# Motor Challenge Programme in Austria – Improving industrial energy efficiency

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## Abstract

Improving energy efficiency is often the cheapest, fastest and most environmentally friendly way to meet the world's energy demand. The Motor Challenge Programme (MCP) is a voluntary programme of the European Commission by which industrial companies receive assistance in improving the energy efficiency of their motor driven systems. MCP was integrated in the Austrian national energy efficiency programme, which has the first focus on pumps, fans and compressed air systems. These systems are responsible for about 70 % of the electrical energy consumption in the industry. Participants commit to identify and realise energy efficient measures defined in an action plan. In the year 2005/06 10 companies in Austria decided to join the MCP – the results indicate success: Consultants were able to prove the high economic potential for energy savings in motor driven systems and found out an average economic saving potential of about 500 MWh. The electrical energy demand of 8 companies could be reduced by an average of 12 %. The following measures were taken in the companies: Application of high efficient motors (efficiency class 1) – potential approx. 8 %, Eliminating leakages in compressed air systems, reducing pressure level, of a control system integration – total potential approx. 30-50 %, reducing the operation time of fans, assembling a variable speed drive (VSD) – potential 40-60 % optimization of hydraulic systems for pumps, VSD instead of throttles – potential 20 %.

## Introduction

Improving energy efficiency is often the cheapest, fastest and most environmentally friendly way to meet the world's energy needs. Many energy efficiency measures are already economic and they will pay for themselves over their lifetime through reduced energy costs. But there are still major barriers to overcome.

This paper deals with the pilot phase for the implementation of the Motor Challenge Programme in Austria, which was integrated in the national programme klima:aktiv energy efficient companies. This programme supports industrial companies in improving the energy efficiency of their motor driven systems.

Target of the pilot phase was the collection of experience for conducting energy audits in industrial companies in the field of compressed air, fan, pump and drive systems. Basic questions in this context were:

- Can financial supported consulting service make a substantial contribution to the implementation of energy saving measures for motor driven systems in industrial companies?
- Which time frame and which financial support are reasonable for conducting an inventory in this field?
- Is there a relevant saving potential in motor driven systems in Austrian companies?
- Which kind of technical measures are useful to save energy in this field?

As an additional target of the pilot phase best case studies should be compiled to be published in the web.

**Table 1: Examples of energy saving measures in motor driven systems (European Commission, 2003)**

| | |
|---|---|
| Compressed Air | Modify or improve compressor control system |
| | Replace compressor with newer or better adapted machine |
| | Reduce air leaks |
| | Optimise system air pressure |
| Fans | Select the right type and size of motor |
| | Install a demand control |
| | Optimize operating schedule |
| Pumps | Use of variable speed drives |
| Drives | Energy Efficient Motors |
| | Correct Sizing |
| | High Efficiency Transmission |

This article consists of the following parts:

- Firstly the significance of energy saving measures in the field of electric drive systems and the main barriers for implementation of energy saving measures are mentioned.
- Secondly the Motor Challenge Programme is described, which should realize the energy saving potential in this field and which was started with a pilot phase in Austria.
- The third section outlines the analysis of the financial support programme for conducting 10 energy audits in different companies. In addition to the saving potential the most important saving measures are reported.
- Furthermore this article lists the best case examples which were derived from this programme.
- The end of this article provides the conclusions of the energy audits for energy audit programmes.

## Energy efficient motor systems as important part for $CO_2$ reduction

According to the IEA Energy Technologies Perspectives 2006 energy efficiency improvements in the end-use sectors are the single largest contributor to $CO_2$ emission reductions in the more ambitious scenarios until 2050, and contribute between 45 and 53 % of the emission reductions. In the Low Efficiency scenario, this share falls to 31 %. (IEA, 2006a, p. 47)

Two-thirds of the industrial electricity demand There is a potential to improve the energy efficiency of industrial electric motor systems by roughly 20-25 %. This does not include potential process improvements and the "demand side savings" from changes in useful energy distribution and use. This means, that approximately one third of energy used for motor systems could be saved. Electricity demand of the industrial sector could be reduced by 20 %. (IEA, 2006b, S2)

