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INDUSTRIAL ENERGY MANAGEMENT*

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Content

Abstract

The energy consumption has grown, depending on the industrial development as well as population growth. Energy management in industrial plants shows main areas for continuous efforts to lower energy consumption and environmental pollution.

Industrial energy management, however, is the complex, integrated activity, related to the management, research, production and investment policy of each company. Therefore, main steps of energy management in industrial activities are analyzed and conclusions are furnished with brief examples which have lead to the energy conservation in industrial activities.

United Nations Industrial Development Organization (UNIDO), the executing agency of UNDP, elaborated the regional project proposal "Regional Co-operation in the Field of Industrial Energy Conservation". Nine European IPF countries agreed to participate in the project. Due to good results, the project was extended for the period 1988 - 1990.

Experience of UNIDO-Czechoslovakia Joint Programme, Nonmetallic Industries, Pilsen is extensive due to more than 10 years activities in different regions of the world. Contribution of the Joint Programme and Research Institute Pilsen in the frame of European Regional Industrial Energy Conservation project DP/RER/83/003 is mainly related to energy auditing and to energy savings in the building materials industries.

I. Introduction

The growing prices of energy resources in the world markets, the forecast of energy growth for the forthcoming period created the necessity for more efficient energy use in all developed as well as developing countries around the world. Many national programmes for energy conservation have been implemented by countries in general, including those receiving technical assistance from the United Nations Development Programme (UNDP).

The majority of countries does not have own energy resources large enough to ensure the needs of their countries. Therefore, the importation of energy has become very important and, therefore, energy saving is one of the serious issues for any country not only from the point of economic development, but also from the point of environmental protection.

In general, it is possible to say that

- the higher is the living standard of a country, the higher is its industrial development
- the higher is the industrial development, the higher is the energy consumption
- the higher is the energy consumption, the higher is the environmental pollution.

Industry, as being the major energy consumer, has a lot of possibilities to lower its energy consumption as the mean to lower its manufacturing costs. In such activities, energy conservation in industry is the joint interest of the enterpreneur as well as of the Government. Therefore, energy management in industry has become during the last decade, very intensive.

The industry keeps a foremost position in the energy consumption. The present energy consumption is derived from its capacities, technical level of the equipment and its control proper; the prospective one then from its further development, rationalization and application of the scientific and reserch results in the entire production cycle.

Therefore, the idustrial sphere is the main field of activity that should reach an optimum stage in the energy consumption through the complex control system of energy consumption whereby the entire all-country balance in energy should be improved or, to enable further expansion of the industry, by energy economization, as the case may be.
In order to assist African countries, main issues of industrial energy management are presented as the accumulated experience from the period of seventies and eighties.

II. The principles of energy management

The complex control system of fuel and energy consumption in the industry aims at reaching optimization of production capacities and thermal processes under the condition of minimum energy consumption. Each industrial branch is of a different nature given by the technological process. Therefore, the consumption control system can be most properly applied within the individual industrial branches so that it should act effectively and completely. Despite that the principle of this system is common for all branches.

The primary purpose of energy management is to identify the possibilities of energy and then to find out the ways for the realization of changes which lead to the reduction of energy consumption. The feasibility of any financial expenditure for energy conservation is the important factor from the enterpreneurial point of view.

Energy management therefore, is an integrated approach of any plant management, in which united energy management is represented by the managing team, which co-ordinates, evaluates and decides the actions, which are suggested for energy savings. Since they are many opportunities for energy conservation in any plant, the managing team takes into the account all suggestions, which are coming from the internal as well as external informational resources in the field of

- technology,
- energy,
- economy.

In order to be well oriented the managing team has own means in the structure of its management in order to determine priorities in the energy savings measures.

Well conducted energy management in industry shows positive impacts not only on the reduction of energy consumption, but also in other ways, such as

Intensification of thermal processes, which increases the plant output,

Lowering of rejects by well managed thermal processes,

Quality increase by reaching more homogeneous heat conditions during heat treatment.

In order to show the ways how to organize the managing team in the industry, the following chapter brings some examples.

III. Organization of energy management at industrial site

The organization of energy management at industrial site is very important. Such energy management, on one site, must take into account a series of different suggestions and possibilities, how to lower energy consumption, on the other site it must be in the position to establish priorities for such activities according to the economic evaluations and, finally, it must be able to realize such measures. Therefore, the technical Director of an industrial company is usually the top responsible man for creation of the managing team for energy conservation. In many cases, the Technical Director is the Head of this managing team.

Managing Team

The managing team and its activity (Fig. 1) should ensure all the research and technical activities in the principal areas aimed at the energy consuming equipment and should elaborate finally a complex rationalization programme based on the informational resources, research results, analysis of the consuming equipment and on the optimation considerations.

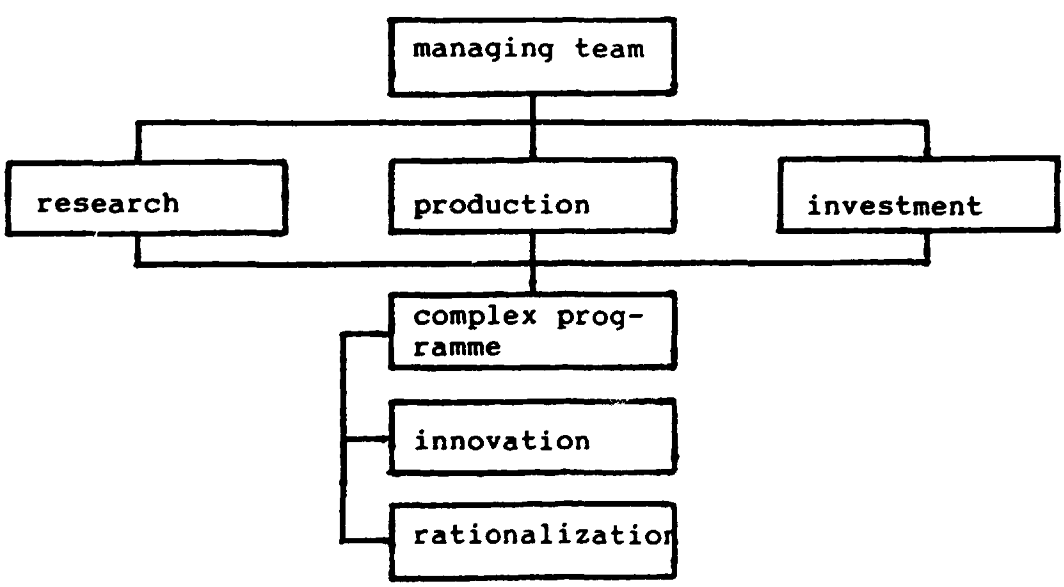

Fig. 1 Managing Team Activity

The managing team makes its activities in specialized groups according to its organization chart (Fig. 2), of which the technological team takes care on all technological measures which lead to energy savings, the energetical team identifies all measures from the view of energy transfer, losses, reduction etc. and the economical team assists in the determination of all financial implications.

