Stefano Cocchi, Flavio Conti

A new instrument for market transformation for industrial equipment: The EuroDEEM database

Stefano Cocchi, Flavio Conti

European Commission - Joint Research Centre (JRC)
Environment Institute - Renewable Energies Unit

21020 Ispra (Varese)
Italy

Phone: 0039 332 789299
Fax: 0039 332 789992
E-mail: flavio.conti@jrc.it

Energy Efficient Equipment - STRATEGIES AND TASKS

SESSION IV / Lecture 9

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1. THE EMS EVOLUTION IN THE EU.

The growing attention of national energy agencies and European Commission on the sector of Electric Motor Driven Systems is due to the following reasons:

a) the EMSs account for half of all electricity consumed in the EU /ref. 1/ and , accordingly, there is a large energy saving potential;

b) commitments for emission reductions taken at international conference on environment protection, (e.g. Rio, Kyoto Conferences) are forcing national governments to identify largest and most attractive energy saving potential "mines";

c) the increased competition on the global market obliges industries to improve every cost aspect, including energy costs

d) last but not least, the liberalisation of the electricity market in many developed countries and in the European Union, in particular, has created an interest of the electric utilities in identifying Energy Services for industrial and tertiary sector customers. If, on the one side the competition among utilities is reducing budgets devoted to DSM actions, on the other side, utilities are interested in actions for delaying their own investments for increasing power supplies and for providing energy services to medium and large clients. Customer retention and enlargement of corporate activities can be the reasons for supporting energy efficiency initiatives.

Historically, the design of EMSs and the purchase choices were aimed, on the manufacturers' side, at producing motors as cheap as possible and, on the user side, at ranking at highest priority factors such as reliability, noise minimisation and risk avoidance.
In the past motors were rather inefficient, both because design and manufacturing techniques were less developed but mainly for minimisation of production cost. Many existing old motors, still running, are oversized because the users, for reasons of reliability, preferred to install oversized motors, capable to overcome temperature peaks, to better withstand to overcharge conditions and therefore, lasting a longer lifetime.
Today's motors are designed with higher and better efficiency vs. part load characteristic curve (in the range 60 - 100%), reducing motor heating so that oversizing reasons are less valid. High efficiency premium motors are available on the market with limited extra-cost, between 0 and 30%, recoverable in few months, taking into account that 97% of motor costs are running (energy) costs.
But inefficiencies are not only in the motor but also along the whole motor drive system. In particular, in most applications with variable load or torque, control was obtained by installing throttling valves. This choice was in the past justified for a number of reasons, many of which are still valid today and represent major non-technical barriers:
a) low electric energy prices and high value of process
b) high costs and low reliability of Variable Speed Drives (VSD)
c) choice of minimum investment and simplest solution
d) limited knowledge of new technologies and insufficient definition of best available technologies (transaction costs)
e) aversion to downtime, to risk and to innovation

Today conditions have improved. Technology of VSD is well established and prices have considerably reduced. Innovation is no longer seen as a difficulty but rather as a market opportunity.
Many information campaigns contribute to spread a better knowledge of EMSs, thus contributing to reduce the so-called transaction costs.
The EC has set up during past years several various information actions, aimed at coming to a negotiated agreement on the definition of efficiency classes for electric motors, creating databases and analysis tools, organising workshop, conferences, seminars, training courses, etc. All these initiatives produce a strong impact on users' knowledge and are modifying the EMSs market.

2. THE EC ACTIONS ON BEHALF OF ENERGY EFFICIENCY POLICY

As mentioned above, one of the major non-technical barrier for a larger adoption of energy efficient technologies is the lack of information to likely users, which increase the transaction costs and do not reduce the aversion to risk in adopting innovative solutions. These kinds of barriers are defined in the neo-classical economic theory as *market failures*, since the market fails to provide adequate information or signals.
But sometimes users don't even know at all about the existence of new energy saving devices. In these cases it can be spoken of *market limits*, because decision-maker has not been given any matter on which to decide. /ref. 3, 2/.

The development and availability of information tools, such as databases and auditing schemes, combined with clear and common definition of efficiency classes, can be very useful in overcoming both these barriers. For these reasons the European Commission, through its Energy-DG, has promoted a number of actions aimed at fast transformation of motor market.

