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ENERGY EFFICIENCY IMPROVEMENT PROGRAM WITHIN AN INDUSTRIAL COMPANY, THE RESULTING COLLABORATION OF ENERGY MANAGEMENT SERVICES AND ENERGY AUDIT

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Executive Summary (one page): aims, scope, core findings, conclusions
An important role in achieving the objectives of the National Energy Efficiency Action Plan (PNAEE) for 2015-2020 in the field of "Energy efficiency in the industrial sector" is the development of energy efficiency services, namely audit and energy management.

In this context, the elaboration of the **Energy Efficiency Improvement Programs** has an essential role, imposing its structuring, achieving a unitary realization framework, equipment typologies and sectors of industrial activity. This must be the conjunction of the audit and energy management activities carried out within the industrial contour.

The main objectives foreseen in the development of the **Energy Efficiency Improvement Program** were:

- efficient use of energy and assurance of energy security in the short and medium term,
- the quantification of the energy efficiency criterion for both existing equipment and installations and the selection criteria for the proposed equipment solutions,
- compliance with the legal framework of energy regulations issued at national or local level,
- correlation with the energy management program for solving the proposed objectives.

The "energy efficiency" component is found in the structure of the proposed program by: evaluating the energy situation of the company (the development of an energy audit program with clearly quantified solutions in energy saving, reduction of emissions and financial revenues), the elaboration of a plan to rehabilitate the parameters of the inefficient equipments including the optimal loading in order to obtain a maximum possible yield under the existing conditions, avoiding to oversize equipment related to proposed new solutions,

monitoring of energy consumption (in all existing forms), evaluation of the opportunity of implementing an **EMCS** (Energy Management Control System).

An important role in the program is assigned to the organization of energy management, by creating a firm working group for energy management, permanently improving its structure, as well as establishing the collaboration with the superior level of management including involvement in the processes of purchasing efficient energy equipment.

Keywords (3-5 keywords) energy efficiency, energy management, energy audit, industry, program

1. General considerations about using energy management and energy audit for elaboration of energy efficiency programs

Evaluation and improvement of energy efficiency of an industrial company is a result of cumulative actions of energy management (a continuous activity within the company) and energy audit (performed periodically by energy auditors). [1]

The analysis of industrial activity (based on energy management and energy audit) has as a starting point the initial situation within the company, which includes:

- Establishing the energy flows that enter the analyzed contour and their order of magnitude;
- Establishing the concept of the monitoring and control system at the company's level.

Generally, in industrial companies "the attitude" towards energy bills can be described as follows:

- The energy bills are paid in time without any internal analysis;
- The energy bills are compared with monthly readings of measurement equipment installed at the company's border;
- The monthly readings are used to calculate different specific criteria, such as specific global energy consumption;
- There is a data acquisition system (not necessarily automated), which provides at least on a weekly basis a monitoring report of all main internal energy consumers;
- There is implemented a high-level monitoring and control system that continuously evaluates the efficiency of energy use.

The latter two mentioned above can represent the major objective, for companies that do not have installed, as a first measure for increasing energy efficiency within an industrial contour.

The concept and the operating mode of energy related data acquisition informational system within a company can include the following:

- The way and frequency the data is taken from the measurement equipment;
- The way of data transmission (using written forms, electrical signals, IT network, etc.);
- The way the data is processed (using a model, an algorithm, calculating some values, etc.);

- The content and frequency of elaboration of energy related reports (daily, weekly or monthly) and its purpose;
- The process of decision making regarding increasing energy efficiency.

The attitude of the company's management and the rest of personnel towards energy efficiency is reflected through their interest, attitude, quality and efficiency of the monitoring system, the way of data and results analysis, their reaction towards different aspects regarding energy costs and energy efficiency measures. An important role for dealing with all these issues has the energy manager that should be present at any industrial company. [2] [3]

2. Aspects regarding elaboration of the energy efficiency program with an industrial company

The elaboration of an energy efficiency program in an industrial company has to be adapted to the specificity of its activity and corelated with its development strategy and its financial situation.

At the same time, there should be taken into consideration the awareness and technical skills of the entire personnel regarding energy efficiency measures that are implemented within the analyzed company.

The energy audit (performed by authorized personnel or energy service companies) ensures an objective analysis that is necessary for evaluation of energy efficiency. [4]

The energy efficiency measures are usually proposed in groups due to dependencies of different equipment within the company and sometimes due to financial limitations.

