

# 015 – EMSA--Analysis of Motor Policies around the World

Konstantin Kulterer

Austrian Energy Agency

Mariahilfer Strasse 136, 1150 Vienna

AUSTRIA

konstantin.kulterer@energyagency.at

[www.energyagency.at](http://www.energyagency.at)

Rita Werle

A+B International

Gessnerallee 38a, CH-8001 Zürich

Switzerland

[rita.werle@abinternational.ch](mailto:rita.werle@abinternational.ch)

## Abstract

Within the Project Electric Motor Systems Annex EMSA of the International Energy Agency's Implementing Agreement 4E (Efficient Electrical End-Use Equipment) a reference guide of successful programs and policies for implementing motor systems efficiency all over the world is developed. The first part consisted of reviewing existing policy instruments with focus on motor systems efficiency in the area of industrial applications. Instruments described are mandatory minimum energy performance standards – MEPS, legal or voluntary labels, energy management schemes and audit programs, rebate programs, training and education programs, financial incentives (taxes, funding schemes, credits...), public awareness raising programs and information platforms. The regions for the policy analysis included: USA, China, Australia, European Union (some European Union member countries and Switzerland). As it was not possible to consider all countries with relevant motor policies or general/industrial demand side programs, the focus were on programs of participating countries and on two major countries (US, China). The Austrian Energy Agency summarized the most relevant elements of these policy instruments in a standardized form. Aspects assessed were: program goal, calculation methods, success evaluation (e.g. energy savings), enforcement, compliance and financial considerations. In the end, recommendations for successful program design were formulated and a mix of policy measures was proposed: mandatory minimum energy performance standards, information and education and financial incentives. This paper summarizes the results of the policy overview and gives some outlooks and ideas on future motor policies.

## Introduction

Electric Motor Systems account for between 43% and 46% of all global electricity consumption. [2, p.9]. There is a potential to cost-effectively improve energy efficiency of motor systems by roughly 20 to 30%, reducing global electricity demand by about 10% [2, p.11]. Those potentials are not being realised, even if economically cost-effective. [2]

A lot of barriers exist for optimizing motor systems or for investment in efficient motor systems in industrial plants (develop, produce, sell, buy and use efficient motor systems). Already well known barriers are:

- Lack of awareness of the savings potential of motor systems (among politicians, Original Equipment Manufacturers - OEMs, production managers, etc.);
- Investments based on first-costs and not on life-cycle costs assessments;

- Lack of know-how for efficient use and calculating quickly saving potential of existing motor systems;
- Other barriers. (see for example:[2], p. 82, [4])

To overcome these barriers a combination of different policy approaches is needed. But which policy options already exist around the world and what is the experience so far?

An analysis of successful programs and policies for implementing motor systems efficiency all over the world was compiled within Task D “Instruments for coherent motor policy”, part of the Electric Motor Systems Annex EMSA of the International Energy Agency’s Implementing Agreement 4E (Efficient Electrical End-Use Equipment). The aims of this task are to:

1. Share information on what is needed to make each type of program successful, including pitfalls to be avoided.
2. Understand what mix of policies and programs are needed to achieve particular goals.

Policy Instruments with focus on motor systems efficiency included are for example:

1. Minimum Energy Performance Standards - MEPS (legal or voluntary),
2. Labels,
3. Energy management schemes and audit programs,
4. Rebate programs,
5. Training and education programs,
6. Financial incentives (taxes, funding schemes, credits...),
7. Public awareness raising programs,
8. Projects of energy service companies,
9. Information platforms.

As it was not possible to consider all countries with relevant motor policies or general/industrial demand side programs, the focus laid on programs of participating countries (Australia, Austria, Netherlands, UK and Switzerland) but also included USA, China and Sweden.

In the end, a total of 11 case studies were prepared and described in the review.

Input for the policy guide was provided on one hand by the EMSA participating countries (Australia, Austria, Netherlands, UK and Switzerland) on selected motor policy measures in their countries. On the other hand, the Austrian Energy Agency collected information on relevant policy measures in those and other countries and regions. Sources were: web, articles, conference proceedings, interviews, public statistics and personal contacts.