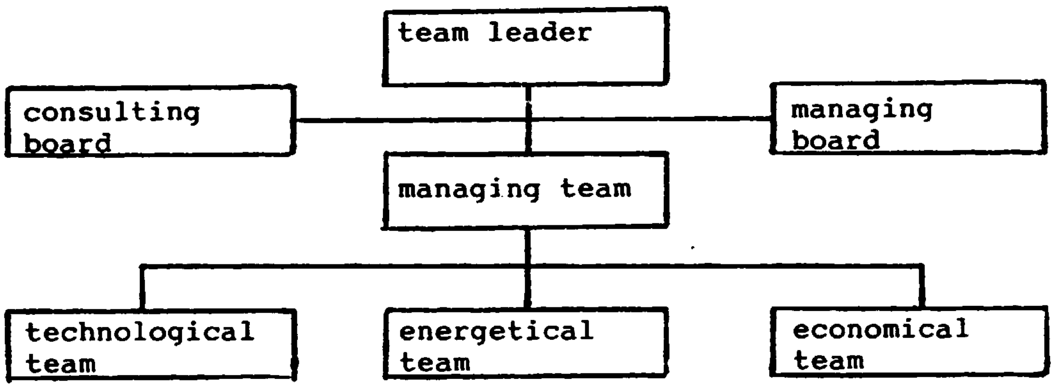

Fig. 2 Managing Team Organization

The results of the individual sectional works should be compiled into the proposals for solution, consulted in the consulting board and submitted to the managing board. The managing board then takes into consideration the results obtained from the technological, energy and economical teams, summarizes the appropriate proposal and takes a decision on incorporating the proposal into the complex programme including the determination of time and extent.

Research area

Research and development form a very important area which, when aimed at reducing the energy consumption, plays a vital role in the development of a particular branch. The programmes of the tasks specified by the managing team and solved by the research are classified into two parts - the technological and thermal ones cover the following principal problems: (Fig. 3).

Since energy consumption is very closed to the environmental pollution, the modern research activities take also into account the environmental engineering with special attention to the purification of waste waters and to the air pollution control.

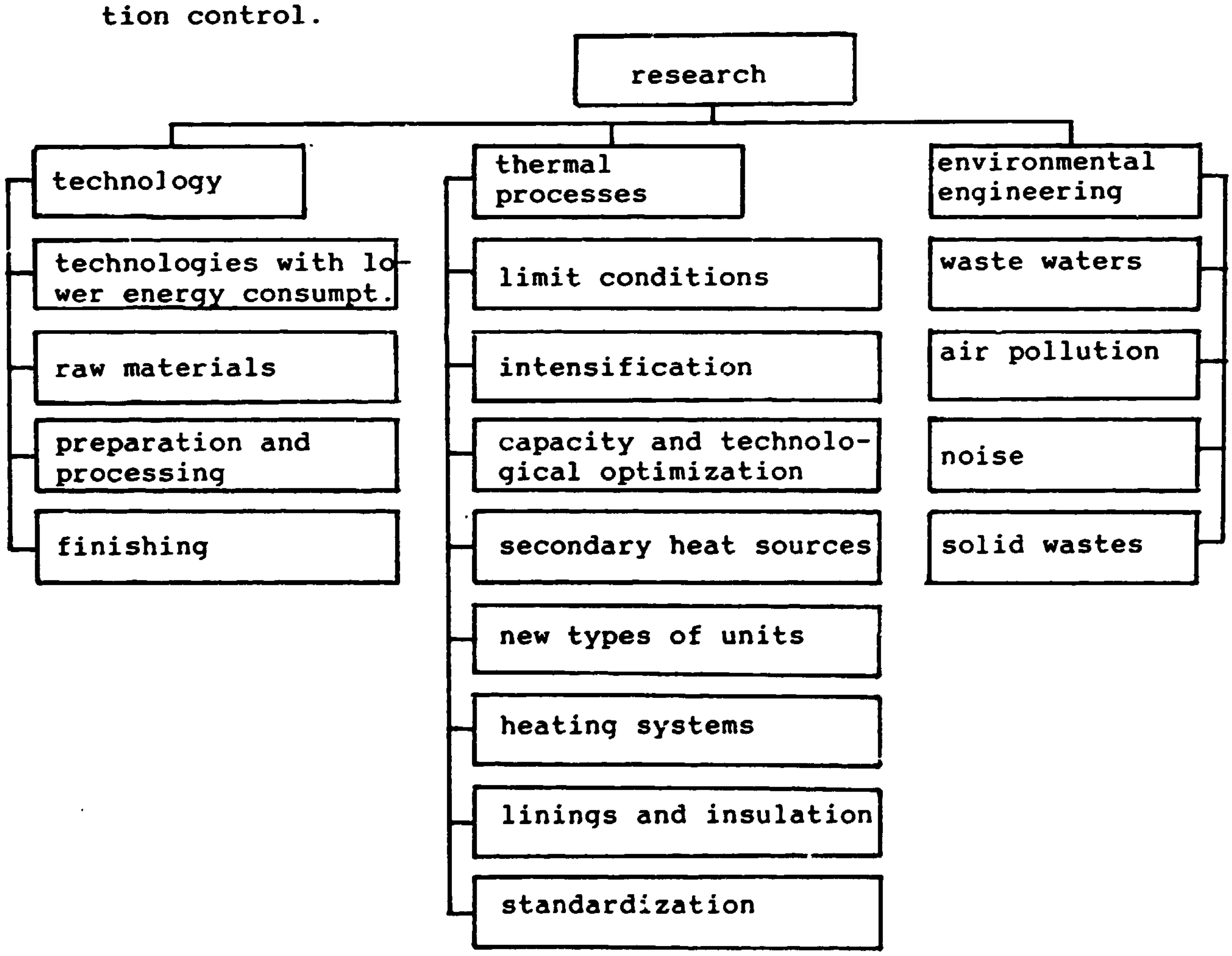

Fig. 3 Research Organization

The research tasks may be, as partial ones, aimed at the solution of some contemporary problem in the production to reach more effective production by means of a reconstruction, changes in technology or by an optimation of the process. Mostly, however, they are aimed at a future innovation programme through which more distinct energy effects should be achieved.

