Paolo Bertoldi, Bogdan Atanasiu  
European Commission DG JRC, Ispra Włochy

THE EUROPEAN MOTOR CHALLENGE PROGRAMME  
EUROPEJSKI PROGRAM MOTOR CHALLENGE

Abstract: Electric motor driven systems account for the greatest part of industrial electricity consumption in Europe. Numerous studies on individual component (motors, pumps, compressors) and on the consumption characterisation have shown the considerable potential for improvement of energy efficiency of these systems, and have recommended suitable policy actions. A number of policies have succeeded in making improvements on the supply side for individual components of systems, such as the electric motor itself. For electric motor a EU wide classification scheme and labelling exist together with a voluntary agreement by motor manufacturers to substantially improve the efficiency of motor placed on the market. Following the recommendation of experts, the European Commission decided to that a concerted effort on the demand side could very usefully complement the efforts being spent on components and technologies. The European Commission has decided to launch “The European Motor Challenge Programme” (MCP). This is a voluntary programme for motor systems end-users to agree to look at their motor systems and to carry out within a specific time frame the savings measure that are economic. The paper describes the programme and its implementation. The programme is based on the analysis of the main reasons why profitable energy savings measures are not put into practice in the private companies and on the successful examples where high level management made the necessary decisions to carry out motor systems energy efficiency programmes.

The publicity aspect of the programme would be used to convince top management of the usefulness of subscribing to the MCP “Guidelines”, in some ways similar to the existing EU “GreenLight” Programme commitment. Because of the very wide variety of situations, this commitment is open ended and flexible, a sort of “variable geometry” system, where each company, with aid from national energy agencies (the MCP “National Contact Points”) the Commission, would target those areas and measures most likely to be effective in its operations. The company will commit to carrying out these measures, and reporting on the results, within an agreed upon time period.

1. Introduction

Electric motor driven systems account for 69% of industrial electricity consumption in Europe (EU-15). The base year for the characterisation of motor electricity use is 1998. Motor electricity consumption in the industrial and in the tertiary sectors in the EU in 1998 was responsible for 69% and 38% of the total electricity consumption, accounting for 590TWh and 190TWh respectively.

Figure 1 shows the share of motor electricity consumption by end use in the industrial and in the tertiary sector in the EU-15.

![Figure 1: Share of motor electricity consumption by end-use](image-url)
Numerous studies and projects have shown the considerable potential for improvement of energy efficiency of these systems. The electricity savings potential are estimated for the year 2015. The annual average growth rates of the electricity consumption up to 2015, in the industrial and in the tertiary sector is assumed to be 1.2% and 1% respectively. A more recent study coordinated by the European Copper Institute (de Kuelenaer) estimated savings of 202 TWh per year for the EU-25, equivalent to electricity cost savings for industry in the range of 5 to 10 Billion Euro. For the estimation of the motor electricity and carbon savings potential, the efficiency improvements considered, are the application of Energy-Efficient Motors (EEMs), Variable Speed Drives (VSDs), and energy efficient end-use devices and system (pumps, fans and air compressor systems). The total technical and economic electricity and CO₂ savings potential in Industry and in the Tertiary sector in 2015 are presented in Table 1:

Table 1. Total final technical and economic electricity and CO₂ savings potential in Industry and in the Tertiary sector by 2015

<table>
<thead>
<tr>
<th></th>
<th>TWh Savings by 2015</th>
<th>CO₂ Mtons Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>107,1</td>
<td>42,9</td>
</tr>
<tr>
<td>Tertiary</td>
<td>36,7</td>
<td>14,7</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>84,3</td>
<td>33,7</td>
</tr>
<tr>
<td>Tertiary</td>
<td>24,5</td>
<td>9,8</td>
</tr>
</tbody>
</table>

The above estimated savings potential would be higher if other efficiency improvements would be included. The application of low cost efficiency measures which do not require sophisticated technology, such as improving maintenance practices, reducing waste, switching off the equipment when it is not being used (for example for the case of belt conveyors), would lead to large savings. These “Housekeeping Measures”, deserve to be strongly publicised among motor users. Drive-train and connection systems are another possibility for efficiency improvements (gears, belts, chains and bearings). Losses in the power transmission system are often surprisingly large, but carefully selection and maintenance of drive-trains and their components are crucial for improving energy efficiency.

Figure 2. Economic Savings potential in Industry by 2015
A number of programmes have succeeded in making improvements on the supply side for individual components of systems, such as the electric motor itself. For electric motor a European classification scheme and labelling exist together with a voluntary agreement by motor manufacturers to substantially improve the efficiency of motor placed on the market.

