POWER PLANT EFFICIENCY INDICATORS MONITORING SYSTEMS

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This paper presents the architectural model for a OPC based on-line monitoring system for efficiency indicators for a coal based cogeneration power plant from Craiova City, Dolj County, ROMANIA (www.cencraiova.ro) .In order to achieve these goals an OPC based on-line monitoring system was implemented together with an existed enterprise economical database.Both databases are implemented on a Microsoft SQL Server using Visual Basic ODBC interfaces.

This OPC based architecture, although is very complex from the implementation's point of view, brings huge advantages in cogeneration power plant management.

Keywords: efficiency, power plant, OPC, Visual Basic, management

This paper presents the architectural model for a OPC based on-line monitoring system for efficiency indicators for a coal based cogeneration power plant from Craiova City, Dolj County, ROMANIA (www.cencraiova.ro) .

The plant is among the newest TPPs of the Romanian power sector. It contains both electricity to the power system and hot water and steam for Local Craiova District Heating Company and industrial consumers. It is based mainly on 2x150 MW CHP units.

The main equipments of Craiova II TPP are:

1. GENERAL OVERVIEW

The main efficiency indicators which are follow-up are:
-the daily and cumulative cost for sold (net) electrical energy Cost EE [lei/MWh] .
-the daily and cumulative cost for sold (net) thermal energy Cost ET [lei/Gcal] .
-the electrical daily specified consumption Cspe [gcc / kWh]
-the thermal daily specified consumption Cspt [Kgcc / kWh]

In order to achieve these goals an OPC based on-line monitoring system was implemented together with an existed enterprise economical database.Both databases are implemented on a Microsoft SQL Server.

OLE for Process Control (OPC) is designed to allow client applications access to plant floor data in a consistent manner. With wide industry acceptance OPC provide many benefits:

- Hardware manufacturers only have to make one set of software components for customers to utilize in their applications.
- Software developers will not have to rewrite drivers because of feature changes or additions in a new hardware release.
- Customers will have more choices with which to develop integrated monitoring systems.

With OPC, system integration in a heterogeneous computing environment become simple.

In the context of world wide energy saving, environmental protection, climate change and market policies the reduction of fuel consumption, especially coal, become a "hot" goal for the management.

An OPC based monitoring system was develop to help operators to optimize on-line the fuel consumption and also the management level to identify the "hot-point" of the energy production business.

The main architecture, described in Figure 1 , cover the necessities of the application.

