Motor Challenge Program 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 needs. The Motor Challenge Program (MCP) is a voluntary program 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 program, 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, on average, 12%.

The following measures were taken in the companies:

- Application of high efficiency motors (efficiency class 1) – potential ~8%
- Eliminating leakages in compressed air systems, reducing level of pressure, integration of a controlling system – total potential ~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

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 economically viable, and they will pay for themselves over their lifetime through reduced energy costs, however there are still major barriers to overcome.

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

A goal of the pilot phase was gaining experience in conducting energy audits in industrial companies, in the field of compressed air, fan, pump and drive systems. Basic questions as part of the auditing process were: Can a financially supported consulting service make a substantial contribution to the implementation of energy saving measures for motor driven systems in industrial companies? What time frame and what financial support is reasonable for conducting an inventory in this field? Is there a relevant saving potential in motor driven systems in Austrian companies, and what kind of technical measures are appropriate to save energy in this field?

As an additional goal of the pilot phase example case studies should be compiled for publication on the Internet. The article consists of the different parts: Firstly the significance of energy saving measures in the field of electric driven systems and the main barriers for implementation of energy saving measures which are mentioned. Secondly the Motor Challenge Program 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 program for conducting 10 energy audits in different companies. In addition to the potential savings the most important saving measures are reported. Furthermore the article lists the best case examples which were derived from this program and in the end it provides the conclusions of the energy audits for energy audit programs.

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)

Approximately two-thirds of the industrial electricity demand is accounted for by motor driven systems, at the same time there is a potential to improve the energy efficiency of industrial electric motor systems by roughly 20-25%. This does not take into account 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. The 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 these systems will provide the biggest impact in the reduction of CO_2 emission. In contrast to carbon dioxide storage, energy saving measures are already widely applied and well proven for industrial electrical motor systems, thus 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 refers to a machine (i.e. pump, fan, compressor, mixers, conveyor belts, packaging machines etc.) that is driven by an 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)

Table 1: Examples of Energy Saving Measures in Motor Driven Systems (European Commission, 2003)

Examples of saving measures	
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
	Replace of oversized pumps
Drives	Energy Efficient Motors
	Correct Sizing
	High Efficiency Transmission

These saving potentials are recognized in the political decision process: Annex III in the EU Energy Service Directive is an indicative list of examples of eligible measures to improve energy efficiency for the industry and includes for to a large part measures in the field of motor driven systems: e.g. more efficient use of compressed air, motors and drives (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:

The primary aim for industrial managers is first of all to reach the production and quality targets. The main pre-occupation of the plant manager is to keep the production process operating as long as possible. Because of this and also low energy costs, the electricity costs are a low priority.

Furthermore, due to a lack of appropriate measuring equipment and data collection it is not possible to accurately analyze and calculate exact electricity costs of specific processes. Furthermore, because of a split budget, the maintenance department is responsible for bearing the costs for new parts of compressed air, pump systems or leakage control, while the savings accrue to the budget of general costs. Quite often the consumers are not aware of the real costs and the potential savings, both technological and economical, that can be achieved in these systems and therefore neither time nor budget is allocated to optimize energy efficiency of these systems other than the key-production process. According to the energy managers of industrial companies these two points – lack of time and budget – are the main barriers for implementing energy saving measures. (*Austrian Energy Agency, 2006*)

If the decision is made to investigate possible energy savings – often in connection with an increase in capacity or breaking down of an equipment – further obstacles have to be

overcome. Most companies lack personal with the expertise to provide solutions. Managers are often reluctant to change systems that are familiar and work satisfactorily. In bigger companies identifying saving potentials and the techno-economic evaluation of such opportunities is rather complex.

After identification of potential energy saving measures one more obstacle has to be overcome: the extremely high expectations on the return of the investment based on pay-back-times of two years equivalent to a rate of a return of 50%. Managers and maintenance departments fear the risk of reduced reliability and availability with new energy-saving technologies and system solutions. A shortage of capital makes it difficult for companies to invest in energy efficiency opportunities. Also, such long-term and high-level decisions on a complex new system will most likely affect several departments.