In the first phase there can be proposed energy efficiency measures with no cost or with low cost that can lead to energy savings and thus to financial savings for the analyzed company.

The financial savings obtained in the first phase can then be used in the second phase that can include high cost energy efficiency measures.

All energy efficiency measures with high cost should be analyzed in terms of energy savings, financial criteria and environmental impact reduction.

The energy manager and company's management should set a priority list for all proposed energy efficiency measures, which should take into consideration company's strategy for development and its current financial situation.

The energy efficiency measures can include optimization of operation, changing and even replacing of equipment's components, all having the goal to reduce energy consumption and energy bill of the company. [5]

Even though industrial equipment is various and different form company to company, an energy audit can lead to proposing measures that can be grouped in several directions:

- Modification of energy supply solution and/or of the concept of energy utilization within the company;
- Advanced recovery of available energy within the technological process using different new energy recovery equipment;
- Partial or total replacement, for certain heat using processes, of fossil fuels or heat flows (that come from outside the company) with electricity leading to financial savings;
- Reducing environmental pollution, especially through utilization of alternative or synthetic fuels;
- Implementation of new procedures and techniques (with high energy performance and low environmental impact) that can lead to reducing energy bill;
- Organizational measures that can lead to lower energy tariffs.

3. Case study: Energy efficiency program for cogeneration plant within S.C. ENET S.A. FOCŞANI

The elaboration of an energy efficiency program for the analyzed company implies a certain methodology and active involvement of company's energy manager and energy auditor, and include:

- Energy evaluation of current situation taking into consideration all technical, economic and environmental aspects;
- Identified energy related inefficiencies;
- Proposals for energy efficiency measures within an energy efficiency program.

3.1. Evaluation of the existing situation

The elaboration of the energy audit for the cogeneration plant within S.C. ENET S.A. FOCŞANI included the following methodological phases.

1. Establishment and description of the analyzed contour – cogeneration plant – includes identification of all energy flows that come in and out of the energy generating facility.
2. Description of main technological processes within the cogeneration plant nad all energy flows.

3. Analysis of all energy generating equipment (indicating the main technical characteristics and their integration in the cogeneration plant). The main energy generating equipment are presented bellow.

New equipment

- Two internal combustion engines operating in cogeneration mode using natural gas having an installed power capacity of 6.8 MWe each;
- A hot water boiler (CAF 1) of 58 MWt (50 Gcal/h);
- A steam boiler (CA 1) of 10 t/h, that generates steam at p=10 bar t=176 °C for covering internal demand and for preparation of adding water into the district heating system.

Old equipment (in reserve)

- Two steam boilers CR5/3, which were installed in 1969-1970, having a steam flow of 20 t/h each, with parameters p=40 bar and t=450 °C, equipped with 4 burners that can operate in natural gas or fuel oil;
- Two steam boilers ID 513, with steam flow of 50t/h each, and parameters of p=40 bar and t=450 °C, equipped with two burners operating on natural gas;
- Two steam turbines AKTP4, of 4 MWe each, having initial steam parameters of D_{abur}=50t/h, t_{abur}=435 °C, p=35bar, with a steam extraction at 16 bar/340 °C (D=15t/h) and counterpressure at 3 bar / 195 °C (D=35t/h);
- One hot water boiler (CAF3), of 58 MWt (50 Gcal/h), having a burner operating on natural gas or fuel oil;
- One hot water boiler (CAF4), of 25 Gcal/h, operating on natural gas or fuel oil

4. Establishing of the contour for the analysis.
5. Analysis of daily variation curves for electricity and heat for different energy generating equipment within the cogeneration plant.

3.2. Identified issues

An identified issue at the cogeneration plant is the significant variation of daily heat demand that implies frequent changes of operation regimes of cogeneration equipment (fig. 1).

It can be observed that during the winter and spring-autumn periods the heat generated by internal combustion engines varies between 4800-6000 kWt each.

During summer time it can be observed, except when engines are shut off, that the heat generated varies between 3500-4000 kWt for each engine.

The shut off of the engines has been caused by the very low heat demand during summer time and due to a very low price for electricity for certain periods of time during a day. These factors led to same curve for electricity generation by the internal combustion engines (fig. 2).

The variation curves for electricity and heat have been drawn based on data measured and analyzed by the auditor.