For industrial technologies, in the so called Map scenario a share of 27 % (1,5 out of 5,4 Gt) of the industrial contribution to the global $CO_2$ emission reductions will come from the energy efficient motor systems. Together with $CO_2$ capture and storage it will be the measure with the biggest impact by far. But different to carbon storage the systems are well proven and widely applied and a smaller share of R&D, demonstration and government support for deployment is needed. (IEA 2006a, S 158-159)

A motor system in this case means a machine (i.e. pump, fan, compressor, mixers, conveyor belts, packaging machines etc.) that is driven by a electrical motor. While the efficiency of motors is generally high, the efficiency of the whole system is very low. The application of a motor system (i.e. pipeline, compressed air system) has important energy impacts. In particular existing installations are poorly designed for system efficiency. (IEA 2006b, S2)

These saving potentials are already recognized in the political decision process:

In the EU Energy Service Directive, Annex III, the indicative list of examples of eligible energy efficiency improvement measures for the industry includes for a big part measures in the field of motor driven systems: e.g. more efficient use of compressed air, motors and drives (e.g. increase in the use of electronic controls, variable speed drives, frequency conversion, electrical motor with high efficiency); fans, variable speed drives and ventilation. (European Union, 2006)

In the draft for the IPPC BAT Reference Document for energy efficiency several chapters are devoted to energy efficiency in motor driven systems (pumps, fans, compressed air, cooling systems,…). (European Commission, 2006)

### BARRIERS FOR THE IMPLEMENTATION OF ENERGY SAVING MEASURES

Though energy saving measures are available, save money and often increase the availability and quality of systems the following barriers exist within the decision process in companies:

Target of industrial managers are first of all reaching production and quality targets. The main preoccupation of the plant manager is to keep the production process operating as long as possible. Therefore and the relative low share of energy costs, electricity costs are of low priority.

Secondly, there is a lack of measuring equipment and therefore a lack of knowledge of the electricity costs of different processes. Because of split budget the maintenance department is responsible for bearing the costs for new parts of compressed air or pump systems or leakage control, while the savings accrue to the budget of general costs. Most motor users are unaware of the large savings potential, both technological and economic, to reduce motor system energy consumption. Therefore time and budget devoted to optimize energy efficiency of other systems than the key-production process is often zero. According to the energy managers of industrial companies these two points – lack of time and lack of budget – are the main barriers

for implementing energy saving measures. (Austrian Energy Agency, 2006)

If the decision for investigating the energy efficiency possibilities in a company is taken – often in connection with an increase in capacity or breaking down of a equipment – further obstacles have to be mentioned: In the companies there is lack of expertise to provide solutions, the plant managers are reluctant to change systems that are familiar and work satisfactorily. In bigger plants identifying saving potentials and the techno-economic evaluation of such opportunities is rather complex.

At last, when the possibility is elaborated, there are extremely high return on investment expectations based on a pay-back-period of three years. This is equivalent to an internal rate of return of 31 % for a system with a life time of 8 years, assuming constant savings over time. Plant managers and maintenance departments are fearing risks of reduced reliability and availability with new energy-saving technologies and system solutions. Shortage of capital makes it difficult for companies to invest in energy efficiency opportunities. Finally long-term, high-level decisions are to be taken on complex new system solutions affecting several departments.

On the supply side motor distributors or motor systems manufacturers respond to industrial customers, and supply equipment at the lowest first cost, rather than life cycle costs. They have no incentive to use high-efficiency motors if there is a cost penalty involved. For the customers the energy costs should be more important, as they account for more than 80 % of the life cycle costs. (IEA, 2006a, p 161-162; IEA, 2006b, European Copper Institute, 2004)

#### OVERCOMING MARKET BARRIERS

To overcome at least some of the barriers a programme has to incorporate several actions, in a coordinated approach to change the market:

- Information of the key users, to raise awareness of the saving potential
- Develop best case studies and conduct pilot audits
- Education of key users and energy auditors
- Assistance via partly financed energy audits
- Assistance for financing of resulting investments
- Work with suppliers, as ideal partners to distribute information and specific know-how

## The Motor Challenge Programme in Austria

The Motor Challenge Programme (MCP) is a voluntary programme of the European Commission (launched in February 2003) through which industrial companies receive assistance in improving the energy efficiency of their motor driven systems. In the case of appropriate national support it covers most of the instruments above mentioned. In the participating countries a National Contact Point gives information on the Motor Challenge Programme and implements marketing activities. In Austria this is the Austrian Energy Agency.

