhei Energy Audit laundry services consume an average of 576 kWh of electricity per month. The need for heat has not been specified.