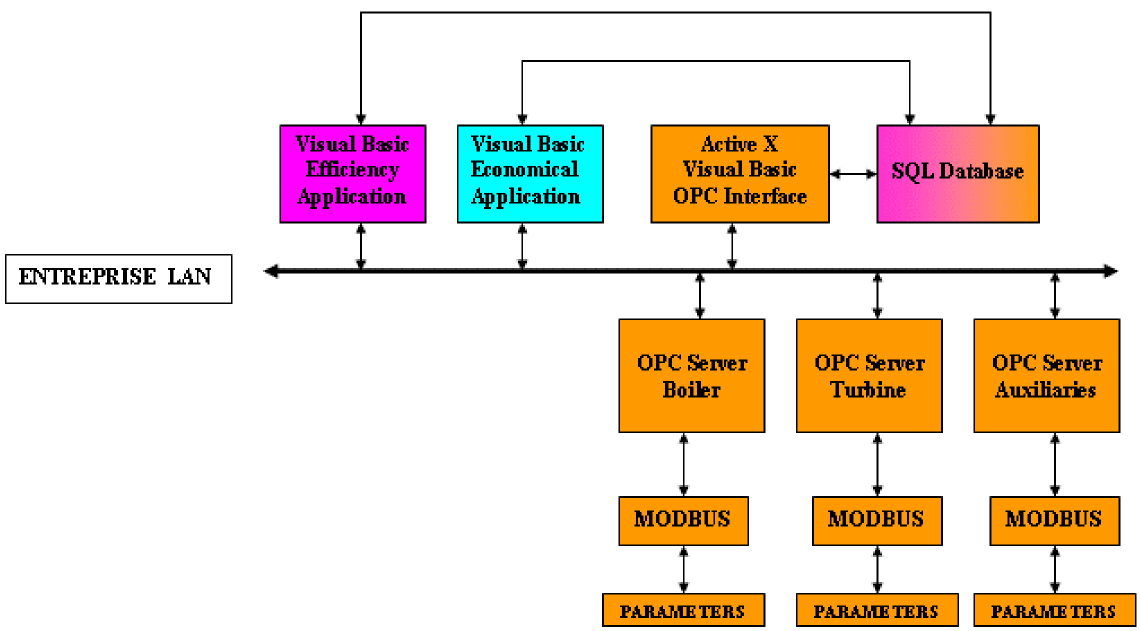

Figure 1. Efficiency application structure

Those above mentioned efficiency indicators are calculated with the following formula, in respect with ANRE (Romanian National Energy Authority – www.anre.ro) orders:

1) Cogeneration electrical energy cost:

$$Cost_{EE} = \frac{K_{EE} * (FuelCost + Salaries + Depreciation + Servicies + General)}{Net\ Electrical\ Energy} \quad [lei / MWh] \quad (1)$$

2) Cogeneration thermal energy cost:

$$Cost_{ET} = \frac{K_{ET} * (FuelCost + Salaries + Depreciation + Servicies + General)}{Net\ Thermal\ Energy} \quad [lei / Gcal] \quad (2)$$

3) Electrical daily specified consumption:

$$Cspe = \frac{K_{EE} * Fuel\ Consumption}{Net\ Electrical\ Energy} \quad [gcc / kWh] \quad (3)$$

4) Thermal daily specified consumption:

$$Cspt = \frac{K_{ET} * Fuel\ Consumption}{Net\ Thermal\ Energy} \quad [Kgcc / Gcal] \quad (4)$$

Where:

FuelCost - the plant cost for fuel consumption (coal, heavy oil and gas)

Salaries - the salaries cost

Depreciation - equipments depreciation cost

Servicies - the services cost (maintenance, repairs and common services)

General - the financial cost (rate for loans, taxes, others)

K_{EE} - the ratio of electrical energy cost from the total cost (0…1) according with ANRE prescriptions

K_{ET} - the ratio of thermal energy cost from the total cost ($K_{ET} = 1 - K_{EE}$)

Fuel Consumption - the total fuel consumption quantity, in conventional fuel unit measure $1\,t_{cc} = \frac{Pci\ [kcal/kg] * 1\ tonne}{7000}$

Net Electrical Energy - the sold electrical energy quantity

Net Thermal Energy - the sold thermal energy quantity

2. OPC STRUCTURE

The OPC Foundation was established in 1996 by several leading Industrial Automation Manufacturers (including Fisher-Rosemount, Rockwell Software, Opto32, Intellution, Intuitive Technology, and Microsoft) to create OLE for Process Control (abbreviated as OPC), which now serves as the standard interface for the Process Control industry.

The OPC interface is based on such technologies Microsoft Windows COM/DCOM and ActiveX, has the advantage of being easy to learn and implement, and does not require a lot of modifications to your system. Furthermore, OPC defines a control and automation data exchange standard that supports process control. It is for these reasons OPC has become the standard interface for the process control profession, and in addition serves as a communication vehicle for automatic control systems.

The OPC architecture describes below shows a simple system diagram for OPC.

The OPC Client block represents HMI/SCADA control systems, such as Wonderware Intouch, Citect, etc. or an Active X OPC VB ,VC++ interface, and the middle block represents the OPC Server, which is situated between the control system and field device that is used to control networking devices (like in Figure 2).

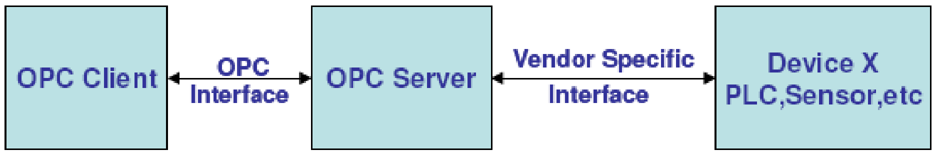

Figure 2. OPC main philosophy

Data exchange in OPC has two parts. One part, which is for exchanging data with controlled devices, implements the corresponding OPC Server for different communication rules specific to the device.