## **Overview of motor policy programs**

Table 1 gives an overview on the different policy approaches in different countries analysed in the Motor Policy Guide. Policy measures are divided into three main categories: mandatory actions (such as Minimum Energy Performance Standards), information & education actions and financial incentives.

**Table 1 Overview of motor policies for motors in the industrial and service sectors (more details on the programs are published in [3])**

Country Program	Financing, Management	Program Elements			Results
		Mandatory actions	Information & education	Financial incentives	
<b>Australia</b> Equipment Energy Efficiency (E3) Program	Australian Government  State and territory governments  New Zealand government	- MEPS, voluntary High Efficiency Performance Standards (HEPS) - Compliance testing in accredited laboratories - Sanctions for non-compliance: deregistration	- Awareness raising: <a href="http://www.energyrating.gov.au">www.energyrating.gov.au</a>		- 6000 motors registered for MEPS 2, 20% of these meet HEPS
<b>Austria</b> klima:aktiv energy efficient companies program	Financing: Ministry of Environment  Managenemt: Austrian Energy Agency  Financing: Regional public administration (for energy audits)		- Training of energy auditors - Audit guidelines for motor systems (compressed air systems, fans, pumps) - Template for audit report - Award ceremonies - Workshops - Conferences	Subsidies for energy audits from regional programs  Additionally on national level (not within specified program): Financial subsidies for purchase of IE3 motors	- Savings of 60 GWh p.a. (not only motor systems, for specified program only!)
<b>China</b> China Energy Label  China Energy Savings Program  China Motor System Market Transformation Program  Motor Systems Challenge	Chinese Government	- MEPS - Labeling - Lab accreditation program	- Information exchange - Awareness raising	- Financial subsidy (for highly efficient motors) - Income tax concessions	- 30% of registered motors are IE2 level (corresponding to CEMEP eff1 level)

Country Program	Financing, Management	Program Elements			Results
		Mandatory actions	Information & education	Financial incentives	
<b>Netherlands</b> Long Term Agreements (LTA)	Financing: Ministry of Economic Affairs Management: Dutch Energy Agency (former SenterNovem)		- Voluntary target for energy efficiency improvement - Measure list with motor relevance - Motor system quick scans - User groups	- Investment allowance	- 2,2% p.a. energy efficiency gains (over all technologies)
<b>Sweden</b> Programme of improving energy efficiency in energy-intensive companies	Financing: Government Management: Swedish Energy Agency		- Energy audit - List of measures - Purchasing recommendation (Life Cycle Costing) - Reporting on energy management	- Voluntary energy efficiency improvement in return for electricity tax exemptions	- Targeted savings: 1,4 TWh p.a. (75% within surrounding systems, 25% in production processes)
<b>European Union</b> Motor Challenge Programme	Joint Research Centre National Contact Points		- voluntary motor measure list (Action Plan) - Use of program logo - Awards		By 2009: - 95 Partners - 93 Endorsers - 185 GWh/a savings
<b>Switzerland</b> Topmotors Easy	Financing: Government Management: Swiss Agency for Efficient Energy Use (non-governmental organization)		- Awareness raising: <a href="http://www.topmotors.ch">www.topmotors.ch</a> - Training for energy advisers - Software tools for audits	- Incentives for audits and efficiency measures	- 17 pilot objects - 1000 newsletter recipients - 350 conference & workshop participants - 8.000 downloads
<b>UK</b> Enhanced Capital Allowance scheme	Financing: Government Management: Climate Change Levy Programme, Carbon Trust	- Government procurement	- Information, guidelines (Carbon Trust)	- 100% first-year capital allowance on energy-saving equipment - Energy-efficiency loans	- Market share of IE2 motors 15% (2009) from 5% (2001)