Figure 3: EU/CEMEP Motor Efficiency – Classification scheme
A similar action has been introduced for pumps for clean water, the so-called procurement lines. It appears that a concerted effort on the demand side could very usefully complement the efforts being spent on components and technologies. The essential thrust of such an effort would be to:

- raise awareness among industrial users of motor systems about the potential for energy saving (and money saving) measures;
- make available a wide range of information tools, to aid users in optimally designing, purchasing, installing and operating motor driven systems;
- create a European wide framework to encourage top level decision makers to make the implementation of these energy savings measures a management priority. This framework could adopt some of the successful elements of similar programmes, such as the European Union GreenLight programme, or the US DoE Compressed Air or Motor Challenges.

There are multiple reasons that explain why profitable (sometimes very profitable) energy savings measures are not put into practice in the private sector:

- motor systems electricity consumption is "invisible" to top management, since it is most often a relatively small cost item for any one company.
- electricity consumption in general, and motor systems consumption in particular, is usually treated as a general overhead item in company analytical accounting schemes. Thus reducing this cost item is not the responsibility of any particular manager.
- measures to optimise the cost of equipment purchases, such as competitive bidding procedures, rarely take into account long term operating costs due to electricity consumption. Thus these cost cutting practices can be counterproductive in terms of reducing life cycle costs for electricity. This is particularly true since the optimal systems according to the electricity consumption criterion often require higher initial investment. Thus they are not even proposed by suppliers in competitive bidding procedures.
- responsibility for potential optimisation measures is largely diffused among several management functions: Production, Maintenance, Purchasing, Finance. It is difficult to get high-level management agreement, cutting across departmental responsibilities, on a low priority item such as electricity consumption.

Despite all these difficulties, in those cases where high level management makes the necessary decisions to carry out motor systems energy efficiency programmes, the results are often outstanding, and management retrospectively is happy with the decision. Many European Union and Member State programmes have focused on the problem, and have had some success in stimulating the necessary high level consideration of the problem.

The "Electric Motor Driven Systems" considered in the MCP are the typical fluid handling application such as compressed air, pumping or ventilation (and in future will also include commercial refrigeration). These applications have in common:

- an electric drive (consisting of a motor and perhaps an electronic motor controller) which converts electrical energy into mechanical energy in the form of a rotating shaft;
- a second conversion device (compressors, pumps or ventilators) which use the mechanical energy delivered by the drive to displace and/or compress a working fluid;
- a network through which the fluid circulates. (In compressed air systems, this network may terminate with an end use device which again transforms the mechanical energy in the air into some other type of service);
- some kind of control mechanism to adjust the output of the system to the needs of the application.

For the purposes of energy efficiency, it is essential to note that the overall efficiency of these fluid circulation applications depends on course on the efficiency of the drive and of the conversion device. It depends even more on the design and operation of the networks of which they are a part, and the inter-relationships between the components. For this reason, the MCP will mainly address the systems, and not only the individual components.

2. The Framework of the Motor Challenge Programme

The first activity has been to establish the basic elements of the MCP including the Guidelines. As the GreenLight programme as demonstrated, is expected that this will be an iterative process,
and that experience from the early phase of the programme will be used to correct and improve the proposed Guidelines.

The purpose of the Guidelines is to define the nature of the commitment of companies, which choose to participate in the Challenge Programme, and the requirements, which have to be fulfilled by participants. While the Challenge Programme must be sufficiently flexible to accommodate diverse situations, the general requirements of the approach must be sufficiently rigorous so that the commitment to the Guidelines is meaningful and results in energy savings. Thus, the commitment must contain clearly defined and verifiable actions, which the companies will carry out. These actions must be of such a nature, that they will lead to realising the bulk of profitable energy savings measures in plants of participating companies. The actions will include:

- a public Commitment, including internal communication of this Commitment;
- integration into management procedures of those reporting and evaluation mechanisms necessary to verify dissemination of the MCP action within the company;
- inspection, audit and reporting procedures, to allow top level management to control energy consumption;
- integration of energy consumption criteria into design and purchasing procedures (including, for instance, "Life Cycle Costing").

The MCP is based on a number of "building blocks" covering three of the main types of motor driven systems (Compressed Air, Pumping and Ventilation Systems)\(^1\), for which major energy savings potentials exist.

A specific building block will address the horizontal elements such as motors, transmission element and adjustable speed drives. The use of high performance motors and of electronic motor controllers are common elements to all motor driven systems and can in any case lead to substantial energy savings. The wide experience already gained through the use of EuroDEEM database together with the motor classification scheme would play a major role in the construction of this block.

The basic element of the building block will be to define the technical nature of an appropriate commitment for the specific type of motor driven system. Because of the very heterogeneous nature of these systems, and the diversity of specific company installations, the "building block" must specify a general approach, consisting of verifiable actions, which when carried out lead to optimal system functioning.