Suppliers and manufacturers of motor systems 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 program 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 Program in Austria

The Motor Challenge Program (MCP) is a voluntary program 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 Program and implements marketing activities. In Austria this is the Austrian Energy Agency. Any enterprise or organization planning to contribute to the Motor Challenge Program 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 program draws the attention of the companies to the saving possibilities. An 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 manager has the support to implement his energy saving measures. The annual reporting procedure ensures the continuous development of 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 be implemented into this program in Austria and integrated into the national "klima:aktiv" program for energy efficient companies:

- Energy savings in motor driven systems were chosen as a first focus of the national program, a result of the successful MCP pilot studies.
- The technical modules for pumps, fans, compressed air and drives of the Motor Challenge Program 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 program 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

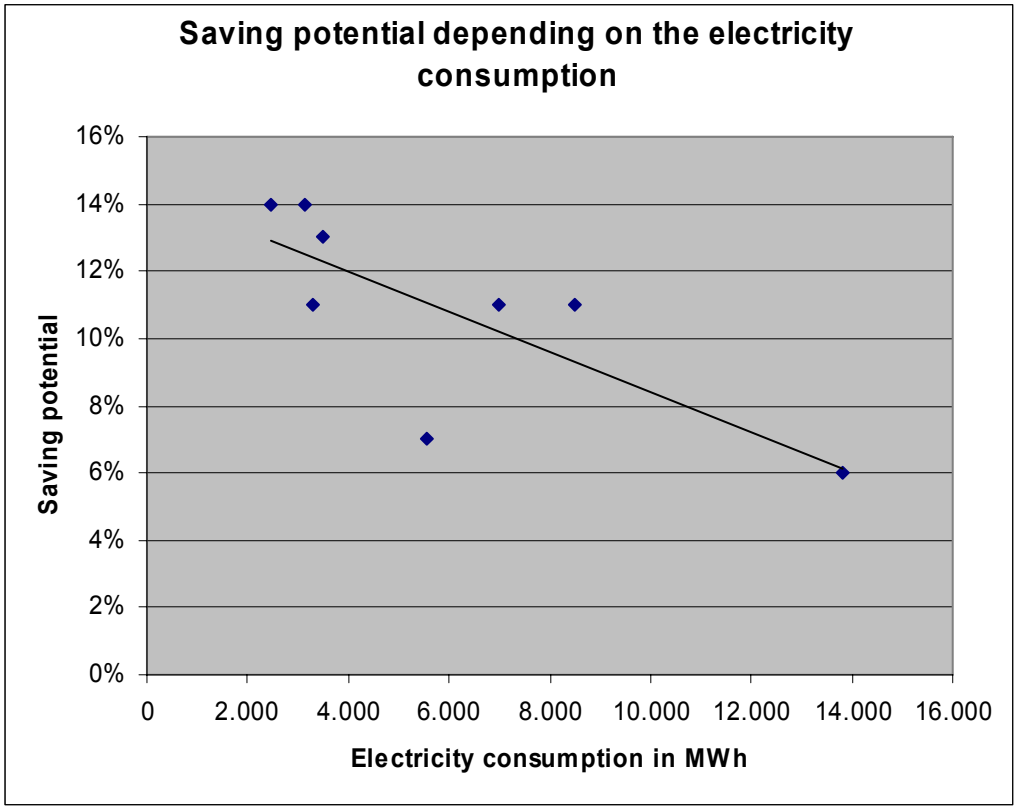
The following part analyzes the results of the audit campaign carried out in the framework of the Motor Challenge Program pilot phase. The audits were conducted under following conditions: an 'Action Plan' has to be formulated in compliance with the MCP technical module documents to provide a clearly defined goal for the consultant. After this the technological modules will be chosen by the companies (compressed air, pumps, fans or drives). Then companies got 5 days for a complete energy audit and a financial support for 3 audit days.

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

8 companies participated and their demand for electricity and the potential savings were analyzed. A reduction of 6% to 15% (12 % on average) could be achieved if the action plan recommended by sattler energie consulting was implemented. In one company potential savings of 20% were identified by only analyzing the compressed air system. Another 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 higher in companies with a smaller electricity demand. This could be due to the short time frame for the analysis of bigger companies. In addition, only companies with high expected saving potentials participated in the program and thus the results are somewhat biased.