Country Program	Financing, Management	Program Elements			Results
		Mandatory actions	Information & education	Financial incentives	
<b>USA</b> Epact92, EISA NEMA Premium Utility Rebates	Financing: Government Management: National Electrical Manufacturers Association (NEMA)	<ul style="list-style-type: none"> <li>- MEPS</li> <li>- Labeling</li> </ul>		-Fiscal incentives for VSD and high efficient motors (from utilities)	- In 2006 NEMA Premium sales share 27%
Motor Systems Initiative Motor Decisions Matter Compressed Air Challenge Green Motor Initiative	Consortium of Energy Efficiency (Non-profit)		<ul style="list-style-type: none"> <li>- Forum for members</li> <li>- Awareness Raising</li> <li>- Trainings</li> <li>- Best practices</li> </ul>	- Financial incentives for rewind motors	- 104 TWh electrical savings, in US and Canada (not only motors)
Motor Challenge Program Industrial Technologies Program Save Energy Now, LEADER	Department of Energy's Office of Energy Efficiency and Renewable Energy		<ul style="list-style-type: none"> <li>- Information</li> <li>- Training</li> <li>- Conferences</li> <li>- Best practices</li> <li>- Free software tools</li> <li>- Government procurement recommendations</li> <li>- Assessments</li> <li>- Guidance Documents</li> </ul>		- Motor Challenge Program: 520 GWh savings (in 6 years)

## **Program elements**

Most of the programs described consist of one or more of the following elements.

### **Legally enforced minimum standards for motor system components**

Legally binding standards for efficiency of electric motors are becoming more popular and have been implemented in USA, European Union, China, Australia, Korea, Brazil and others<sup>1</sup>. Additionally, standards are set for other motor system components, such as pumps, fans and compressors in China and European Union, and are under investigation in several other economies. These minimum standards aim to remove the least efficient products from the market.

Setting legally binding national minimum efficiency standards is a significant stepping stone for progressing motor efficiency, and as an early pioneer in the adoption of standards for motors, the US has served as a role model for other countries. As other countries have followed, the focus has turned to the harmonisation of these standards with each other, and considerable progress has been achieved in the acceptance of international test methods and aligned performance levels.

Measures to improve compliance with MEPS remain an important and on-going issue at a national and international level, particularly market surveillance and the use of certified testing centres or laboratories. Significant initiatives in these areas have been adopted in Australia and China.

### **Building regulation**

The UK encourages the use of frequency converters within the building regulation. There are probably other options to support the use of efficient motor systems with similar instruments.

### **Labelling, voluntary high performance (NEMA Premium)**

Labelling is often used to increase the uptake of highly efficient motors (beyond minimum standards). Examples include NEMA Premium in the US, High Efficiency Performance Standards in Australia, IE3 in Europe, and Grade 1 Motors in China.

The labelling of high efficiency products is often coupled with financial incentives to encourage even greater uptake.

### **Purchasing recommendations (alternative LCC Analysis) for efficient motors**

Programs for Government Procurement (UK, US, others) or the recommendation for purchasing high efficient motors within programs for energy management systems (Sweden) can help to get high efficient motors in the market. This also applies to efficient design and installation services.

### **Financial incentives for higher efficient motors and the purchase of other equipment**

Financial incentives are used in China, UK and Austria, although several different approaches are employed. The key types are:

- Capital allowances (e.g. 100% first-year capital allowance on investments in energy-saving equipment in the UK);
- Loans (interest-free energy efficiency loans for the purchase of energy-saving equipment in the UK);
- Tax incentives (e.g. reduction of electricity-tax upon participation in energy-efficiency program in Sweden);
- Rebates (e.g. utility incentives for highly efficient motors in the US)

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<sup>1</sup> A list of MEPS worldwide will be soon available on [www.motorsystems.org](http://www.motorsystems.org).

- Subsidies

### **Energy audits**

Free or subsidised energy audit services are provided by many countries, often supported by audit guidelines, training, tools and audit report templates to ensure the quality of the service.

Audits tend to address the whole motor system (e.g. from compressor to the machine or tool) providing a range of recommended energy efficiency actions. To reduce the range of options to a manageable level, and in some cases also the cost, some programs focus on particular technologies, as is the case in the US, Europe's Motor Challenge Programme and Austria.