Previous European Commission studies of compressed air systems, pumps, ventilators, motors, electronic motor controllers, have already identified the savings potentials of technical and organisational measures.

The building block must define the notion of a "profitable energy savings measure". It is clear that this cannot be limited to lowering cost, but must include reliability and quality of service criteria. One important consideration is that the targeted types of systems (compressed air, pumping, and ventilation) are usually considered as "technical services" within a production facility. Their failure, or a drop in quality of service, can have catastrophic results on production. Thus, from an industry management point of view, reliability and quality of service are the overriding criteria for judging the cost effectiveness of the service, rather than the actual cost of producing the service. For this reason, the Challenge Programme Guidelines will clearly state that profitable energy savings must maintain or improve reliability and quality.

3. The Guidelines

The MCP Guideline will contain an overall framework for the 4 "building blocks" already described. The framework will be modular, so as to permit the incorporation, in the future, of new building blocks (for instance on refrigeration systems).

The framework must be of an "à la carte" nature, that is to say that companies must be able to choose the elements or types of systems relevant to their operations. This in general means that a company will commit to examine those types of motor driven systems (compressed air, pumping and ventilation systems) that are large energy users in its plants. Some companies might also choose a transversal approach fo-
cused on the drives: high performance motors or adjustable speed drives. Furthermore, the framework must be compatible with the range of approaches of the Member State Energy Efficiency programmes for electric motors systems.

In any case it is not be possible to specify quantitative requirements for energy savings (as is the case for the GreenLight programme), since the level of savings possible depends on the precise nature of each installation and given the wide range of applications. Rather, the target for energy savings must be determined as a part of the audit process to which the company commits itself when signing on to the MCP.

The Guidelines will define the process by which companies commit to the MCP, define their specific company plan, carry out their plan and evaluate the results. Since the process is similar to other environmental and quality certification methods such as ISO 9000, ISO14000 and EMAS, care has been taken to use elements from these methods so as to simplify and reduce the cost of committing to the programmes.

The guidelines will be accompanied by the following documents, initially available in English, and in some national languages:

- awareness raising material to help top company deciders understand the purpose of the MCP and the potential for energy savings. Special attention will be paid to the reliability and quality of service criteria;
- guidelines for the audit and implementation processes, including initial measurements and ex-post evaluation procedures;
- lists of resources (co-operating equipment manufacturers, engineering consultants, software, documents and books, training material, list of possible financing mechanism, list of ESCOs operating in this field, etc.).

As it was experienced with the GreenLight Programme, initially there will an ongoing and permanent manner to improve the MCP. Thus, it is to be expected that more than one working version of Guidelines will be issued during the course of the programme, leading to a consolidated version about three years after the launch of the programme. The first two years were used to test the overall MCP concept, and this phase contributed to improving and validating the MCP Guidelines.

4. The Programme Implementation

4.1 Negotiate participation of industrial enterprises

Perhaps most difficult task of this phase will be to obtain the agreement of companies to participate in the programme. Since at this stage, the MCP will is not well known and publicised, programme participants will not have incentives to participate, including the benefit of the full scale public information campaign. Nor will there be “name recognition” for the Challenge Programme, nor for the logo that is associated with it. It is to be expected that many companies will adopt a “wait and see” attitude with respect to an approach that will be new and untested.

It will thus be necessary to use the full political weight of the European Commission and of the National Energy Agencies (“national promoter”) to convince companies to serve as test beds for the programme.

Each national promoter will seek to obtain the agreement of some key company during the first three years. These companies have been chosen by each promoter as a function of national priorities and programme constraints.

Although the Challenge Programme will ask companies to involve all of their major production facilities, during this pilot test phase, the commitment will most likely be for only one plant, and perhaps for only one service (pumping, compressed air, ventilation).

According to the procedures set out in the Guidelines, the commitment will specify the types of motor systems that will be covered by project activities. The Guidelines should also specify that the results of the MCP may be made public in order to further the aims of the Challenge Programme. In some cases, this will necessitate negotiation on the nature of information to be made public, in order to protect industrial secrets.

4.2 Carry out audits

The National Energy Agencies, in accordance with the terms of their particular national programmes, helped companies with the initial audits during the first year to stimulate company participation. The audits shall include description and measurement of the initial state of the motor systems, so as to permit ex post evaluation of the success of actions carried out. The audit recommendations must of course respect
the "Reliability" and "Quality of service" clauses of the Guidelines. In some countries public funds can be used to co-finance some parts of the audit process, in order to incite companies to participate in the pilot phase. In some countries, this is done within the framework of existing audit programmes. To offer help for the audit is a key policy to achieve energy savings, as companies do not believe that saving exist and thus are reluctant to invest “little” money to carry out an audit. Some countries have mandatory energy audit for the industrial sector this is a very important policy measure to stimulate energy efficiency.

