

Motor Policy Guide

Part 1: Assessment of Existing Policies

August 2011

The IEA Implementing Agreement on Efficient Electrical End-Use Equipment (4E)

4E is an International Energy Agency (IEA) Implementing Agreement established in 2008 to support governments to formulate effective policies that increase production and trade in efficient electrical end-use equipment.

Globally, electrical equipment is one of the largest and most rapidly expanding areas of energy consumption which poses considerable challenges in terms of economic development, environmental protection and energy security. As the international trade in appliances grows, many of the reputable multilateral organisations have highlighted the role of international cooperation and the exchange of information on energy efficiency as crucial in providing cost-effective solutions to climate change.

Thirteen countries have joined together to form 4E as a forum to cooperate on a mixture of technical and policy issues focused on increasing the efficiency of electrical equipment. But 4E is more than a forum for sharing information – it initiates projects designed to meet the policy needs of participants.

Participants find that pooling of resources is not only an efficient use of available funds, but results in outcomes which are far more comprehensive and authoritative.

The main collaborative research and development activities under 4E are undertaken within four Annexes, each of which has a particular project focus. These are:

- Electric Motor Systems (EMSA)
- Mapping and Benchmarking
- Standby Power
- Solid State Lighting (SSL).

Current members of 4E are:

Australia, Austria, Canada, Denmark, France, Japan, Korea, Netherlands, Switzerland, South Africa, Sweden, UK and USA.

Further information on the 4E Implementing Agreement is available from: www.iea-4e.org



This report has been prepared under Task D Instruments for Coherent Motor Policy of EMSA within the IEA research cooperation and performed on behalf of the Federal Ministry for Transport, Innovation and Technology.

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Disclaimer

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1 Summary

Electric motor systems are responsible for more than 40% of global electric energy demand. Technologies to reduce motor system energy consumption by 20% – 30% already exist, however, are not been fully implemented. In order to accelerate new technological developments and transform markets a comprehensive set of policy instruments is necessary.

Impressive improvements have been made in the efficiency of motors in most major economies over the past decade as the direct result of policies implemented by their respective governments. However, considerably greater financial and environmental savings are available by improving motor system efficiency, particularly in the driven pump, fan, compressor, the auxiliary components variable speed drive, gear, transmission belt and brakes. The challenge ahead is to direct national policy initiatives towards motor systems in order to realise these extremely substantial opportunities.

This document presents a survey of existing motor system policy instruments aimed at exploiting existing savings potentials in the area of motors used in industry and the service sector (in the size of 0.7 kW and beyond). The examples presented here range from a) Minimum Energy Performance Standards in effect in Australia, China, the United States of America, to b) information and education programmes in Austria, the United States of America and Switzerland and c) financial incentives in Sweden and the United Kingdom.

The programme elements so far observed are legally binding minimum requirements for efficiency, labelling, voluntary agreements, recommendations for equipment purchasing, financial incentives, information and education, awareness raising, energy audits and industrial efficiency programmes (incl. fiscal incentives), tools for assessment and optimisation decisions as well as energy management guidelines.

The success in market transformation by means of these policy instruments depends on the recognition of the programme, the clear definition of criteria for success and evaluation, the subsequent monitoring, the stringent compliance and the quality of communication directed to the target audience as well as reporting the results of the programme.

The survey found that many countries use the same concepts and similar tools to push efficiency in motor driven systems and concludes that the key elements of a motor policy should comprise several elements, including:

- National mandatory Minimum Energy Performance Standards for motors and motor system components (pumps, fans, compressors).
- Implementation of energy management and energy audit schemes with focus on motor systems
- Training of experts, providing guides and tools
- Financial incentives to encourage investments in improving old, inefficient, oversized industrial installations.

Creating successful national policies is good but not sufficient. A global market transformation requires global action: internationally harmonised testing standards and efficiency classifications as well as mandatory minimum requirements in all countries. These standards have to be developed not only for motors but also for motor systems. For new motor technologies sufficiently robust standards are the way forward. Furthermore, national programmes could benefit from international exchange.

The 4E Electric Motor Systems Annex project aims to meet these challenges.