### **Training, education**

In the US and China, programs to train experts (e.g. ESCOs) in the field of energy efficiency has been used. Tertiary education (e.g. university level) was not explicitly mentioned within the program descriptions, although this would be an essential element for improving awareness and skills in motor system efficiency reaching a relatively large number of people at low additional costs.

### **Industrial energy efficiency programs with targets**

Participants of voluntary agreements with (then) binding efficiency targets are very often big industrial companies (Australia, Sweden, and others not mentioned in this report). Tax advantages are sometimes the incentive for participating in the program. For motor systems electricity targets are relevant. Within these programs other elements are integrated e.g. energy audits, energy saving targets and program monitoring, incl. measure list, and/or purchase-criteria for high-efficient motors (Sweden).

### **Energy management**

Energy Management is one of the most interesting approaches. As motor system efficiency is also a management topic, on the long run it will be improved when companies use an energy management system approach. Elements supporting the installation and use of energy efficient motor systems are: electricity saving targets and programs, purchase criteria, maintenance and repair strategy, trainings, suggestion schemes.

Once again standardization (EN 16001, ISO 50001) will improve motor system efficiency via widespread use of energy management. At the moment this approach is used e.g. in Netherlands and Sweden where purchasing criteria (e.g. CEMEP EFF 1) and/or specific measures are recommended to be used within the implementation for energy management systems. Austria published purchasing recommendations in the framework of recommendations for the implementation of energy management.

### **Awareness raising**

Raising awareness of the opportunity to improve the efficiency of motor systems is important but can be expensive and its impact difficult to measure.

Widely used instruments are: webpages, newsletters, conferences, workshops, press-releases, award-ceremonies, flyers, brochures, direct-contacts. Most programs with the main focus on awareness co-operate with motor system producers or electricity utilities to increase market awareness.

Best practice case studies are used in Austria, US, UK and Europe to transport the main message of saving electricity in motor-driven systems and convince other organisations to follow these examples. For best-practice recognition, pilot projects award ceremonies are helpful.

### **Tools for end-users**

In the US, the UK and Switzerland, self-evaluation tools, system assessment guides and tip-sheets are made freely available, often online. Other useful tools, such as databases with software and/or

user interfaces for the selection of energy-efficient motors, are found in the US and European Union. In Switzerland, specific benchmarking tools for compressed air systems are published.

## **Recommendations for a successful program**

The experience of programs surveyed provides insight into some of the key elements to the organisation and management of successful energy efficiency programs. These general observations are highlighted below.

### **1. Program planning**

Sound project planning is the vital first step towards delivering an effective market transformation program. Amongst the key issues to be addressed by a program plan are:

- What are the aims of the program and the intended duration;
- What can be learnt from other programs with similar objectives;
- How the program will be managed;
- Who is the main target group or groups;
- How the success of the program will be evaluated;
- How the achievements of the program will be measured;
- What financial and human resources will be required to deliver the program;
- Are there any capacity constraints that will limit the effectiveness of the program, e.g. skilled staff, laboratory expertise, etc;
- What other resources will be needed, e.g. information, promotion, materials, guidelines, etc;
- Which external organisations need to be involved in planning or delivering the program and what role will they have;
- How will a communications strategy be developed and implemented.

### **2. Program Duration**

Several years of implementation are necessary to maximise impact. This is due to slow turnover of motor systems technologies and the time taken to develop relationships and reach all relevant stakeholders and gain recognition.

### **3. Program Management and Recognition**

Program management should be neutral and independently financed to be recognized as an unbiased source of information.

Information provided by the program needs to be considered credible and authoritative to maximise the probability that it will be acted upon.

Brand recognition is an important part of raising awareness and promotional activities, but this takes time to establish, as has been the case for the Carbon Trust (UK), the Motor Challenge (European Union, USA) and klima:aktiv (Austria).

#### **4. Partnerships**

It is of great importance to integrate market actors to achieve the greatest possible program impact and encourage further developments. Establishing relationships with and between Government agencies, producers of motor systems and sales companies, experts, installers, service companies and energy consultants is central to most successful programs. Trade associations, chambers of commerce and industry organisations can also be useful partners and for direct contact to motor-system users it is often helpful to work with regional contacts or local energy utilities.