Production area

The energy in the production sphere is first of all focused to a complex diagnostics of the present condition to a detail determination of production conditions and corresponding energy consumption. The specialized teams then work out the initial documents based on the data having been so found out i. e. types of energy, specific consumption and the existing energy standards for each unit. They serve as a basis for the elaboration of a plan and materialization of all types of rationalization actions.
For the scheme of the activities see Fig. 4:

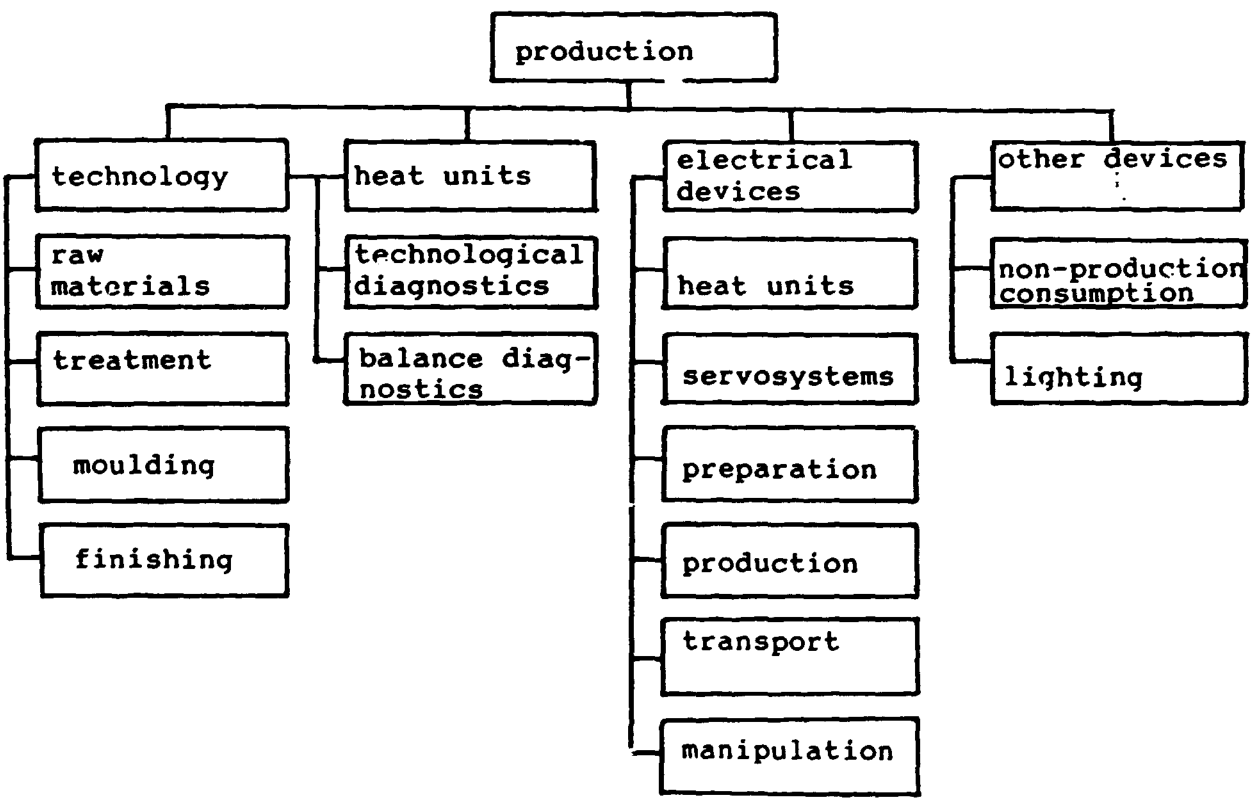

Fig. 4 Production Area Activities

Investment area

Plans of the investment development in every branch are derived from the needs of local markets as well as from the export possibilities. They secure an innovation programme both for individual pieces of production equipment and by a construction of new workshops or factories. The activity of the energy consumption managing team has a double form in the investment stage. Knowing the existing condition of the production equipment and the results of the research and development the managing team is capable of passing a judgement on any intended investment from the energy requirements point of view whether the energy consumption will comply with the intentions determined by the complex rationalization programme. It is also possible to judge the progressivity of every new technological process in comparison with the existing degree of the world technics.

The scheme of the activities within the investment area is shown in Fig. 5:

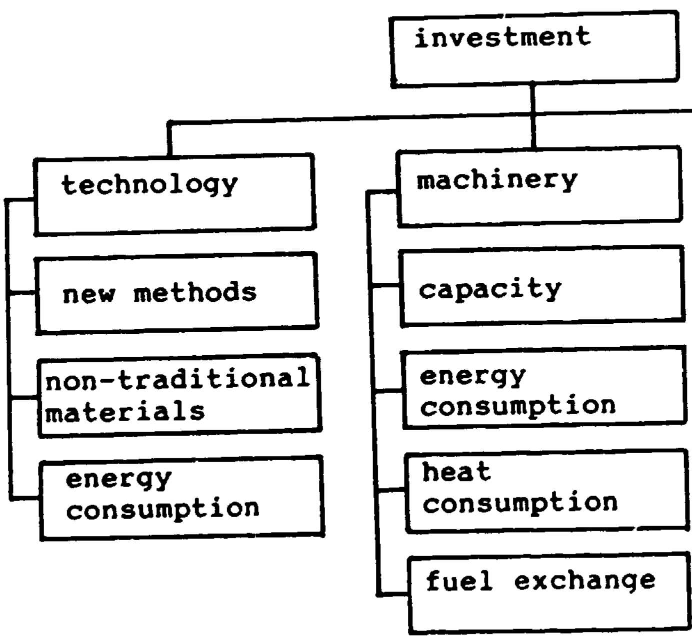

Fig. 5 Investment Area Activities

Complex rationalization programme

Research, technical and production basic documents from the foregoing stages are coming to the managing team where they are processed carefully.