2.1 Efficiency Classes of EMSs

Every action concerning energy efficiency is basically a replacement of an obsolete or inefficient device or system with a more advanced and efficient one. This implies that efficiency levels and efficient devices are identified according to the values of certain parameters and, possibly, labelled in pre-defined classes of efficiency.
An ad hoc study group set up by the Energy-DG, where representatives of the European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP) were present, has treated the problem of identifying efficiency classes for electric motors as a function of motor nominal power. During 1999 an agreement had been reached and three efficiency classes has been defined for 2 and 4 pole electric motors. The following graph (Figure 1) shows the 4-pole motor efficiencies compared to the curves, which define the 3 efficiency classes.

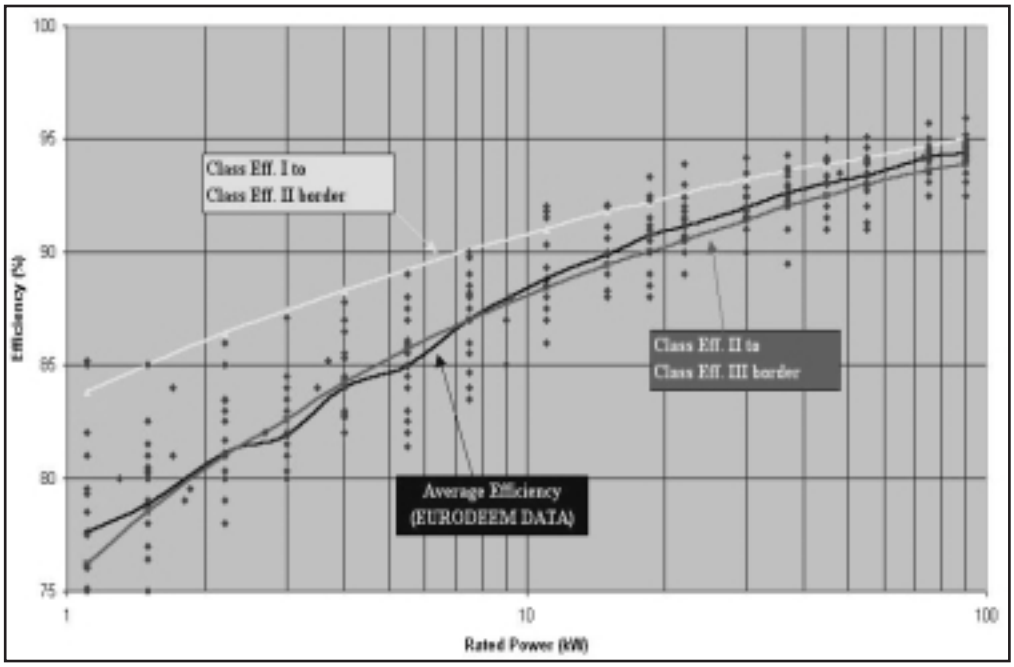

Figure 1: 4-Pole Motor Efficiency Distribution (EuroDEEM data) compared to Final Energy Efficiency Classification Curves for 4 Pole Motors - 50 Hz, according to IEE 34

The agreement between the EC and the manufacturers on the definition of motor efficiency classes provides a common reference for all actors in the EMS field, with a clear identification of the less efficient motors to be pushed out of the market.

Moreover, the definition of efficiency classes is the preliminary and necessary step for any future prescriptive norm. In fact, the are several market supply channels of electric motors /ref. 2/ and, for some of them, the interest of decision-makers is different from that of final motor users (split interest). In particular, OEMs are used to choose the electric motors according to the minimum price, provided that high running costs are paid by consumers. In such cases a normative approach for installing more efficient motors could be much more effective than a voluntary agreement.

2.2 Databases on Electric Motor Systems

Databases are another information tool for industrial and tertiary sector users of EMSs. Some EMS databases had been developed in the USA, New Zealand and Switzerland during early nineties, but the EC initiative in this field for the European market started only in 1996.
In that year the European Commission' Energy-DG (DG XVII), in the framework of the SAVE programme, published the results of the study *Actions To Promote Energy Efficient Electric Motors* (EEMs). This study stressed, among other important issues, the need to improve market transparency for efficient motors and support the market transformation toward EEMs.
Energy-DG, being well aware of the importance and of the large saving potential of the electric motor systems, well before the conclusions of the above-mentioned study, asked the Joint Research Centre (JRC) to create a database and a selection tool on Electric Motor Systems. This work was carried out during 1996 with the production of an initial version of the European Database on Efficient Electric Motor Systems (EURODEEM), which was presented for the first time at the Lisbon Conference at the end of 1996. (Ref. 4 /Cocchi et al., 1996). A revised and enhanced version (EuroDEEM-98) was presented recently at EEMODS'99 Conference in London /ref. 5/, which will be illustrated briefly in the next paragraph.