#### **5. Monitoring and Evaluation**

The identification of clear and measurable target outcomes from the outset, and supporting these with an evaluation strategy is a vital part of program design and management. Regular monitoring provides feedback on progress with implementation and enables the early detection of any problems or issues that require addressing.

Program evaluation, particularly when undertaken by an independent authority, is usually required to secure funding streams, or to support a case for the program to expand or be extended. Publicly reporting program results is also important to increase program recognition.

Most monitoring systems will require close contact with program participants and partner organisations, and a structure for reporting the key outcomes, such as achieved savings. Where possible, efforts should be made to minimise transaction costs, for example through online reporting mechanisms.

#### **6. Compliance and Enforcement**

MEPS and labelling programs require the implementation of systems to ensure compliance and achieve the expected economic and environmental outcomes. Efforts to maximise compliance also safeguards the investment made by end-users in more efficient equipment and protects the investment made by suppliers in order to bring this equipment to the market. Without adequate compliance and enforcement processes, manufacturers of compliant equipment will face unfair competition.

Comprehensive compliance regimes include measures to educate stakeholders of their responsibilities, market surveillance activities, verification testing and a range of enforcement actions scaled in proportion to the severity of the offence. To be effective, there is a need to establish appropriate powers of authority, and ensure that there is a sound technical basis underpinning the program requirements. This requires the use of robust methods of test (where possible, internationally recognised) and measures to assure the availability and quality testing facilities.

#### **7. International exchange**

All countries in this survey have different forms of motor policies in place. But several elements are quite similar. Therefore international exchange on experiences, strategies, monitoring, tools and so on would be very helpful. On an expert-level this is done for example by EEMODS Conferences, other possibilities are the IEA Implementing Agreements (4EM, IETS).

### **Conclusions**

It is important to increase not only motor efficiency but the motor system efficiency (including the driven pump, fan, compressor, the auxiliary components variable speed drive, gear, transmission belt, brakes, etc). How exactly motor system aspects can be integrated in national financial and/or MEPS initiatives is not obvious.

The European Commission is publishing MEPS for core motor systems like fans and pumps. These measures increase the energy efficiency of the single components but not yet of the total system or the machine in which these and all other components are integrated.

Some countries (e.g. UK, US and others) give fiscal incentives for the purchase and/or installation of frequency converters. This measure is focusing on one single, but in some cases the most relevant aspect of adjusting the motor power demand to the actual demand of the system.

However, several other aspects are also relevant, e.g. switching off on weekends or correct dimensioning of machine and motors. For this approach past and current examples are co-financed audits, guides and trainings for motor experts. The Motor Challenge Program has also shown the benefit of gaining the commitment of a company's management team in energy improvements, and such lessons should be applied to programs for motor systems.

The European Commission also published the Reference Document on Best Available Techniques (BAT Document) "Energy Efficiency", which contains a lot of information on saving measures on a system level. Those guidelines should be applied if a new IPPC - plant (according to the Integrated Pollution Prevention and Control-Directive of the European Commission) is built or extended, but the knowledge about the content of this document is not widespread among personnel responsible for the plant approval.

### **Further policy options**

C. Brunner and P. Waide suggest in [2] some interesting policy options in addition to those already mentioned in this paper depending on the barrier and technology addressed:

#### **1. Addressing efficiency of components and systems**

MEPS, Labelling, testing standards are suggested for motor system components like motors, fans, pumps, compressors, VSD but also belts and other transmission components.

Very interesting could be the approach of system-level performance requirements, for example water-pumping energy performance standards or for conveyors, elevators [2, p. 11].

This approach could also address other systems: compressor systems (e.g. kWh/Nm<sup>3</sup>), or for fans, like the Specific Fan Power requirement. Those measures could be measured regularly (e.g. annually) in addition to specific issues (e.g. maximum allowed leakage rate, or max. part load allowed). Here work is required to define the possibility of such requirements.