Any enterprise or organisation planning to contribute to the Motor Challenge Programme objectives can participate through submitting an action plan, which defines measures to reduce energy related operating expenses, whilst maintaining or improving reliability and quality of service.

Specific information elaborated within the programme draws the attention of the companies to the saving possibilities. The external consultant analyzes the energy consumption of the motor driven systems and calculates the costs of these systems. In contrast to the employees of the technical service department the consultant has the time to concentrate on the collection of the most important data and on the potential saving measures. With the partnership commitment form the company commits itself to carry out the described actions. Therefore the Report receives the necessary attention and the energy manger gets support for his energy saving projects. The annual reporting procedure ensures the continuous employment with this topic. The consultant supports the company in the application process for financial support for the investment. Thus investment costs and the pay-back period can be reduced.

Within the frame of Dexa MCP, a European project for dissemination, extension and application of the MCP, the following activities were set to implement this programme in Austria and integrate it in the national klima:aktiv programme, energy efficient companies:

- Energy savings in motor driven systems were chosen as the first focus of the national programme, a result of the successful MCP pilot studies.
- The technical modules for pumps, fans, compressed air and drives of the Motor Challenge Programme were fully integrated in the support tools for consultants.
- Each consultant has been provided with detailed information on MCP.
- Organization of 10 energy audits and marketing activities (articles, newsletter) for presenting the results.
- Furthermore support tools for consultants were based on these experiences and tested in the audits.

Each company audited in the national programme in compliance with the recommended tools can take part in the MCP. Therefore the measures of the audit report must be used in their action plans.

## Analysis of the results of the MCP energy audits

The following part analyzes the results of the audit campaign carried out in the framework of the Motor Challenge Programme pilot phase. The audits were conducted under the following conditions:

- Formulation of an Action Plan in compliance with the MCP technical module documents as clearly defined goal for the consultant;
- Technological modules to be chosen by the companies: compressed air, pumps, fans or drives;
- 5 days – energy audit;
- Financial support for 3 audit days;