The diagnosticsof the production sphere of a branch enables to get an overall picture of the existing situation and how the energy consumption is distributed factory wise, production lines wise down to the individual machines and equipment wise. It also gives data on capacities and technology.

The research and development render the basic information of the present development in the world. The research and development activity in its tasks is to solve new technologies and thermal units applicable in the innovation actions or in the construction of new production lines and plants.

Investment plans and intentions enable to judge further expansion of a branch from the point of view of new technology, sales and, first of all, of the required energy sources and their efficient exploitation.

The managing team elaborates all alternatives of the technical and economical solutions based on these expansive bases and evaluates them economically. The result of it are completely realistic ways of modernization that should secure lower demand for energy. Several solutions on different levels are made for a certain problem. The following alternatives e. g. are elaborated to reduce energy consumption in the firing process of bricks in a tunnel kiln: change in the raw material composition, change in the positioning of bricks on the tunnel cars, optimization of the thermal curve and of the heating system, intensification of the heating, even reconstruction of the unit if necessary, utilization of waste heat and even replacement by a completely new equipment as the case may be. It is a matter of course that several ways may be materialized simultaneously. It is upon the economists and the managing team to decide the time schedule and extent of the whole rationalization action.

The individual stages of these actions may be classified into:

The optimization of the 1st grade covers all technological and thermal changes in the existing state that, according to the diagnosis results, contribute to achieving an optimum process without any substantial modifications.

The optimization of the 2nd grade covers new technology of lower energy demands, reconstruction of heating systems, utilization of waste heat, intensification of processes, etc.

The innovation represents the highest grade and is connected with the implementation of new technologies, change in fuel types, construction of new equipment etc.

Final complex rationalization programme for fuels and energy within a specified branch represents then a set of individual actions being documented technically in details, supported economically and compiled into an accurate time schedule of materialization. It results then in a conclusive programme of progressive reduction of fuel and energy consumption which begins after the diagnosis of the existing conditions and their optimization and ends by the innovation actions. The character of this principle of consumption control is a general one and when worked out for the conditions prevailing in a certain branch it may include specific changes. Nevertheless, it is the only way how to solve progressive reduction of energy consumption in industry completely starting from the present conditions up to realistic prospects.

IV. Energy management in industrial activities

In order to make more concrete assistance for engineers, who are engaged with energy conservation in industrial activities, selected advices are presented as the result from previous achievments in different industrial plants.

1. Non-traditional technologies with lowered energy demand

The most important technologies, in connection with energy and material conservation, are those in which energy demands can be lowered. The energy and material conservation in the production can be achieved by a complex of measures the most significant of which are as follows:

1.a. Non-traditional compositions of different blends and the application of suitable raw materials into the compositions not only lowers the energy requirements but also the material costs. The heat consumption can be lowered by up to 35% depending on industrial sectors.

Such possibilities are:

- application of fluxing materials into the body composition in the ceramic industry
- application of opaque glazes with lowered maturing temperatures in the ceramic tiles inuustry enables the management of the application of coloured clays with lower firi temperatures
- lowering the maximum grain size of the siliceous sand in the glass batch composition lowers the time of melting and reduces the energy consumption by about 20-25% from total
- application of glass cullet into the batch composition lowers the energy need for melting
- application of the ceramic reject into the body compositions improves the beahaviour of blends during treatment and lowers energy consumption

1.b. Simplification of production technology characterized by single firing processes, the heat energy savings reach up to 60%. The simplification can also be reached by the connection on several operations in a continuous flow, which eliminates the unnecessary operation.

Such possibilities are:

- single firing technology in the production of vitreous china ware, porcelain technology.
- elimination of calibration in the building materials and special refractory products by developing non-shrinking bodies
- continuous iron and steel products´manufactures instead periodical individual operations

1.c. Production and application of non-fired products with different ceramic, hydraullic, organic or chemical bonds. The energy savings up to 65% can be reached. These products can be shaped or unshaped. The cold hardening methods are becoming very useful in different industries.

- in the modern refractory manufacture the production of non-fired products amounts to more than 40%.

1.d. Minimization of heat treated ingredients in different body compositions of products enabling the energy savings of about 15% of the total.

- different blends in the ceramic, refractory and building materials industries contain fired or calcined ingredients, which can be replaced by other modern compositions.

1.e. Lowering materials requirements brings savings in the materials´costs and in those technologies with heat treatment it lowers the heat consumption.

Such possibilities are:

- substitution of available and cheaper raw materials for the deficite ones

- application of opaque or partly opaque glazes on tile products to balance the influence of cheap raw materials in the body
- lowering of rejects by proper technological development and strict technological process control
- product dimensions and mass kept in minus tolerances
- mass reduction of products according to their functional requirements
- optimization of kiln output according to the minimum specific energy consumption
- reduction or elimination of auxiliary material consumption during the whole production process. The most important material for heat savings is the kiln furniture which can even more than double the heat specific consumption for the ceramic product if no care is kept. The modern single layer firing kilns mostly work without the kiln furniture.
- application of green and fired rejects as the secondary raw material into the manufacturing processes leads to the low-waste technologies.

1.f. Application of progressive production operations, depending on the assortment produced and installed capacity of the unit can influence the energy consumption.

- dry pressing of dinnerware by isostatic presses saves the electric energy by about 35% and the heat energy by about 5% from total.
- continuous heat treatment, compared with the discontinuous operations in drying, firing, tempering and heating in different metallic and non-metallic industries, lowers the energy consumption in average by about 50% from total.
- shaping of non-metallic and refractory products by vibration lowers electric energy requirements up to

40% from that which is necessary for pressing.

- proper regulation of all parameters of heat units

1.g. Reducing heat losses by proper insulation

In case that insulation of different units is not properly done then heat transfer by conduction results into the increased surface temperatures.

2. Thermal Process Optimization

To reach the optimum heat consumption during the firing process, two factors are to be analyzed:

2.a. Limiting firing conditions of the products, which depend on different structural changes of the blend during their heat treatment, such as loss of mechanical and chemical water, decomposition of kaolinite, crystallographic changes of silica modification, changes of alumina structure, decomposition of montmorillonite etc. Many of those changes must be respected during drying and firing to avoid any damage to the products. The other products require controlled cooling in order to regulate the speed of growing and size of crystals. The shortest heat treatment which respects all technological requirements is called the limiting treatment with the lowest possible heat consumption.