The other part is based on the COM specification of communication between Client and Server, and consequently needs to be set up as a client/server architecture. In order to accommodate the majority of system developers, many development tools come equipped with an OPC Client function to make the tools easy to learn and use.

The OPC specification contains two sets of interface, provided by the software developers, due to the communication capability of industrial controlled equipment.

The interface is known as a collection of methods or related functions and procedures that perform some specific service that the COM object provides.

COM does not specify the implementation of interfaces, only their behavior when interacting with clients (like in Figure 3).

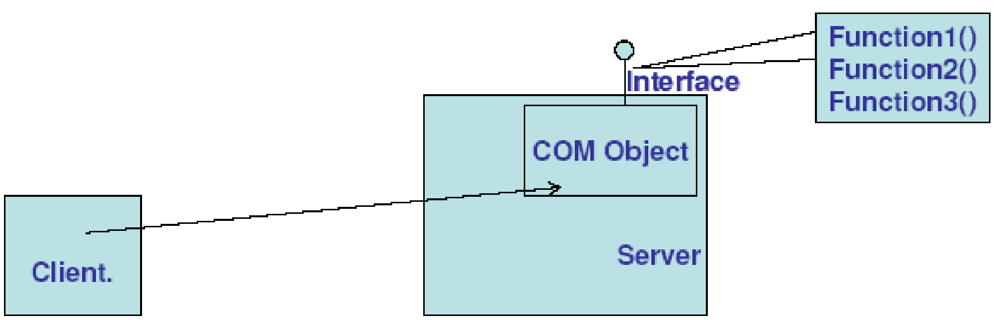

Figure 3. OPC COM interface

The OPC Automation interface is intended for use by applications such as VB, Delphi, and Excel script based programs.

The OPC Custom interface is intended for use with higher level programming languages, such as C++.

OPC Client exchanges data with OPC Server according to the OPC criterion. In fact, most management systems play the role of OPC Client, and some manufacturers also provide an OPC Client component, such as ActiveX, so that application engineers are able to connect quickly to the OPC Server.

Because the main parameters are located in different places, we use 3 OPC Server :

- A Boiler OPC Server for monitoring the milling machine flow (fuel on-line consumption) and live steam parameters (flow, temperature and pressure)
- A Turbine OPC Server for monitoring the turbine and heat exchangers parameters
- An Auxiliaries OPC Server for monitoring the generator parameters (electrical power production), main border transformers parameters for in-out energy consumption and hot water delivery thermal energy.

The communication with PLC's is made by a MODBUS RTU network. Because of commercial constrains we are not able to provide the name of OPC Server and PLC manufacturers.

The OPC Servers above mentioned are configured like in the Figure 4.