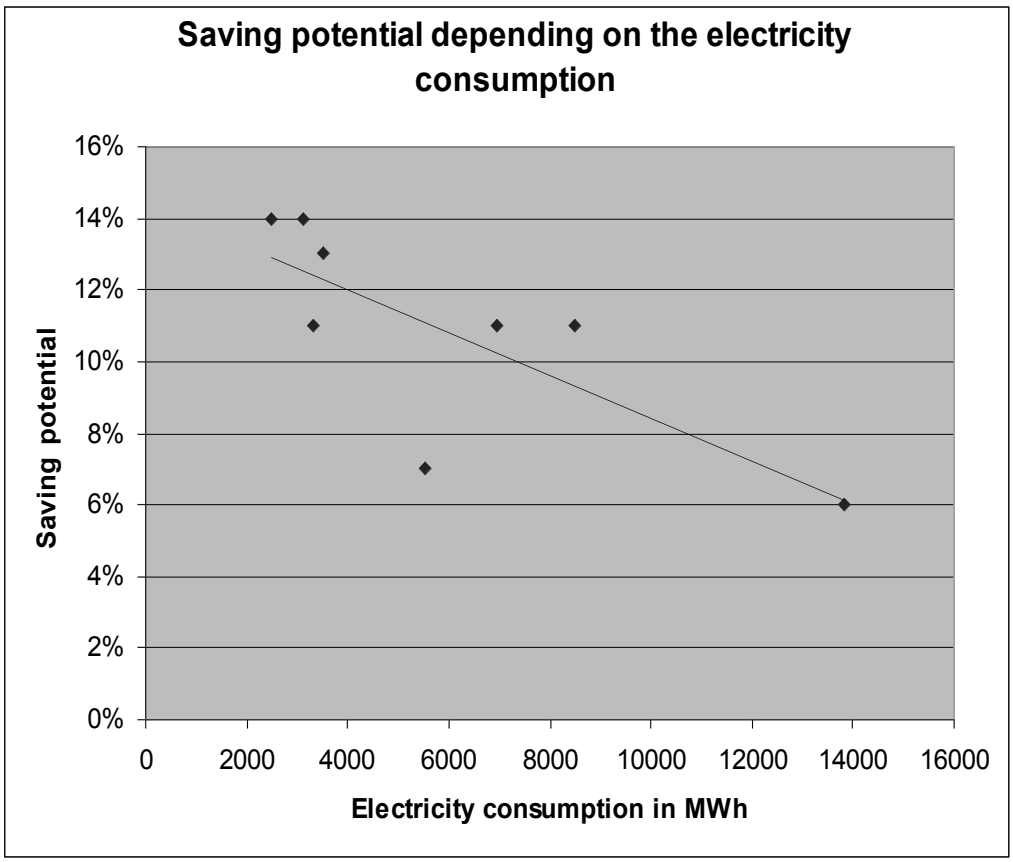


*Figure 1: Saving potential depending on the electricity demand of 8 companies*

Which potential could be detected, which technological module was the most important? Which measures were most recommended in the action plans? This section answers these questions:

#### SAVING POTENTIAL OF AT LEAST 6 % IN THE PARTICIPATING COMPANIES

The electricity demand of 8 companies could be reduced by 6 to 15 %, 12 % on average, if the action plan recommended by Sattler Energie Consulting is implemented. For one company only the compressed air system was analyzed and a specific saving potential of 20 % was identified. One company did not disclose the data for the overall electricity demand. Figure 1 shows the saving potential depending on the electricity demand. It is obvious, that the relative saving potential is bigger in companies with a smaller electricity demand. One reason could be the relative smaller time frame for the analysis of bigger companies. In addition it is clear that only companies with high expected saving potential participated in the programme.

#### TOPIC COMPRESSED AIR

During the energy audits a number of measures have been identified and were already partly implemented. Especially compressed air systems were the most important topic, which affected most industrial companies. Especially in this field the data for the energy demand and energy costs were incomplete. Leakages wasted 30 to 50 % of the compressed air produced in the companies. Hence for most participating companies measures for avoiding leakages can lead to important savings. An appropriate measure would be the implementation of a regular (quarterly) leak detection programme.

An unloaded compressor typically consumes one quarter of full load power. Depending on the running time the unload operation time accounted for 30 to 70 % of the whole running time. For all but one participating companies intelligent control systems coupled to machines of different sizes were recommended as economic measure.

After a detailed analysis of the necessary pressure level for the end use devices and the elimination of unnecessary pressure drops the pressure level could be reduced by one bar in most companies, which leads to energy savings of 7 %.

#### FANS, PUMPS UND DRIVES

For Fans and Pumps the inventory revealed that a lot of such systems did not work within the original design conditions and its best efficiency point and therefore with a lower efficiency. Inefficient throttle valves were replaced by frequency converters or by changed gear transmission ratio. Pay back periods of less than one year can be achieved.

In the field of drive systems the additional costs for the purchase of high efficient electric motors paid off within one year because of the lower energy demand during the running time.