However, not all kilns and other heat units are adjusted to the shortest treatment which is expressed in the limiting firing conditions. Fig. 6 shows average reduction of firing cycle at double fired wall tiles and Fig. 7 shows average firing temperatures for the same assortment.

Fig. 6 Average reduction of firing cycle at double fired wall tiles

	bisque firing hrs.	glaze firing hrs.
after the World War II	60 - 120	24 - 48
at the beginning of 60's	24 - 48	3 - 24
at present	1 - 24	0,5 - 24
prospects by the year 2000	0,5	lower than 0,5

Fig. 7 Average firing temperatures of double-fired wall tiles

	bisque firing temperature °C	glaze firing temperature °C
after the World War II	1280 - 1300	1180
beginning of 60's	1120 - 1200	1080 - 1120
at present	1040 - 1060	960 - 1020
prospects by the year 2000	lower than 1000	900 - 960

The best kilns for firing with the lowest energy consumption are, at present, single laye firing kilns, which are called roller kilns, which operate with the fast speed and without the kiln furniture.

2.b. Optimum unit output

It is obvious that the specific heat consumption grows if the unit is only partly loaded with green products. Each unit's output shows an optimum of energy consumption since overloading of the unit will extend the time of heat treatment and will waste the energy again. (Fig. 8)

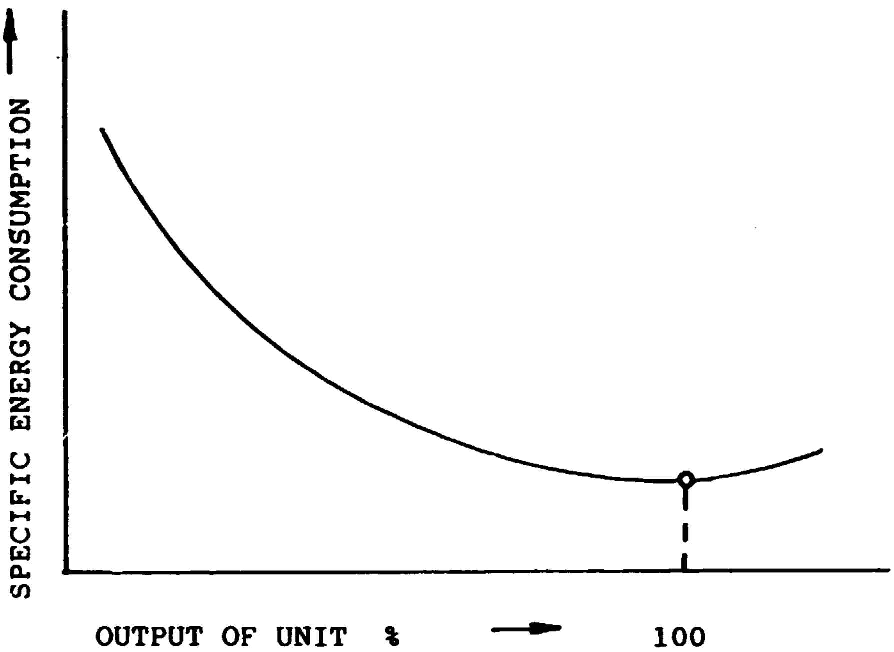

Fig. 8

3. Diagnosis of heat processes

The objective data of the actual stay of a thermal unit, such as of the kiln or drier are necessary as the basis for the improvement of processing. To obtain these data, the diagnostic measurements are performed by a Mobile Diagnostic Unit, which is equipped with instruments, recorders and evaluating units enabling to perform the analyses of thermal processes as well as the heat balance of production units. This activity is called energy auditing.

The primary purpose of energy auditing is to identify the losses in the use of energy (conversion and consumption) and then to find the way of reducing or eliminating those losses. Therefore, in the course of the energy audit, it is necessary to

- determine accurately the total consumption of every energy carrier
- examine why, at what equipment and in what volumes the different energy carriers are used
- determine how much of each energy carrier is consumed usefully, depending on the type of technology and manufacturing equipment, installed and how much is lost
- specify unavoidable losses, which occur due to the nature of energy use and conversion and specify the other losses, volume of which can be affected, covered or fully avoided.

It is obvious that achievment of the above goals requires availability of both measuring instruments and devices as well as skilled personnel capable to do an audit.

Meanwhile, the instrumentation constantly installed in industrial plants is often insufficient and sometimes out of order. It can only indicate how much energy is consumed, however, it is not suitable for identification of the efficiency of energy use.

Even modern energy consuming units have problems caused by unsuitable operation, bad maintenance and shortage of spare parts. Technicians and workers in industrial plants are concerned mainly with production quality and quantity and they are not trained and experienced as specialists in energy auditing and conservation. Therefore, 15 years ago, the Research Institute for Ceramics, Refractories and Nonmetallic Raw Materials developed the Mobile Diagnosstic Unit (Energy Bus), which being modernized in the co-operation with UNIDO-Czechoslovakia Joint Programme, Pilsen is an ideal mean for energy auditing within the driving instance. For overseas operation, so called Energy Kit was developed, which represents a miniaturized version of the Energy Bus, transportable by plain.

In this context, the concept of carrying out energy audits by an independent team of qualified specialists, equipped with necessary instrumentation, proved to be the most appropriate.

The engineering approach of energy audits represents a combination of both energy saving measures and technological improvements. This type of audit lasts usually about one week and uses data obtained from the plant and, mainly, data produced by the auditing personnel. The audit results in a final report which includes besides all the data and calculations, detailed recommendations of the measures to be taken to save energy, improve product quality and increase production. The final report is discussed with the plant management and the recommendations are realized by the client, if necessary with technical assistance of auditing personnel in a follow-up stage. The final report of the audit serves also as objective supporting material for decision-makers in planning reconstruction or modernization of the equipment, or substitution of one type of fuel by another.

According to the results obtained in different industrial plants from a series of developing and developed countries, energy consumption of nearly any audited device can be reduced by 5-10%, with simple measures that require no or very low investments. In some cases the percentage of reductions can be higher, even 50-60%, as for example with putting the thermal devices in or out of operation.

The experience gained from various countries proved the usefulness of diagnostic audits, which strengthen significantly the capability of their users in surveying the industrial enterprises with the aim to identify the potential and also to recommend the measures for energy conservation, production intensification and quality improvement. However, the audits supply the necessary data for decisions on modernizations and reconstructions of equipment and on waste heat utilization in production plants.