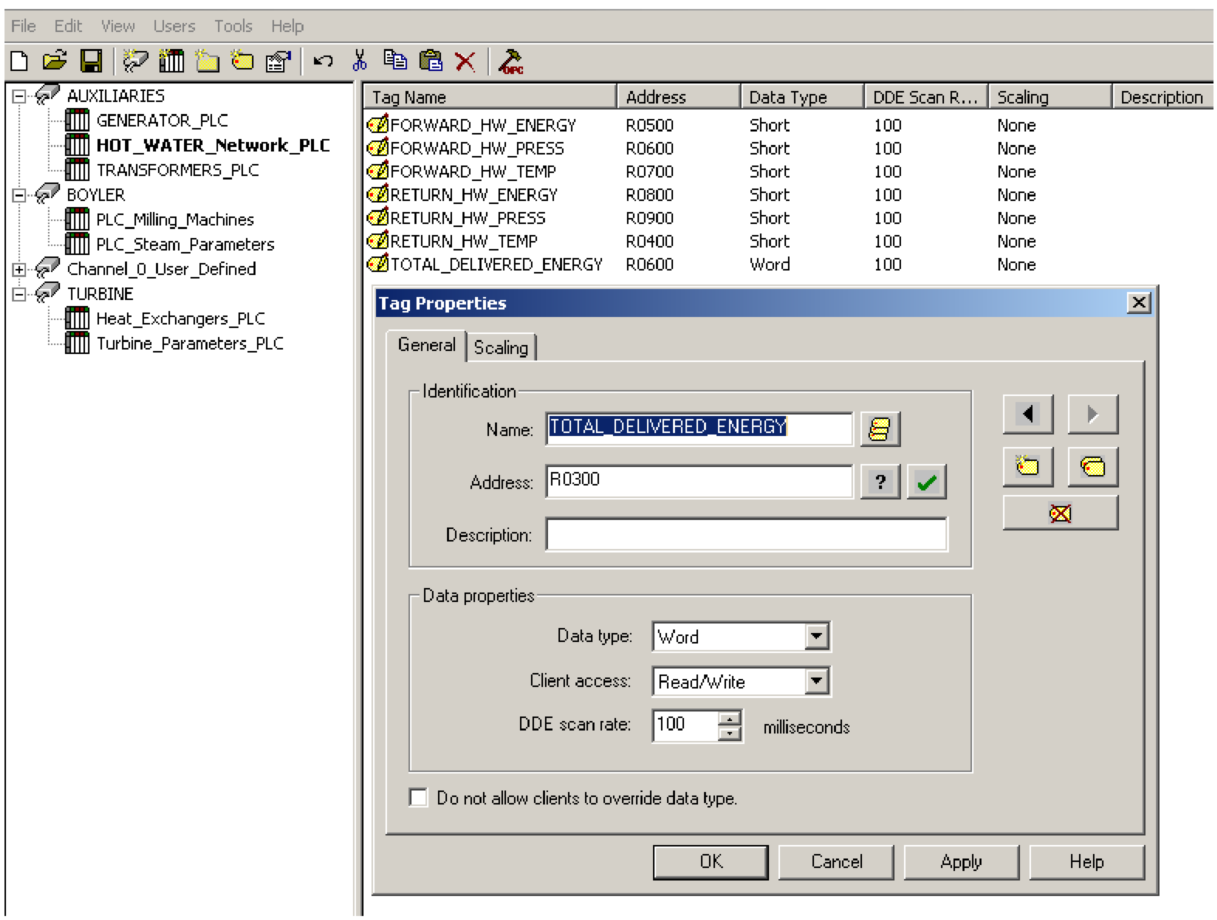

Figure 4. Screenshot with OPC Servers configuration

These parameters are collected using an ActiveX OPC control in a Visual Basic 6 interface and storage into SQL Database using ODBC technology.

3. EFFICIENCY AND ECONOMICAL APPLICATION

Both these applications are written in Visual Basic 6.

The economical application collect some monthly and daily economical data from the enterprise managerial SQL database such : monthly budget data, fuel prices and some parameters data from the OPC SQL database and using the formula from 1 to 4 update the efficiency SQL database.

These applications use ODBC solution using ADO recordset for SQL statement like INSERT INTO, UPDATE, DELETE and SELECT.

The efficiency application gives to the user's daily and cumulative indicators and some economical details for an on-line management.