2 Introduction

2.1 Electric Motor Systems

Electric motor systems are responsible for more than 40 % of global electric energy demand¹. They are used in industry, infrastructure and large buildings to drive pumps, fans, compressors, traction systems and industrial handling & processing equipment. By using best available technology, energy efficiency can be improved by 20 % to 30 % on average. Most improvements have a payback time of 1 to below 3 years. The potential reduction of global greenhouse gas emissions due to available energy efficiency technologies is therefore extremely large and cost effective.

In order to gain fast and efficient access to the large potential of energy efficiency improvements of motor systems the 4E Electric Motor Systems Annex (EMSA) was set up in 2009. EMSA is a project under the Implementing Agreement 4E Efficient Electrical End-Use Equipment of the International Energy Agency. Member countries of EMSA contribute to a coordinated effort towards rapid transformation of global markets by sharing information on:

- Best practice;
- New improved technology;
- Positive policy experiences.

The EMSA work is divided into the following 7 Tasks from A to G:

A	Implementation support & outreach
B	Technical guide for motor systems
C	Testing centres
D	Instruments for coherent motor policy
E	Training & capacity building
F	Energy management in industry
G	New motor technologies

2.2 Target

This guide to best practice policy instruments for implementing motor systems efficiency, based on the experience in the USA, China, Australia and Europe, has been developed under Task D «Instruments for coherent motor policy» of the 4E Electric Motor Systems Annex. This task aims to:

- Share information on the key elements that make each type of programme successful, as well as any pitfalls to be avoided.

¹ «Electric motors and the systems they drive are the single largest electrical end-use, consuming more than twice as much as lighting, the next largest end-use. It is estimated that electric motor systems account for between 43 % and 46 % of all global electricity consumption, giving rise to about 6040 Mt of CO₂ emissions«, in: Energy-Efficiency – Policy Opportunities for Electric Motor-Driven Systems, Paul Waide, Conrad U. Brunner et al., IEA Energy Efficiency Series, Working Paper, Paris France 2011

- Explain what mix of policies and programmes are needed to achieve particular goals.

This best practice policy guide analyses a range of current national or regional programmes designed to stimulate energy efficient motor systems around the globe to identify success criteria. The guide also makes recommendations for consideration by energy efficiency programme managers and/or public authority financing programmes. Several policy instruments with focus on motor systems efficiency in industry and the service sector are included in this guide, others (e.g. white certificates, projects of energy service companies) were not integrated because of budget constraints.

2.3 Methodology

A total of 11 case studies including 22 policy instruments are described and analysed in the guide, spanning nine countries.

The relevant policy measures in Australia, Austria, Netherlands, UK and Switzerland were selected by EMSA members, who also reviewed the descriptions in this guide.

In addition, the Austrian Energy Agency collected information on relevant policy measures in other countries and regions. Sources used included: web, articles, conference proceedings, interviews, public statistics and personal contacts.

2.4 Structure

The main elements of all policy instruments are summarised in a table, based on a standardised reporting structure developed by the Austrian Energy Agency. This summarises key elements of each programme, including financial considerations, efficiency gain calculation methods, enforcement, compliance, and an evaluation of the policy instruments (e.g. energy savings, success, lessons learned).

For each country or region, the summary table is followed by a brief description of the policy instrument(s). This is followed by recommendations for programme planning.

Keywords: MEPS, compliance testing

Programme Name	Equipment Energy Efficiency (E3) Programme
Web	www.energyrating.gov.au
Implementation Framework	National Framework for Energy Efficiency
Programme Start and Duration	■ 1999, ongoing ■ 2001, specifically for motors
Geographical Coverage	Australia, New Zealand
Enforcement	a) by law (MEPS) b) voluntary (HEPS)
Compliance	Check testing
Financing	Australian Government, State and Territory Governments, New Zealand Government
Costs	Registration costs for motor suppliers (depending on where the motor is registered)
Management	Australian Government, State and Territory Governments, New Zealand Government (E3 Committee)
Target Group	Motor manufacturers and importers
Technology covered	Electric motors from 0.73 to 185 kW, (2, 4, 6 and 8 poles)
Sector	All sectors
Main Instruments	a) MEPS b) High Efficiency Performance Standards (HEPS)
Other Programme Elements	Webpage
Saving Calculation	n.a.
Success Criteria	■ Motors offered for sale are registered ■ Motors meeting MEPS 2 levels ■ Share of registered motors meeting higher efficiency levels (HEPS 2)
Main Results	Motors offered for sale are registered, most motors are passing check tests and meeting MEPS 2 levels, motors meeting HEPS 2 levels are available on the market
Main Success	Nearly 6,000 motors have been registered for MEPS 2 and about 20% of these meet voluntary HEPS levels
Main Disadvantage	Education of importers is difficult

Framework

The Equipment Energy Efficiency (E3) Program uses a range of measures to increase the energy efficiency of products used in the residential, commercial and industrial sectors in order to reduce greenhouse gas emissions. These measures include regulations mandating the energy labelling of products or minimum energy performance standards (MEPS).