2.3 Audit Schemes for EMS

Another important tool for improving the users' knowledge on EMSs is the availability of effective diagnosis tools and schemes.
The technology of the Electric Motor Systems (EMS) is well established and well defined since many decades, although always new and more efficient products appear on the market. But the need for making the use of electricity more rational requires a different approach and the development of more sophisticated and advanced energy analysis and auditing tools.
Although Electric Motors design procedures are well established since many years, nevertheless, in the real conditions an EMS can be built up with various motor components not optimised or recovered from other systems or simply chosen because they were the only available in the company's stock. In old motor systems, information or design data of EMS are no longer existing or available, motor plates are missing, nobody remembers the motor specifications, the load may change with the time while keeping the same system which in the meantime may become to be oversized. Energy savings measures are often not implemented because users are not aware of the amount of inefficiencies and do not know what best technological solution is the best suitable for the specific situation.
Every motor expert can mention many examples of very irrational layout of existing EMSs. Therefore very often it is necessary, when a motor expert enters particularly into a Small/Medium size Enterprise for energy efficiency upgrading, to have clear and effective guidelines for carrying out the audit of each EMS.
An Energy Audit scheme should address the following items:
a) **Standard data forms for EMS data gathering**, subdivided in various forms for each EMS component (e.g. power supply, motor, controls, coupling, load type and process).
b) **Information Form about the Company's attitude and behaviour** with respect to motor component purchasing, technical management, care to energy consumption and savings, operation conditions, maintenance procedures, priorities and primary drivers, business constraints, perceived threat to business, etc. These pieces of information are necessary 1) to increase awareness of the company about its EMS situation, 2) to ensure the persistence of upgrading actions with the time, 3) to provide hints to the Company about the improvement in the Energy Management.

c) **Preliminary quick data gathering and analysis** process aimed at taking the decision of further detailed Audit.
d) **Annotated List of Energy Conservation Opportunities** (ECOs)
e) **Detailed Audit Procedure** oriented to the assessment of applicable Energy Conservation Opportunities
f) **Measurement Techniques, Analysis Procedures** and **Reference Values** associated to each ECO
g) **Interaction effect of various ECOs**.
h) **Complete auditor's List of Measurement Devices and Instruments**
i) **Cost-effectiveness Calculation and Decisional Criteria** for the implementation of an ECO, expressed both in descriptive terms and as algorithms.
j) Scheme of the **Form for Reporting to the Company**.

The development of the Electric Motor System Audit should be made as general as possible in order to ensure the largest applicability.
Moreover, the Energy Audit should be designed to be as cheap and simple as possible. This implies relying more on existing data, reference values and proven calculation algorithms than on expensive and time consuming field measurements, whenever possible. The best compromise between accuracy of the result in triggering investment decision and the cost of the audit must be ensured.

3. EURODEEM DESCRIPTION

The ultimate goal of EuroDEEM project is the development of a whole motor system assessment tool, as user friendly as possible, and able to provide advises and decisional support for electrical efficiency. Therefore the main scope of the work is to extend the database of electric motors to all the other motor system components. In this way the tool can reach a full capability of assisting plant eergy manager to identify inefficiencies in the motor system chain and to take optimal decisions.