Some screenshots for this application are described in Figure 5 to 8

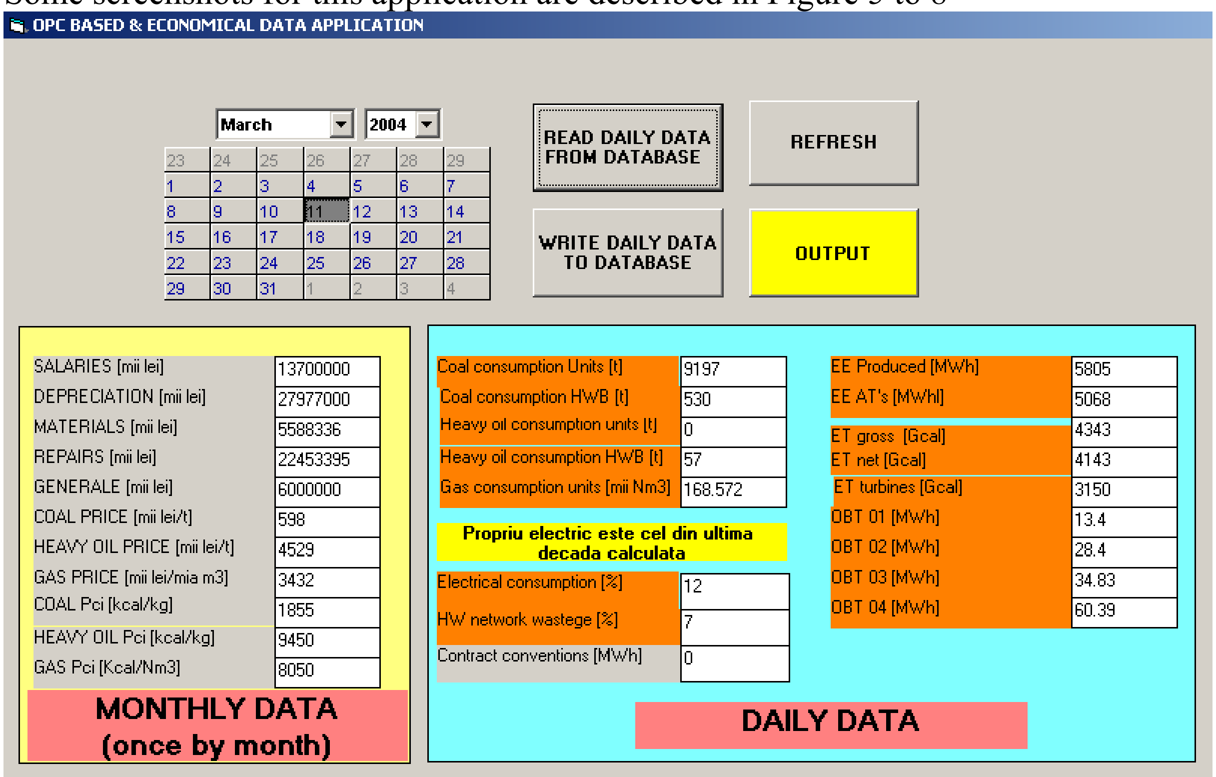

Figure 5. Screenshot of economical application

4. CONCLUSIONS

This OPC based architecture, although is very complex from the implementation's point of view, brings huge advantages in cogeneration power plant management. From these advantages, we point out a few important ones:

- Flexibility - the system variable can be easily configured through a OPC Server structure;
- Stability - this system is stable even under problematic circumstances because of Microsoft 2000 operation system and SQL Client/Server technology;