Determination of the energy consumption of the main production process must be, however, completed by the determination of the processes and systems of other supporting and servicing plants, as the production process of any industrial plant is almost always supplemented by one or more other auxiliary activities, which are indispensable for the operation of the main production process. As auxiliary plants, the following processes are specified:

- boiler plants
- thermal and/or electric plants
- compressor houses
- tempering plants
- store houses
- central assembly halls
- preventive maintenance plants
- water plants
- environmental protection and engineering plants
- cooling houses
- driers and other possible plants

When determining the energy consumption of the auxiliary plant it is again metering that comes first. The way of metering depends on the type of auxiliary plant. Metering has to cover both input and output data as these are necessary to form those specific values which, if applied into the production process, provide a truly reliable result.

4. Thermal equipment modernization including insulation

Thermal equipment modernization means a step in which a capital input is already necessary. Therefore, the modernization is to be considered in two different levels:

4.a. Partial modernization which is usually realized according to a feasibility study. It covers, for example, the change of burners, increasing the cooling capacity, insulation, installation of mixing fans to the preheating zone, etc. The increased efficiency of the kiln will cover the costs spent on the partial modernization.

4.b. Complex innovation of the unit which requires high investments and, therefore, this step is usually applied when the increased output is requested and it must be based on a feasibility study. The traditional lining is replaced by new insulating materials; the kiln can be extended, the automated regulation applied, etc.

5. Waste heat utilization

Waste heat is the heat rejected from the thermal process at the temperature high enough above the ambient temperature to permit the extraction and utilization of additional value from it. Usual sources of waste heat are combustion gases, air from the cooling zones of kilns and driers outlet. Such heat is utilized either directly or indirectly, transferred in a heat exchanger.

The attempts to exploit waste heat quantitatively leads to the cases that outlets from different driers, boilers and kilns with lower enthalpy is being exploited. It is therefore that low temperature heat exchangers are developed which enable the service to operate with combustion gases of relatively low temperatures. Many such cases occur in the food, chemical and building materials industries. Since these temperatures are usually already below the dew point, attention is to be paid to different problems of corrosion.

However, different feasibility studies made show that period of the return of total capital invested is usually not higher than one to the three years.

6. Electricity conservation

In energy conservation in industry, the heat energy usually plays more important role compared with the electric power as far as savings in the consumption are concerned. However, following examples show that the electric power can be saved in the practical plant management as follows:

6.a. To switch off equipment when not necessary (transformers, motors, air conditioning, lighting with low or no load)

6.b. Periodical maintenance

6.c. To review contracted power when actual power demand is much different.

6.d. To optimize capacity of transformers if load factor is less than 0.5.

6.e. To rationalize transformer voltage on low-voltage side (in case the difference between actual and rated voltage $\geq$ 3%).

6.f. To raise power factor of entire factory (in case the power factor falls under 0.9 to install adequate condensers for improvement of power factor).

6.g. To minimize voltage-drop on distribution line.

6.h. To watch maximum demand automatically (for larger plants).

6.i. To select an adequate motor capacity (if the load factor is too low to replace the motor by smaller one).

6.k. To keep high power factor of main facilities.

6.1. To optimize capacity and revolution speed of large motors of pumps, blowers, fans, etc.

6.m. To optimize the exhaust pressure of compressors and to repair leakages on compressed air lines.

6.n. To supervise lightload automatically.

6.o. To optimize and control temperature of rooms.

6.p. To limit electrical heating to special use (to change to heating with fuel or steam).

6.r. Good maintenance and introduction of high efficiency lamps.

7. Space conditioning

Climate conditions which differ according to the geographical location influence the energy consumption of an industrial plant in both ways, in the technological energy consumption as well as in the overheads energy consumption.

The manufacturing technology must respect the temperature, pressure and relative moisture content of the air additionally, those countries with intensive sun radiation exploit the solar energy either directly for drying or preheating different raw materials and semiproducts or indirectly by converting the solar energy into the increased enthalpy of different liquids and gases, which is then exploited in the manufacturing process.

Overhead energy is called that energy which must be spent in order to enable the operation of an industrial plant during all the year. Overhead energy is the energy which is spent for heating, illumination and air conditioning. Meanwhile some of the Middle European industrial plants show the overhead energy to be between 10 to 16% from total energy consumption, it can be expected that plants located in more northern altitude will need higher proportions meanwhile southern location will lower the consumption of the overhead energy needed.

8. Motivation of unit service

Economic motivation of the persons, who can affect the energy consumption of any energy consuming unit, is a very important issue. These people are influencing the energy consumption as they directly manage the operation of the unit, they apply their services non-stop, they release immediate decisions on the regulation and operation and, finally, they are responsible for the outputs and quality produced. Therefore, they are the first who can play the role in energy conservation, if properly motivated.

To be able to apply economic motivation on energy unit servicing people, it is necessary to know the standardized conditions of the unit, i. e. the standard energyconsumption is derived from energy auditings, analysis of results achieved and established consuming and manufacturing standards for the unit.

If the servicing people prove that they take care on the operation, if they apply positive measures for energy conservation by keeping jointly the products quality for their attempts, they receive bonnusses which are only fragments for the total benefit of an industrial plant. If the servicing people do not care on the operation of the energy unit, they are punished gradually according to the weakness of their discipline.

Practical examples show that any industrial activity and energy conservation depends on the economic stimulation of the servicing persons and on the introduction of proper standards of energy consumption. In such a way considerable energy saving can be achieved up to 10% from total depending on the type of industrial activities.

9. Evaluation of results

The overall situation in the institutions where the energy management system is to be applied should be carefully evaluated and all the data recorded before any strategy for measures to be taken is elaborated and actions taken. It enables objective comparison of original situation with final one, i. e. after the measures of energy management system are implemented. This way the evaluation of results shows actual contribution of energy management to energy conservation in the respective situation. Moreover, the contributions should be expressed not only in technical values, but also in economic level and compared with financial inputs to calculate feasibility and profitability of individual ventures. For this purpose a special software package was elaborated for UNIDO's technical assistance projects under the name ENERCOST within a special project launched by UNIDO to bridge the gap between engineering and economic issues of energy conservation. This software is available at UNIDO Headquarters in Vienna.

V. Elaboration of a plan of action

Plan of action for proper application of Energy Management System consists of four systematic activities:

- set up of the organizational structure for energy management
- analysis of existing situation
- set-up of the targets and their priorities
- implementation and follow-up

The organizational structure for energy management is established in the institution where energy management is to be applied to secure its relevant and detailed preparation and implementation. On a plant level such a team is usually headed by the technical director and representatives of the energy, economic, technical and R+D departments participate in the team.