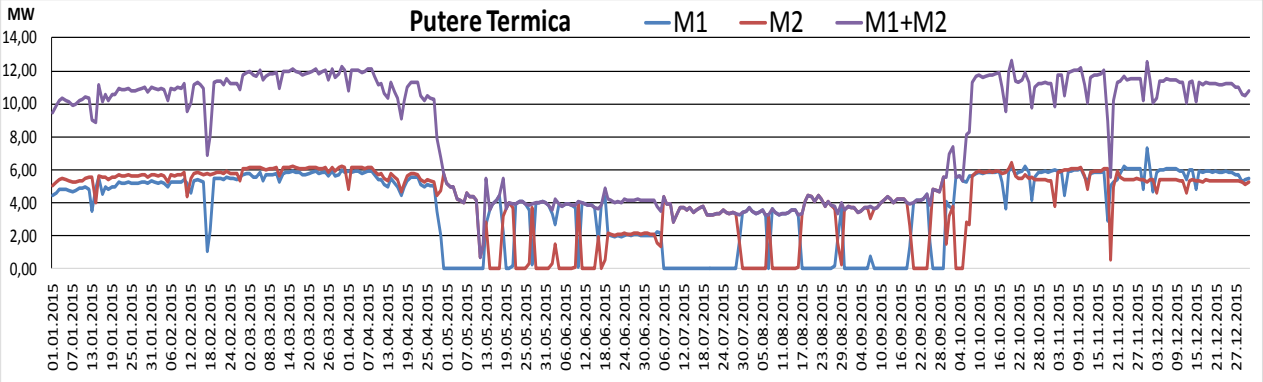

Fig.1 Variation curve for heat generation for internal combustion engines 1 + 2, (2015)

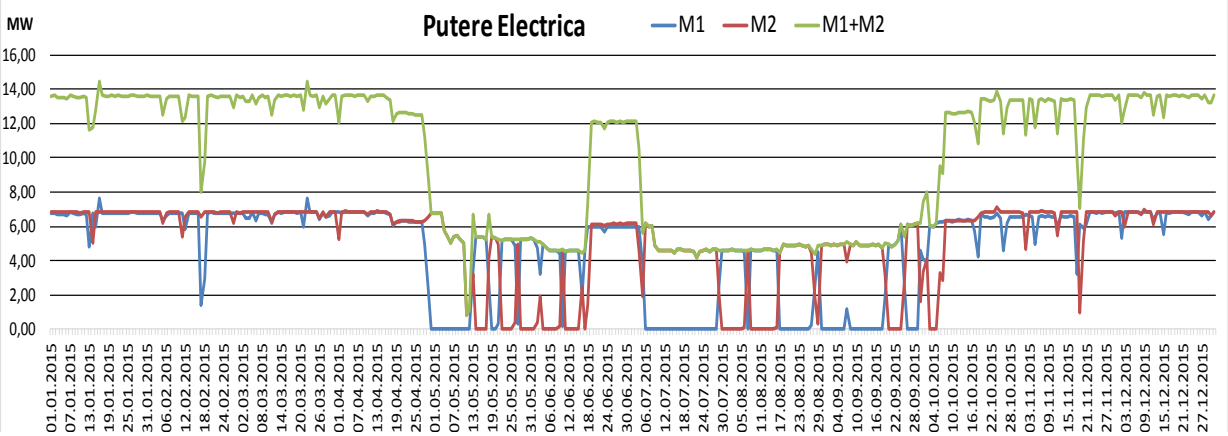

Fig. 2 Variation curve for electricity generation for internal combustion engines 1 + 2, (2015)

4. Proposals for solving identified issues and conclusions

The proposals for energy efficiency program for the cogeneration plant are synthetized and prioritized bellow.

A. Optimization of equipment operation

The aim of this measure is to determine the optimal operation mode of the internal combustion engines (with and without heat recovery, with and without hot water boilers, etc.) so the heat generation could better match heat demand.

The optimization procedure considered all annual energy production and fuel consumption and have been determined mathematical functions that define the main operating parameters of internal combustion engines for partial loads, as well as main performance criteria and environmental impact reduction.

B. Technological solutions for heat storage

To avoid operating cogeneration equipment when there is no heat demand there has been analyzed the implementation of a heat storage tank. This measure can allow operation of the internal combustion engines at loads close to nominal with all advantages of cogeneration and at the same time ensuring heat supply by demand to all customers.

C. Operation of energy facility in trigeneration mode

Another proposed solution is to operate both internal combustion engines during summer time: one for heat supply and the other one can be used for supplying heat to an absorption chiller for cold generation. This measure can allow operation of both engines during summer time, which can lead to increasing the energy and economic efficiencies of the company, and, at the same time, can lead to reducing environmental impact.

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