Figure 1: Saving Potential of 8 Companies Depending on the Electricity Demand



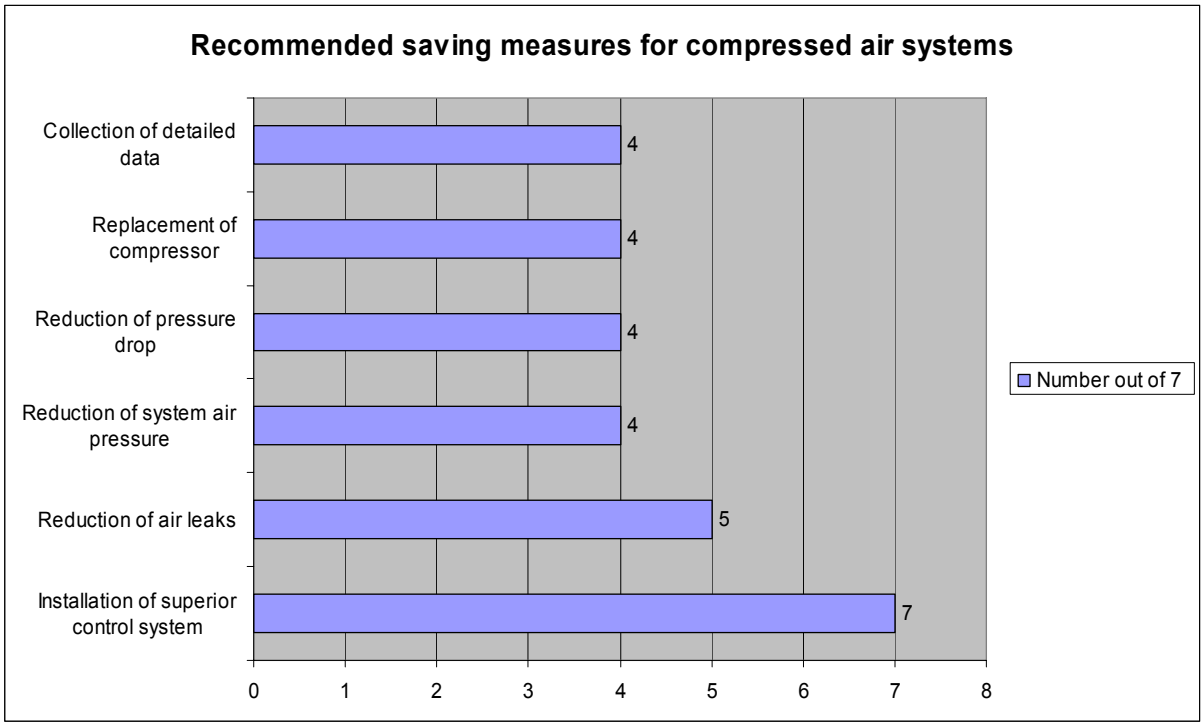
Compressed Air

During the energy audits a number of measures have been identified and were already partly implemented. Compressed air systems were the most important topic, as these affected most industrial companies. However, data on the energy demand and energy costs were incomplete. Leakages can waste 30 to 50% of the compressed air produced in the companies. Hence, most participating companies can achieve significant savings by implementing measures to leakages. An appropriate measure would be the implementation of a regular (quarterly) leak detection program.

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 total running time. For all 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%.

Figure 2: Recommended Measures for Compressed Air Systems (7 Companies)



Fans, Pumps and Drives

For fans and pumps the inventory revealed that many of the systems were not working within their original design conditions and therefore were operating with a reduced efficiency. Inefficient throttle valves were replaced by frequency converters or by a changed gear transmission ratio, and with these modifications costs can be recouped in less than one year. With regard to drive systems the additional costs involved with the purchase of high efficiency electric motors was paid off within one year through lower energy demand.

Case Studies

Knauf – Fans, Change of a Pulley

Knauf has a production site in Austria, producing building materials and construction systems, including gypsum plaster boards, ferro-concrete profiles, and different smoothing cements. The Knauf group has 1,350 employees in 16 countries with 13 production sites.

Within the drying plant in Austria large fans are necessary to remove humid air. The drying plant consists of three zones, and in each zone there are two fans. The flow rate of the fans was controlled by an inappropriate vane control, which had the effect of a throttle due to its large distance to the fan. The six fans of the drying plants consume 20% of the overall electricity consumption.

By changing the size of the pulleys operating the fans in zone 1 and 2 the speed and flow rate were reduced. This reduced the power requirement by 63 kW, and the resulting energy

saving lead to cost reductions of 24,000 EUR. The investment cost of 3,500 EUR for the purchase and fitting of two pairs of pulleys paid off in only two months.

Results

Cost reduction	24,000 EUR/year
Cost reduction for electricity for the drying plant	9 %
Investment costs	3,500 EUR
Payback period	2 Month
Whole saving potential in the field of motor driven systems	ca. 866,000 kWh/year
Implementation	February 2006

Obersteirische Molkerei – Fans and 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 combustion air fan was operated by an electric motor of a nominal power of 30 kW, which was run up by a star-delta starting. The fans consumed approximately152,400 kWh per year.

With the installation of a frequency converter the speed was reduced and the actual air flow was adjusted to provide only the necessary airflow. This installation resulted in an electricity demand of only 21,900 kWh/year, with corresponding energy cost savings of approximately 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 an overall investment of 8,000 EUR the payback period was less than one year.

Results

Energy saving	130,500 kWh/year
Cost reduction	86 %
Investment costs	8,000 EUR
Payback period	9 months
Overall potential energy saving in the field of motor driven systems	ca. 400,000 kWh/year
Overall potential cost saving in the field of motor driven systems	34,000 EUR/year

Laufen – Compressed Air System

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

The compressed air end use devices were supplied with unnecessarily 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 approximately 30,000 kWh/year without any investment costs. By eliminating leakages the loss of compressed air was reduced by 50% and resulted in savings of 100,000 kWh/year or 6,250 EUR/year. Electricity savings in the compressed air systems bring down the running costs by 8,000

EUR/year. As a result of this the investment costs of 6,000 EUR were paid off in less than 9 months.