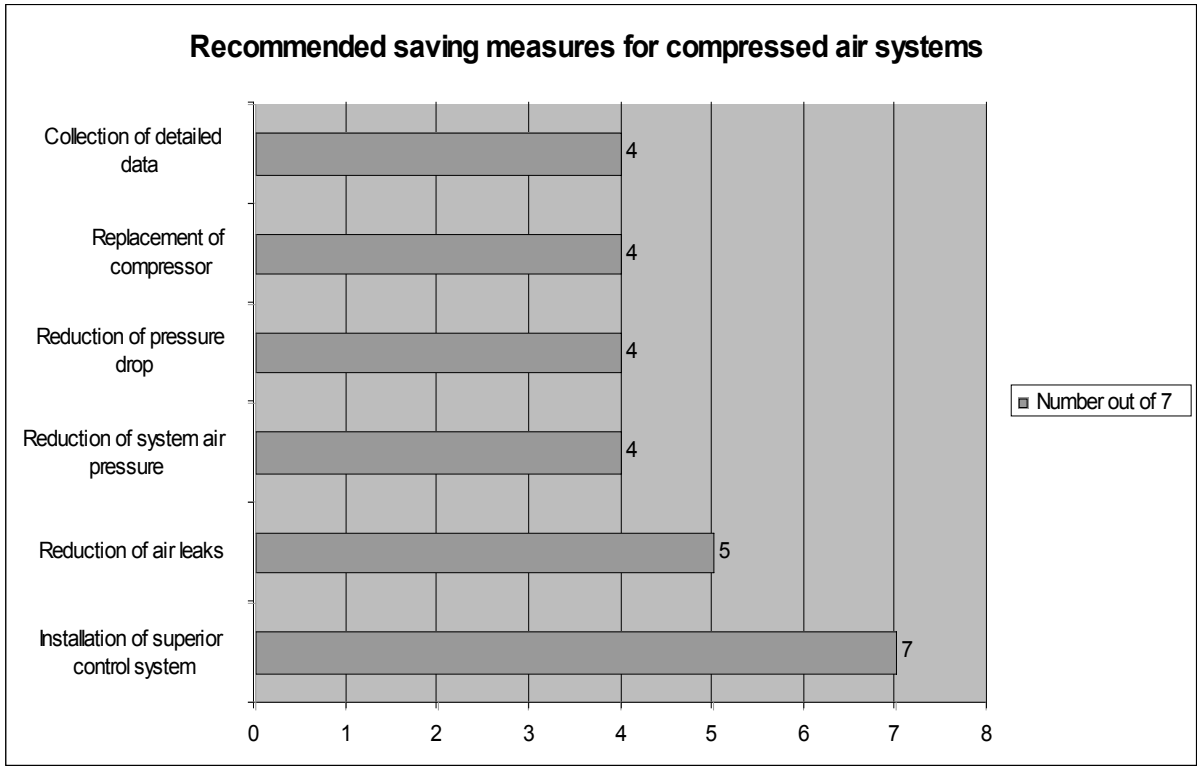


*Figure 2: Recommended measures for compressed air systems (7 companies)*

**Table 2: Results of the Knauf case study and energy audit**

| | |
|---|---|
| Cost reduction | 24,000 EUR/a |
| Cost reduction for electricity for the drying plant | 9 % |
| Investment | 3,500 EUR |
| Payback period | 2 months |
| Whole saving potential in the field of motor driven systems | about 866,000 kWh/a |
| Implementation | February 2006 |

**Table 3: Results of the Obersteirische Molkerei case study and energy audit**

| | |
|---|---|
| Enery saving | 130,500 kWh/a |
| Cost reduction | 86 % |
| Investment costs | 8,000 EUR |
| Payback period | 9 months |
| Whole saving potential in the field of motor driven systems | about 400,000 kWh/a |
| Whole saving potential in the field of motor driven systems | 34,000 EUR/a |

## Case studies

### KNAUF – FANS, CHANGE OF A PULLEY

Knauf produces on its production site in Weißenbach, Liezen building materials and construction systems, especially gypsum plaster boards, ferro concrete profiles, and different smoothing cements. The Knauf group Austria has 1,350 employees in 16 countries with 13 production sites.

In the area of the drying plant big fans are necessary to exhaust the humid air. The drying plant consists of three zones, in each zone there are two fans. The flow rate was controlled by an inappropriate vane control, which worked rather as a throttle because of its big distance to the fan. The 6 Fans of the drying plants consume 20 % of the overall electricity consumption.

By changing the size of the pulleys of the fans in zones 1 and 2 the speed and the flow rate were reduced. The reduction of the necessary power by 63 kW and the resulting energy saving led to a cost reductions of 24,000 EUR.

The investment costs of 3,500 EUR for the purchase and fitting of two pairs of pulleys paid off in only two months.

### OBERSTEIRISCHE MOLKEREI – FANS UND COMPRESSED AIR

Obersteirische Molkerei (OM) is the biggest dairy in Styria and among the 10 biggest dairies in Austria. The export quota of the main cheese product "Bergkäse" is around 45 %. The production sites are in Knittelfeld and Kapfenberg.

The combustion air fan was driven by an electric motor of a nominal power of 30 kW, which was run up by a star-delta starting. The fans caused an annual energy consumption of about 152,400 kWh.

By installation of a frequency converter the speed was reduced and the actual air flow was adapted to the necessary airflow. This action resulted in an electricity demand of only 21,900 kWh/a and energy cost savings of about 86 %.

The purchase costs of a frequency converter for the 30 kW electric motor are approximately 3,000 EUR. The costs for the installation and other fittings were about 5,000 EUR. For the whole investment of 8,000 EUR the payback period was less than one year. The maintenance costs of the frequency converter are neglected.