Analysis of existing situation comprehends:

- review of the energy consuming units, heat transfer equipment, electrical installations
- collection of the operational and projected data about these units and equipment and their comparison with the standardized date and/or with the performance of similar units and equipment of high technical level both home and in industrialized countries. In this point the energy auditing plays an indispensable role, being able tc secure objective data about the equipment and analyze them
- evaluation of deviations and their sources in the performance of the existing equipment comparing with the standardized one from technological, energetic and economic points of view.

Based on the detailed analysis the set-up of the targets and their priorities follows to select optimum strategy and reach the best efficiency of the measures which will be taken.

The measures can be classified according the capital investments necessary for their implementation into three groups:

- with no or very low capital investments (proper adjustment of the equipment to the optimum operational regime, organizational actions, etc.)
- with medium capital investments (installation of devices for automated control, regulating elements, partial reconstructions, etc.)
- with high capital investments (large scale reconstructions and modernizations, installation of new, advanced heat consuming units and equipment, etc.)

Implementation of measures and follow-up represent factual realization of the recommended measures and evaluation of the final results. For objective evaluation a repeated energy audit is suitable to supply all the necessary data concerning energy consumptions, production quality and technological parameters of the production. Evaluation of the results enables, if necessary to elaborate further strategy for application of energy management system or introduction of some modifications.

VI. Co-operation with developing countries

United Nations Development Programme (UNDP) and its executing agency United Nations Industrial Development Organization (UNIDO) are deeply involved in the assistance to developing countries in the field of energy management in industry. Therefore, the different projects are being executed and implemented in this area.

One of the successful projects is DP/RER/83/003 "Industrial Energy Conservation Network".

During the Preparatory Assistance Phase, seven areas of mutual interest of European membering countries were defined, of which three were cross-sectional, common for all industrial branches:

- energy conservation policy
- energy auditing
- secondary energy resources and waste materials

Four industrial sectors were defined as the most interesting for the participating countries

- iron and steel production
- chemical industry
- building materials manufacture
- food processing industry

During the operation of the project, a Regional Network on Energy Conservation in Industry was initiated (Fig. 9).

The Network covers seven areas and nearly 40 institutions from the nine countries, involving approximately 200 specialists, who submitted more than 100 technical papers at the different expert group meetings, which were organized annually.

Due to good results, the project was extended for the period of 1988 - 1990 with the new target to achieve a self-sustaininability of the Network by 1990, i. e. to operate without external support, relying on the common interests and benefits of the participating countries.

This project has accumulated, during its operation, lot of know-how and experience in the field of industrial energy management, which can be efficiently exploited in various developing countries outside Europe.

Another example of the good co-operation with developing countries in this area is the UNIDO-Czechoslovakia Joint Programme, Non-metallic Industries, Pilsen.

Its scope of activities is the following:

ACTIVITIES The UNIDO-Czechoslovakia Joint Programme, Non-metallic Industries, Pilsen has been carrying out a broad range of activities. The most significant activities are as follows:

1. Fostering of twinning arrangements between Czechoslovak orgnizations and counterparts in developing countries.

2. Individual training programmes which are of two basic types:
   a) study tours
   b) fellowship programmes

   Aim:

   up-grading of knowledge, training of different fields of interest.

   In 1987 - about 500 man/days of indiv. training
   In 1988 - 940 man/days of individual training

3. Group training programmes which are organized as seminars, technical workshops and expert group meetings on regional or interregional basis.

   Together 22 such events has been organized for more than 500 experts from developed and developing countries.

   Highlighted topics:

   - integrated exploitation of local non-metallic minerals
   - energy management
   - application of non-metallic sorbents in agriculture
   - environmental engineering
   - advanced ceramics

   Over past 10 years, more than other 500 experts from developing countries have benefited from this programme.

4. Raw materials testing and exploitation, technology development

   3 types of testing:

   a) orientation laboratory tests
   b) bench tests
   c) pilot tests

   The raw material testing exhibits an increasing number year by year:

   1985 - 56 different raw materials from 9 countries tested,

   1988 - 104 different samples from 9 countries tested

   Integrated approach to raw material evaluation which results in all possible applications and utilization of non-metallic resources in developing countries, traditional and new.

5. Transfer of know-how

Joint Programme prepares its own publications dealing with the production and technology problems, management, evaluation of different projects etc. To cover the growing needs of developing countries in informatics the Programme established:

a) an INTIB node (Industrial and Technological Information Bank, in 1987, for non-metallics)

b) INECA (Industrial Energy Conservation Abstracts in 1988)

On-line connection of computers of the Joint Programme in Pilsen makes available utilization of host computer of UNIDO Vienna and international databanks so far.
Together 452 papers have been published in the Joint Programme activity and more than 5,000 titles have been dispatched to developing countries annually.

6. Integrated utilization of non-metallic sorbents

- introduction of non-traditional and low-waste technologies

agriculture - application of selected industrial minerals for soil conditioning, increased crop yield in developing countries, improving sandy soil profile-desert countries.

water purification - sorbents like perlite and bentonite after simple treatment give excellent results in improving water quality.

UNEP-UNIDO-UNESCO joint seminars on this topic take place yearly.

UNIDO at present gives no support to industrial ventures without proper environmental protection.

7. <u>Advanced ceramic programme</u>

8. <u>Non-waste technologies</u>

9. <u>Conservation of historical buildings and natural objects</u>

10. <u>Energy management and conservation</u>

    <u>Aim:</u>
    reduced energy consumption in heat aggregates, optimization of firing, waste heat utilization in industrial plants.