Results

Energy saving	128,800 kWh/year
Cost reduction	8,100 EUR/year
Cost reduction in percent	26 %
Investment costs	6,000 EUR
Payback period	8 ½ months
Overall potential energy savings in the field of motor driven systems in kWh	ca. 432,000 kWh/year
Overall potential cost saving in the field of motor driven systems in EUR	27,300 EUR/a
Realization	2005 / 2006

Landfrisch Molkerei – Optimization of the Compressed Air System

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

Compressed air was supplied by three compressors, which were activated based on pre-set pressure levels. In the absence of a superior "intelligent" control system for all three machines the heavy fluctuating workload and the operating mode of the compressors resulted in high energy consumption. Furthermore no heat recovery system had been installed. The consultants felt there was a potential for savings by changes to the pressure level and leakage reduction. The following measures were implemented:

- New aggregates with high efficiency 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/year.
- Waste heat of 150,000 kWh/year is used for heating the neighbouring hall. Through reduction in gas consumption fuel energy costs are reduced by 3,600 EUR/year.
- The reduction of the pressure level by one bar resulted in savings of 2,375 EUR/year without negative consequences to the equipment.
- The elimination of most leakages led to a cut in running costs of 9,500 EUR/year.

The energy saving measures for optimizing the compressed air system bring down the running costs by approximately 25,000 EU per year, and in two years the investment costs of 50.000 EUR will be paid off.

Results

Cost reduction	24,975 EUR/year
Cost reduction in percent	25 %
Investment	50,000 EUR
Payback period	2 years
Realization	Sept. 2006

Conclusions

The European Motor Challenge Program started in 2003, and Austria´s first pilot projects started in summer 2005. To data there are 52 partners in Europe and 10 in Austria.

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

Industrial companies are interested in specific energy audits and consultancy services. Therefore in larger companies it is appropriate to concentrate on some parts of the energy system, such as 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. In taking the the program to a wide range of companies it is recommended that they contribute at least 40% of the total costs to indicate the willingness of the company to implement energy saving measures. An offer open for a short period of time is an additional incentive for industrial companies to use consultancy services. We determined that a financially supported consultancy service is a useful instrument to make companies aware of the savings potentials and to reduce existing barriers for the implementation of energy saving measures in the industry.

The standardized, specific tools for the inventory and evaluation of systems operating outside their optimum efficiency are important but are not yet fully developed.

Summary

A consultancy service helps to overcome many barriers, one of these being the lack of time available to the technicians for inventory of the system and evaluation of energy saving opportunities. Another barrier that can be overcome is the lack of awareness of the actual costs and savings available, which can be investigated by the consultant. Furthermore there is still a 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 the potential for significant energy savings where electric motor driven systems are employed, particularly in compressed air systems. These savings have the potential to be expanded from the single branches where they were tested to larger sections of the companies, and this is recommended. However information about the peripheral systems is not fully known, hence there is a lack of data to indicate the savings that may be achieved through modifications to these peripheral systems

For Austria the implementation and integration of two different programmes was chosen to overcome the barriers: the European Motor Challenge Programme and the national programme “klima:aktiv” for energy efficient companies:

In 2004 the Ministry of Agriculture, Forestry, Environment and Water Management has launched the klima:aktiv programme for active climate protection. The program combines various market-constituent measures in line with the Austrian Climate Strategy and effectuates target-oriented implementation. In addition to research and development, investment promotion as well as environmental governance, klima:aktiv introduces issue-specific and target-group oriented programs in the areas of construction and living, mobility, company policies, energy saving and renewable energy sources.

For the financing of energy audits the Austrian Energy Agency seeks cooperation with the environmental programmes of the federal provinces of Austria. The klima:aktiv management

organizes training workshops and supports consultants in these regions with detailed tools for energy audits and reports, covering all aspects and technologies of energy supply and demand in companies. Until September 2006, 60 consultants have been trained in using these tools.

Looking to Austria´s Kyoto goals it is a step in the right direction but it is still not enough. Austria´s primary Kyoto Goal was to reduce emissions at 13% in comparison to 1990. The actual statistic showed an increase of emissions about 18% compared to the database in 1990. This means a wide difference of 24.5 Mio to CO_2.

The potential of energy saving in the 10 case studies is about 9,000MWh electrical energy just in a few sections of motor driven systems and means a CO_2 equivalent of 2,900 to/year. The figures show quite great potential for Austria´s industry to reduce emissions.

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