### LAUFEN – COMPRESSED AIR SYSTEM

Laufen Bathrooms is a part of the ROCA group which is leading in Europe and is second place worldwide in many segments of the sanitary ware market. In Austria 350 employees work for Laufen Austria AG on two production sites (Wilhelmsburg in Lower Austria and Gmunden, Upper Austria).

**Table 4: Results of the Laufen case study and energy audit**

| | |
|---|---|
| Energy saving | 128,800 kWh/a |
| Cost reduction | 8,100 EUR/a |
| Cost reduction in percent | 26 % |
| Investment | 6,000 EUR |
| Payback period | 8 ½ months |
| Whole saving potential in the field of motor driven systems | about 432,000 kWh/a |
| Whole saving potential in the field of motor driven systems | 27,300 EUR/a |
| Realization | 2005 / 2006 |

The compressed air end use devices were supplied with unnecessary high pressure levels. During the walk through audit a number of leakages were detected.

A reduction in the pressure level by 1 bar has no impact on the connected equipment but saves approx. 30,000 kWh/a without any investment costs. By closing the leakages the loss of compressed air was reduced by 50 % and resulted in savings of 100,000 kWh/a or 6,250 EUR/a.

Electricity savings in the compressed air systems bring down the running costs by 8,000 EUR/a. The investment costs of 6,000 EUR paid off in less than 9 months.

### LANDFRISCH MOLKEREI – OPTIMIZATION OF THE COMPRESSED AIR SYSTEM

The dairy Landfrisch Molkerei produces milk products since several decades. It is the Austrian market leader for cream cheese and butter specialities and the biggest cottage-cheese-producer in Europe.

The compressed air was supplied by three compressors, which were controlled by pre-adjusted pressure levels. Because of the absence of a superior "intelligent" control system for all three machines the heavy fluctuating workload and operating mode of the compressors resulted in high energy consumption. Furthermore no heat recovery system has been installed. The consultants expected in addition to those points for the pressure level and leakage reduction substantial saving potentials. The following measures were implemented:

- New aggregates with high efficient motors were installed.
- Installation of a superior control system which optimises the ratio of full load, part load and unload of the compressors and resulted in savings of 9,500 EUR/a.
- Waste heat of 150,000 kWh/a is used for heating the neighbouring hall. Referred to gas as fuel energy costs are reduced by 3,600 EUR/a.
- The reduction of the pressure level by one bar resulted in savings of 2,375 EUR/a without negative consequences to the equipment.
- The closure of most leakages led to a cut of running costs of 9,500 EUR/a.

The energy saving measures for optimizing the compressed air system bring down the running costs by approximately 25,000 EUR In two years the investment costs of 50,000 EUR will be paid off. The costs for maintenance remained unaffected.

**Table 5: Results of the Landfrisch Molkerei case study**

| | |
|---|---|
| Cost reduction | 24,975 EUR/a |
| Cost reduction in percent | 25 % |
| Investment | 50,000 EUR |
| Payback period | 2 years |
| Realization | September 2006 |

## Conclusions

The following conclusions can be drawn for consultancy services from the implementation of the Motor Challenge pilot phase, especially the 10 energy audits in the field of motor driven systems.

- Industrial companies are interested in specific energy audits and consultancy services.
- In bigger companies it is useful to concentrate on only some parts of the energy system, like compressed air or fan systems. This task can be finished in a manageable time period.
- Nevertheless the time period for consultancy services should be at least 5 days.
- The companies should pay at least 40 % of the total costs to signalize the willingness to implement energy saving measures within the company.
- An offer open for a short period of time is an additional incentive for industrial companies to use consultancy services.
- Financial supported consultancy services is a useful instrument to make companies aware of the saving potential and to reduce existing barriers for the implementation of energy saving measures in the industry.
- Standardized, specific tools for the inventory and evaluation of systems operating outside the best efficiency point are important but are still waiting for further development.

Consultancy services help to overcome especially the following barriers:

- Lack of time of the technicians for inventory of the system and evaluation of energy saving opportunities;
- Lack of awareness; by investigation of the actual costs by the consultant;
- Lack of willingness to invest; as the consultant assists the companies to find financing opportunities and fills in the application form for national financial support mechanisms.

In many industrial companies there is a high energy saving potential in electric motor driven systems, especially in compressed air systems. In spite of the participation of companies of different branches similar saving measures were recommended. A good data basis for peripheral systems within the companies is not state-of-the-art.

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