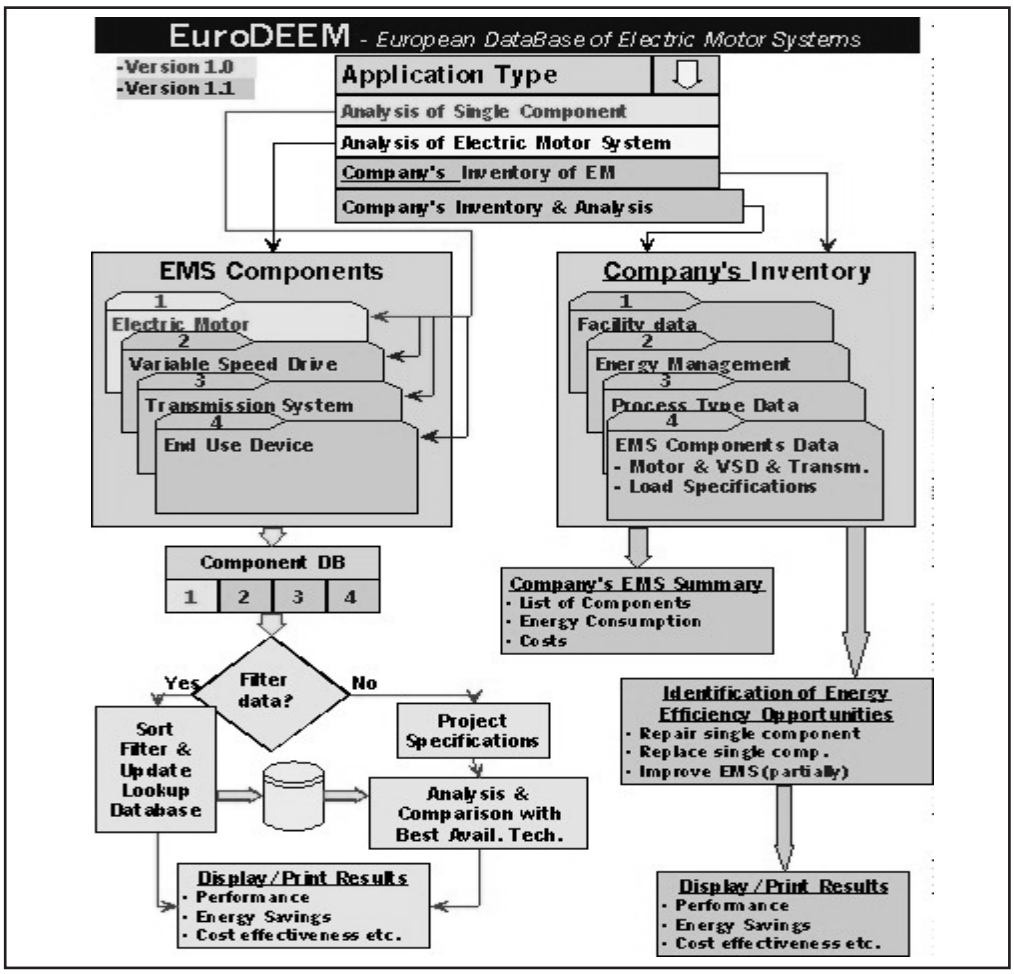

Fig. 2 EuroDEEM structure

To achieve the expected design for the new EuroDEEM software the JRC has conceived a database and selection tool as shown in figure 2 and described by the following four type of user applications:

1. Analysis of a single component: The database permits both to query the database for search on each motor system component (e.g. electric motor, VSD, transmission end-use devices). Each component can be searched either directly, by filtering the data in the base, or according to user's load requirement (project specification). In this latter case the user has the possibility to compare various component available on the market and make a choice based on the cost-effectiveness and/or energy efficiency.
2. Analysis a an Electric Motor System (EMS): It will allow to perform energy and economic analysis of single and combined components of a complete Electric Motor System, (for instance, to assess the overall efficiency of a system chain formed by the motor, the pump and the valve).
3. Company Inventory: The Company Inventory is intended as a tool for archiving all motor system components related data of a company. The Company Inventory is a database that collects all data regarding Electric Motors, Variable Speed Drives, Transmission devices, Load Description, and Utility rates paid by the company. It permits and helps users to organise, maintain, and manage, at different corporation levels (company, factory, department), for inventory, replacements and maintenance of all existing electric motor system components of the user's Company, including the spare stock. For example, once the existing electric motor system is inserted into the inventory database, the user can evaluate the annual energy consumption, find where inefficiencies and losses are located in the motor chain, and analyse upgrading options.
4. Company Inventory Analysis of EMS: It must finally allows the user to perform economic and energy analysis of existing Electric Motor Systems of the Company database inventory, identifying Energy Savings Measures for single and batch components.