    2 specialized devices for energy audits

    - mobile diagnostic unit
    - energy kit (transferable, small)

    <u>UNIDO-Czechoslovakia Joint Programme, Non-metallic Industries, Pilsen is participating in the UNDP/UNIDO interregional Project on Energy Conservation in Industry</u>
    (DP/RER/83/003)

11. Co-operation with other international bodies is a very important part of the Joint Programme activity.

    Co-operation with:

    <u>UNDP New York</u> - regional and interregional projects,

    <u>UNEP Nairobi</u> - ecological planning seminars jointly with the Czechoslovak Academy of Sciences

    <u>UNESCO Paris</u> - Geochim seminars, lectures

ITC Geneva - seminar for commercial attachés assigned to Prague and preparation of the new project proposal

AIESEC Amsterdam - traditional industries in Czechoslovakia

UNCHS - Habitat Nairobi

SACEP - South Asia Co-operative Environment Agency, Colombo

ESCWA - Economic and Social Commission for West Asia, Baghdad

ISO - International Standard Organization

Further participation in important fair events:
PRAGOTHERM (energy management)
BRNO FAIR, INCHEBA FAIR

PARTICIPATION IN UNDP PROJECTS

1. UNDP Project DP/RER/83/003
   "Industrial Energy Conservation Network"

   UNIDO-Czechoslovakia Joint Programme, Non-metallic Industries, Pilsen is active in two subnetworks:

   a) Building Materials
   b) Energy Auditing and Management

   and responsible for the database INECA (Industrial Energy Conservation Abstracts)

2. Accepted project by UNDP:

   Environmental Protection - Wastewater Treatment

3. Further 4 projects are subject to UNDP consideration

   - Ceramic Manufacture Training Courses
   - Integrated Exploitation of Non-metallic Raw Materials

- Promotion of Development of Advanced Ceramic Industries in Developing Countries
- Development of Small-scale Non-metallic Industries

FUTURE TRENDS IN THE JOINT PROGRAMME ACTIVITY, OFFER OF HELP TO DEVELOPING COUNTRIES	- Development of new materials, based on non-metallic raw materials, transfer of technology - Increased capacity for individual and/or group training - Integrated exploitation of local non-metallic raw materials (utilization of local wastes, non-waste technologies) - Application of local sorbents, such as bentonites for water purification due to high efficiency and suitability for small and medium producers of wastewaters - Energy management in industry - Women training and employment (Fine and Artistic Ceramics Decoration Techniques) - Insulating materials - Fillers and extenders - Integrated help for developing countries and least-developed countries in the non-metallic sector (IDDA - Industrial Development Decade for Africa) - Integrated evaluation of building materials for housing

VII. Final Note

Presented paper brings the introduction into the problems of energy management from the integrated view in which the energy auditing is one of the most important measures for energy conservation. After the general introduction, the theory and practice of energy management is discussed. As the energy management of industrial plants always is associated with the technology, main energy management steps are analyzed as the guidance for energy conservation in the industrial plants.

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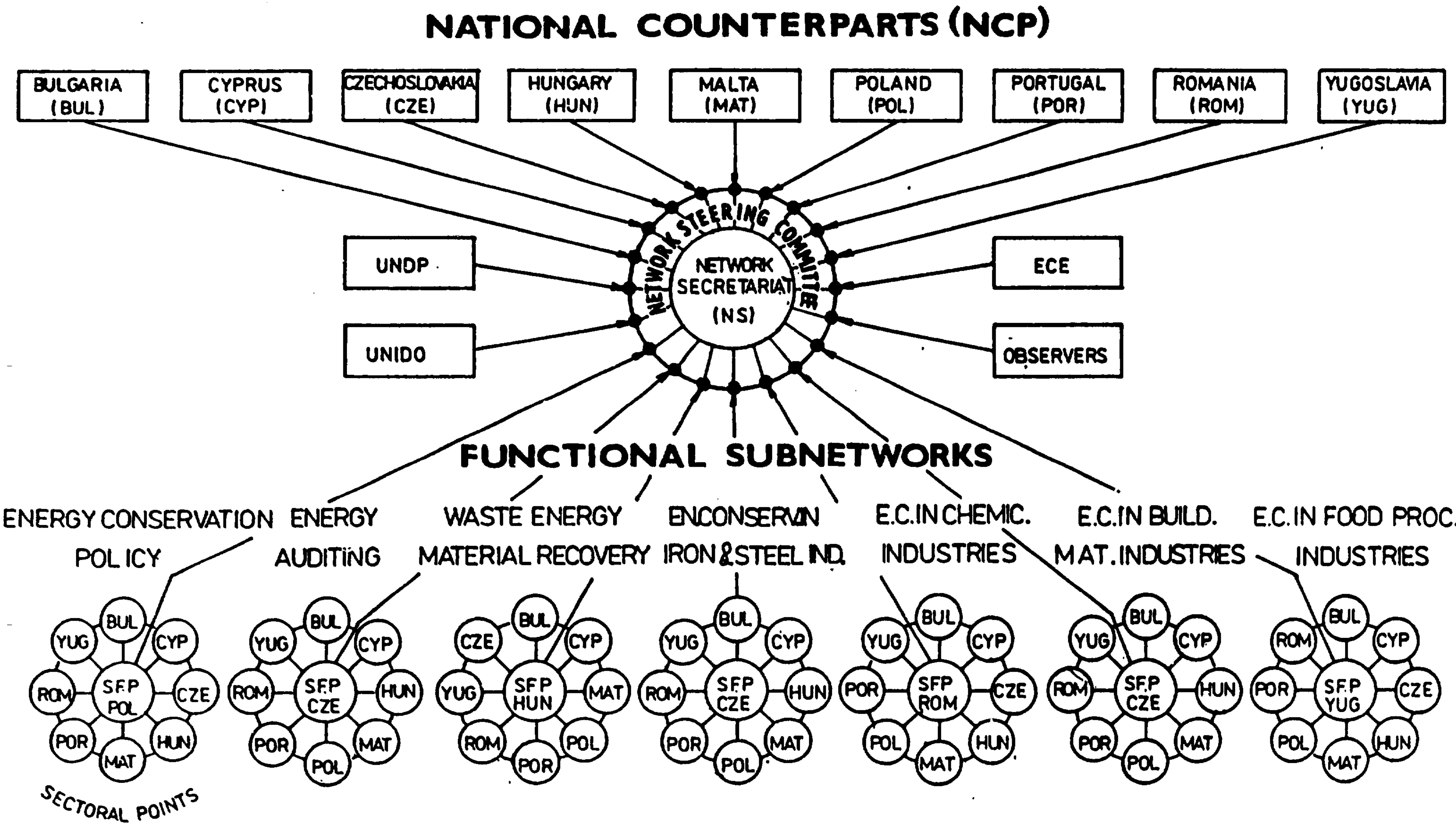

Fig. No 9 ORGANIZATIONAL STRUCTURE OF THE REGIONAL NETWORK FOR ENERGY CONSERVATION IN INDUSTRY