4.3 Accompany enterprises in implementation

The complete implementation of the Guidelines and of the audit recommendations will probably take much longer than the programme. This is because many of the recommendations will bear on design and purchasing decisions for the creation, renewal or upgrading of major systems. Some of the major components (compressors, pumps, ventilators, piping and ducts, etc.) are replaced in 10 to 20 year long cycles. It is thus likely that many of the recommendations will not have been carried out during the life of the MCP programme, which is initially limited to five years. However, at a minimum, the participating company would have put into place:

- those improvements for maintenance and operations procedures for which rapid implementation is technically feasible (for instance leak detection programmes for compressed air systems, and energy efficient drive belts in ventilators drives);
- some retrofit operations, when they are technically feasible and have very short payback times;
- the basic architecture of a management structure to carry out the plan in the long term. This would include:
  - tools for internal communication on the objectives of the companies commitment to the Programme;
  - guidelines for the integration of energy considerations into purchasing procedures (in particular appropriate elements of Life Cycle Costing).

4.4 The information campaign

Participating national energy agencies will develop prototype information campaigns. The agencies will:

- define the way in which the MCP message can be best adapted to national circumstances;
- develop the message to be delivered to the national companies. In particular, by adjusting the European message to correspond to the specific national energy efficiency programmes;
- identify the best vectors to touch the target group of high level industry management;

5. The Challenge Programme Web-site

The technical basis for the MCP (identification of the technical measures necessary, auditing procedures, measurement tools, etc.) have been established in previous European programmes. A key contribution to gathering all this information will be made through the EuroDEEM database and web-site. The European Commission has developed a European database for motor system, called EuroDEEM. This activity started in 1995 with the design of a tool for the promotion and selection of Energy Efficient Electric Motors (EEM). The scope of the database containing electric motor data was to make available an important information tool that allows users to easily carry out an evaluation of the best installation or replacement options, therefore helping the promotion of electricity efficiency. The EuroDEEM software package will permit users to select the most suitable electric motor for their purposes, evaluating energy and financial savings. The first version of EuroDEEM containing only the motor selector database was completed and realised in 1998 with about 3000 motor models available on the EU market. The motor data are loaded directly from motor manufacturers. EuroDEEM has been created to be a complete tool for very wide promotion and dissemination of information about energy efficiency in motor systems to a large range of end-users. EuroDEEM included in 1996 the Motor System Inventory Database for keeping track of all motor systems and electricity consumption in a Company. Utility data and tariff. In 1998 it was decided to expand the database to other important motor system components such as Variable Speed Drives (VSDs), pumps, compressors, fans and other transmission and control devices. Development activities for the
pump and VSD module have started in 1999. A first Demo version of the pump module is available. In year 2000 a motor system audit procedures has been developed and it has integrated in EuroDEEM. The Challenge programme web-site helps in outreach for the Programme, and to provide specific technical information on energy efficiency measures for European companies. It also helps users to easily access the distributed elements of the information centre, lodged at National Energy Agency sites, trade association sites, equipment producer or distributor sites, etc. Existing tools to aid in optimal decision making in the design, purchase, installation and operation of motor driven systems will either be referenced, or where possible integrated into the information centre. It includes references to many different types of resources. The web-site also contains a list of resources that could aid companies in achieving the potential energy use savings, while maintaining or improving reliability and quality of service. The lists includes specialised software, written material (journals, articles, books), multimedia training supports, etc.

6. Expected Results

To the MCP was allocated a budget of 1 billion € for the first two years. A third of this amount was spent in energy audits. The budget directly finances at least 12 energy audits and follow up on efficiency measures. Experience shows that industrial energy use audits catalyse decision making on technical measures with a value approximately 10 to 20 times the value of the audit. Thus, the project should stimulate at least 3 billion Euros of energy efficiency investments. The long term effect of the programme would of course be much greater. The average payback time for the type of energy efficiency measures that the programme aims to encourage is under 2 years. Thus the investments directly stimulated by the programme should permit over 2 000 000 Euros of annual energy savings, equivalent to well over 20 000 MWh in annual savings. The MCP directly aims to create the conditions for an energy efficiency commitment by top level management in industry. Experience in the American "Compressed Air Challenge" is that the original target of 15 to 20% energy savings will more than be met. It may reasonably be hoped that a broader scale European Programme would be equally successful. The benefits of a successful MCP would be very substantial. A conservative estimate would be 10% of industrial electricity use, i.e. about 70 TWh per year to be achieved after the five years life of the Programme.

7. References


---

Note that 2 year payback time, while typical of current industrial practice, is nonetheless a pessimistic estimate. It is hoped that the decision criteria of industrial enterprises will evolve (in part because of the Challenge Programme), so that longer payback time measures will be implemented. The use of Third Party or ESCO financing could play a role.