Regarding the Electric Motor System Components, four databases are foreseen:

- o The database of Electric Motors, which has been enlarged to take into account some extra data fields, such as Efficiency Class, Certification Type, Warranty, WWW links to manufacturers, etc.
- o The database of Variable Speed Drives (VSDs) (both electronic and mechanical). It must include power ratings, drive efficiency and power factor (only for electronic VSDs) at different speed and load, and frequency ranges.
- o The database of Transmission and Coupling devices: Efficiency data is required as a function of load demand.
- o The database of end-use types It will permit the end-users also to check the sizing of end-use devices with the load requirements and to optimise industrial process.

In addition, two other databases had been created:

- o The Company Inventory database: where company motor data are stored
- o Utilities database: needed for hosting tariffs and rates data for economic calculation

The relation between the Electric Motor System Database and the Company Inventory must be straightforward. It must be possible, for example, to insert motors (or other components) from the EMS Component database into the Company Inventory.
There must be an intuitive motor selection tool for choosing best available motor for a desired application, including those belonging to the Inventory Database. The selection tool should take into account the load profile and type, the utility rates and tariffs, and transmission & control devices, if any. The outcome of the selection should give information on energy consumption and costs, and eventually payback times.
Finally, some new tools have been added to enhance the usability of the software:

- o Catalogue Motor-Find tool, selecting through manufacturers, number of poles, motor power, motor torque, motor frame, etc. You can find and store (for later view) a set motors, according to general parameters, and/or detailed electric and mechanical data values.
- o Inventory Motor-Find tool, selecting through manufacturers, number of poles, motor power, motor torque, motor frame, motor load, energy consumption, etc. You can search in a Company, Facility, or Department for Motors or Motor Systems that match a specific request (e.g. Overall system efficiency, annual energy consumption, etc.)

- o A full featured Wizard for guiding the user through the different tools and databases. The wizard is intended to help and guide the user in the selection of the best available motors for specific applications, in the choice between replace or rewind for Inventory Motors, in inserting new motor systems into the Inventory Database, and in browsing the Electric Motor System Catalogue and the Company Inventory.
- o In the Company Inventory database are placed some analysis tools for checking and calculating energy losses due to bad control systems, or motor oversizing (system efficiency and motor load factor).

A clear, fast, and reliable Procedure for Updating the Data in the base has been set-up in order to keep updated the Catalogue Database. The Motor Catalogue Database can only be maintained, updated, and modified by the JRC staff. EuroDEEM has already included a data field for the efficiency class so that high efficiency motors can be easily retrieved.
The JRC staff, in order to avoid any kind of mistakes on the data supplied, has developed an automatic loading procedure of the files received from manufacturers. In this way only manufacturers are responsible of the data shown in EURODEEM.

On the user side, the user can view the EURODEEM data either by receiving a CD-ROM or downloading EURODEEM from the web site

http://iamest.jrc.it/projects/eem/eurodeem.htm ,

but in no way he/she can alter or modify the catalogue data. This is done in order to prevent the circulation of incorrect data. The user can only insert data for the specific use of motor components in the Company Inventory database.

4. FINAL REMARKS ON THE PERSPECTIVES OF EMS

On the basis of what has been presented, there are many topics that need further investigation and development in the near future.

For new electric motor systems the availability of performance data (eventually provided by databases or other tools) and energy efficiency consciousness enables to design and install energy efficient motor driven systems. On the contrary, for already existing EMSs, which are the majorities, the lack of optimisation in system layout is the main source of energy inefficiency. The lack of performance data, of reliable and established energy audit procedures, and of properly trained professionals is a serious barrier to efficient system improvements.

The replacement of an inefficient component with a higher efficiency one is not always a guarantee of system improvement. A wider spectrum of analysis tools of EMSs is the starting point for improving energy efficiency in motor driven system. Standard and reference tools, such as EuroDEEM, can provide a great help for this purpose.

In the future SAVE programme not only new and advanced information tools need to be further developed. Also large testing, training, demonstration and showcase projects must be supported in order to overcome the numerous technical and non-technical barriers that prevent that the large energy saving potential in the field of EMSs be fully exploited.

Up to now, the most outstanding energy saving actions for EMSs concern the improvement of control by means of Variable Speed Drives. But in the EU Demand Side Management programmes, aimed at assessing and exploiting the whole saving potential of electric motor driven systems, are very few. In this field more intensive saving efforts can be carried out, provided that targeted and well-conceived actions are planned.

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