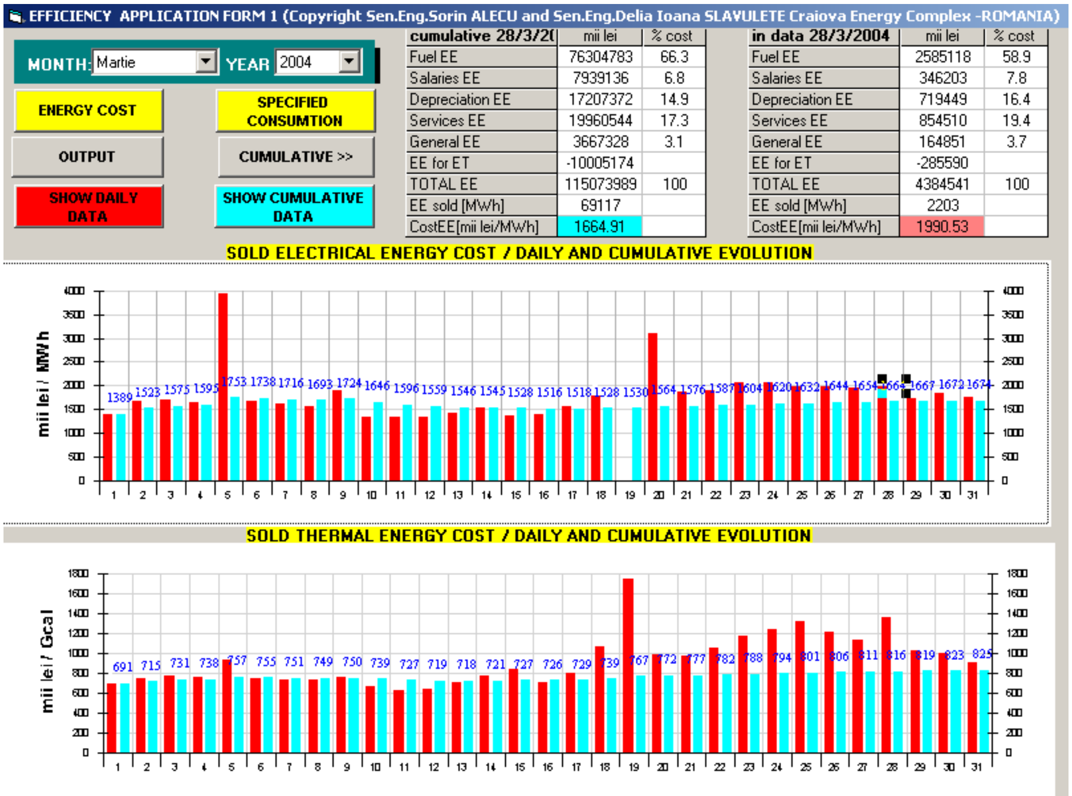

Figure 6 Screenshot of efficiency application sold electrical thermal energy

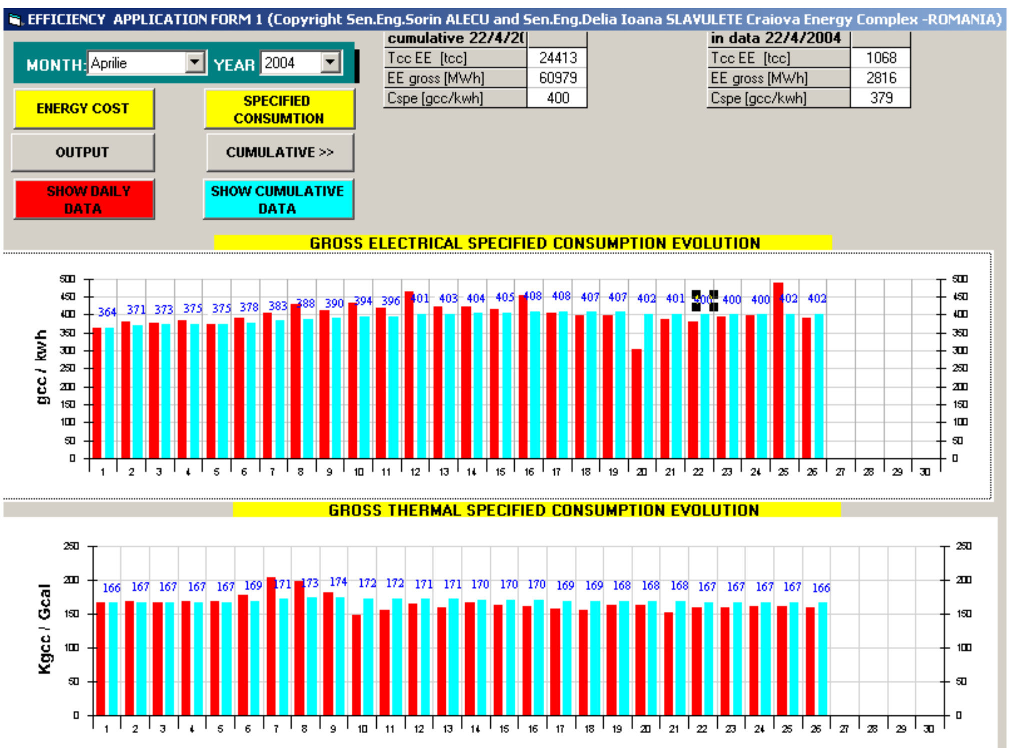

Figure 7 Screenshot of efficiency application specified consumption

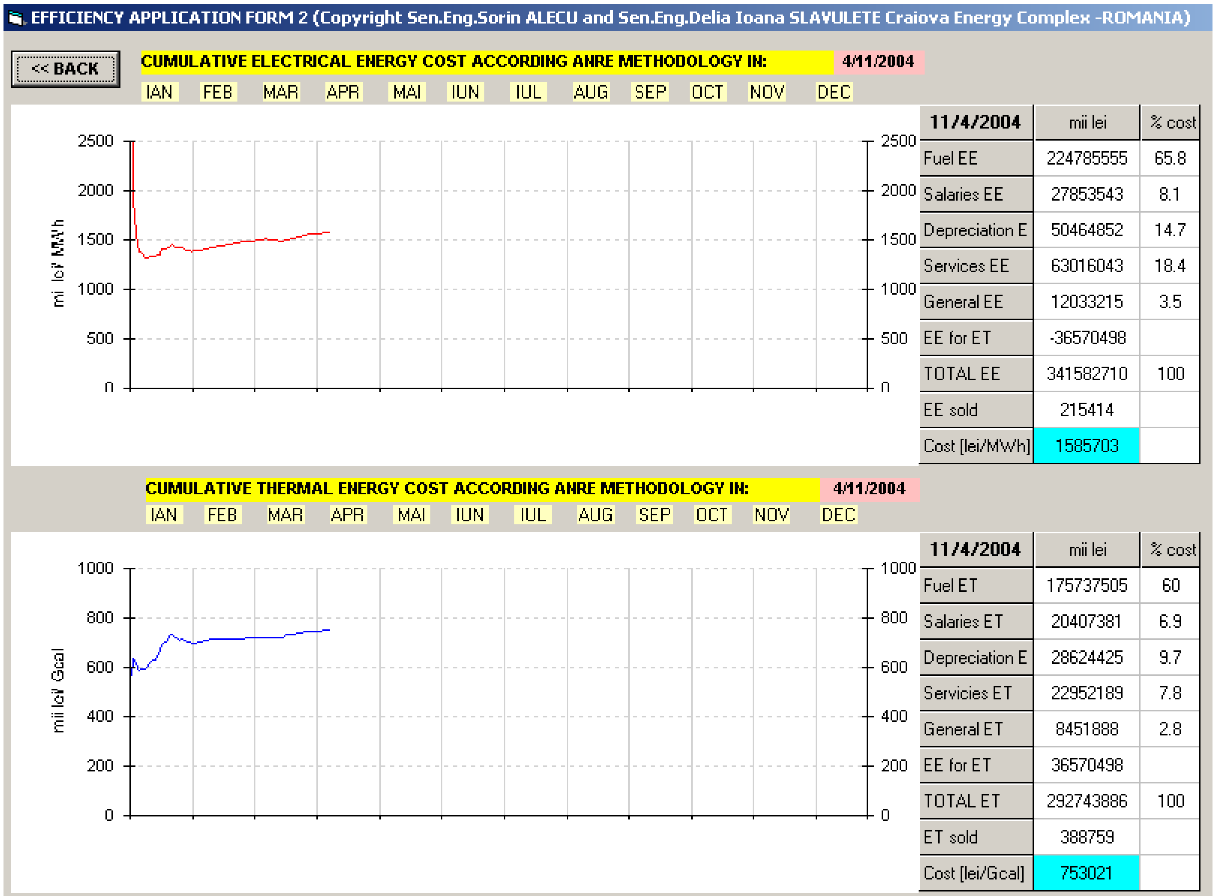

Figure 8 Screenshot of efficiency application cumulative data

- Accessibility – using the existing enterprise LAN the interface can be viewed from any network station;
- Security - the access to the monitoring system is secured using user accounts and passwords;
- Economical efficiency – because of the Romanian electricity open market the produced electricity price is very important for the involved companies. These applications give the chance to adjust the operation parameters "just in time" decreasing the electricity cost up to 5%;

4. References

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