#### **2. Addressing missing Life-Cycle Cost approach**

Information campaign of manufacturers and OEM trade associations should make recommendations to member companies to include life-cycle cost information in their offer, to include life-cycle costing in equipment performance specification [2, p. 89], and/or to include efficiency labels for machines (e.g. only premium motors inside), [2, p. 87]

Within energy management systems purchasing recommendations should include the life-cycle cost approach (e.g. [5])

#### **3. Addressing use and optimization (replacement and enlargement) of existing systems:**

Existing processes should be monitored and equipment measured to define critical dimensioning parameters. Factory automation can be used to monitor and benchmark efficiency in production processes. Here incentives should be developed to encourage and support the correct sizing of equipment, the systematic monitoring of system performance and use. [2, p 121]

For making efficient use of motor systems mandatory or giving at least incentives for efficient use a link with macro-policy initiatives should be provided. Examples could be mandatory implementation of energy management systems (incl. motor system approaches at different levels), mandatory energy audits (incl. mandatory motor system audits), energy saving targets (incl. motor systems) within voluntary or mandatory agreements between authorities and industrial firms, refunding of electricity tax by reaching motor system saving targets or fulfilling motor system system-level performance requirements.

## Policy Recommendations

A good electric motor systems policy scheme includes a combination of three major instruments:

1. National mandatory Minimum Energy Performance Standards for motors and motor systems (pumps, fans, compressors). MEPS should be introduced based on international methods of test with a specified timeline and the minimum requirements progressively tightened. Regular reviews of MEPS levels are necessary to keep pace with technological development. Compliance with MEPS needs to be monitored, verified and – in the case of non-compliance - sanctioned.
2. Information, training and capacity building:
  - Implement energy management (top-down) and energy audit (bottom-up) schemes with focus on motor systems, efficiency-oriented planning process for new and existing installations, yearly monitoring of electricity consumption per production unit and value, efficiency target setting based on benchmarking of efficient technologies (pumps, fans, compressors). The implementation of such schemes can be enhanced by national policies making them either mandatory or voluntary (in exchange for certain benefits).
  - Training of experts. Produce guides and tools (e.g. EMSA's Motor Systems Tool, decision making tools) for on-site analysis and testing, life cycle cost assessment, investment planning and realization for improved motor systems aimed at installers, planners and maintenance engineers.
3. Financial incentives. Investments in improving old, inefficient, oversized industrial installations are hindered because of reluctance to intervene in the production process, fear of new, unproven technology and the considerable efforts (both in terms of costs and time) for assessing savings potentials of complex motor systems. Financial incentives can help to overcome these barriers and also to direct the attention of industrial plant managers to often untapped efficiency potentials in motor systems.

All instruments need to be embedded coherently into national and international energy policy frameworks.

## Outlook

Successful policy instruments on a national level are important, but not sufficient. With motor manufacturers delivering their products across the globe, the needs and risks of a global market have to be faced:

- Where not defined yet, MEPS need to be introduced. Esp. first in countries with high global share of energy consumption (e.g. Russia, India) and then stepwise in all countries.
- The level of MEPS needs to be globally harmonized to avoid parallel markets taking up efficient or inefficient products.
- Testing standards need to be globally harmonized and accepted. This process is already ongoing with more and more countries accepting the upgraded IEC standards.
- Furthermore motor audit schemes and specific performance standards for whole systems must be developed and integrated/combined with industrial energy efficiency programs. These programs must be either compulsory or give a strong financial incentive to join.

Global challenges call for a global effort. The goal of the 4E Electric Motor Systems Annex is to face these challenges and push forward market transformation on a global scale.

The Motor Policy Guide Part 1 shows examples of motor policy instruments and their assessment. Based on these, recommendations for a successful program and for a good electric motor systems policy scheme were formulated. After having closed this assessment, the next step is to identify detailed policy instruments on national and international level and thus map the road to a global market transformation towards more efficient motor systems. EMSA will work on delivering this analysis as Part 2 of the Motor Policy Guide.

## References

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- [3] Kulterer, K., Werle, R.: *Policy Motor Policy Guide, Part I, Task D Report of the Motor Annex within the IEA 4E Project*, to be published on [www.motorsystems.org](http://www.motorsystems.org), 2011
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Details on the programs and all references for the program descriptions can be find in [3]