The programme is administered by the Australian Government (Department of Climate Change and Energy Efficiency), State and Territory Governments and the New Zealand Government (Energy Efficiency Conservation Authority). The E3 Committee, consisting of officials from the Commonwealth, State and Territory government agencies and representatives from New Zealand is responsible for managing the programme. The Committee reports to the Energy Efficiency Working Group under the National Framework for Energy Efficiency and is ultimately directed by the Ministerial Council on Energy.

Programme Description

MEPS

MEPS have been applied to three-phase electric motors since October 2001 (MEPS1) and were increased in stringency to «MEPS2» in April 2006. To ensure that products meet their declared energy rating and comply with MEPS, the E3 Committee implements a robust compliance regime. Motors must be registered on the Energy Rating website (see references) and they must meet the mandatory MEPS levels as documented in AS/NZS 1359.5:2004 before they can be sold in Australia and New Zealand. Nearly 6,000 motors have been registered for MEPS2 and about 20% of these meet voluntary High Efficiency Performance Standards (HEPS) levels.

A recent Discussion Paper «Improving the Efficiency of Industrial Equipment» sets out ideas for improving the energy efficiency of new industrial equipment such as motor-driven systems, that is, electric motors connected to equipment such as pumps and fans, and gas fuelled equipment such as boilers. The paper presents a high level analysis of the issues to stimulate input from industry. Stakeholder feedback will be used to inform the development of a 10-year strategy to address the energy efficiency of new industrial equipment. It contains technical information on how industrial equipment can be made more efficient, with ideas on how these might be implemented in Australia and New Zealand.

Check Testing

Products are not selected for check testing on a random basis. The factors taken into account in determining which models will be tested are: market share, major suppliers, sizes and poles not covered in previous check testing, re-

referrals by third parties, suppliers with history of non-compliant products. However, at this point in time, motors are generally being selected in order to sample the market.

The basic check testing process has two stages: In a Stage I check test the sample will be independently purchased and tested by a laboratory to the relevant standard. In case of non-compliance the supplier may either choose to request cancellation of registration for the model or proceed to Stage II check testing. With Stage II check testing, the supplier needs to provide the regulatory agency with details and a timetable for undertaking testing at an accredited testing laboratory.

Generally only laboratories accredited by National Association of Testing Authorities (NATA) and with a registration that permits the laboratory to issue test reports for the test in question are contracted by E3 Program to undertake check testing.

Sanctions

The major sanction for companies supplying non-compliant products is deregistration or referral to the Australian Competition and Consumer Commission. However, in a world first in 2007/2008 six companies (not motor suppliers) voluntarily entered into agreements with the government to compensate consumers and environment when their products failed MEPS and/or labelling requirements (e.g. by replacing the product with a new compliant product, purchasing greenhouse gas abatement credits).

Results

Between March 2008 and August 2010, E3 undertook MEPS2 screen tests on fifty motors from eighteen suppliers (size range 0.75 to 160 kW) which all passed the tests. This shows a high level of compliance. However, check testing has revealed that a number of motors only passed their check tests because of the allowed tolerance values. For motors with ratings up to and including 50 kW this tolerance is -15% of $(1-\eta)$, where η is the required minimum efficiency. For example the minimum efficiency is 90.1% for a 7.5 kW, 4 pole motor. Such a motor passes in a check test if it has an efficiency of only $90.1 - 0.15(100 - 90.1) = 88.6\%$. This tolerance is not available when measuring the efficiency for initial MEPS registration purposes.

Other Initiatives

Public Awareness Websites

The energy rating website (www.energyrating.gov.au) is a joint initiative of Commonwealth, State, and Territory government agencies. The website includes the government's registration database for appliances that are regulated for energy efficiency and allows consumers to compare the energy efficiency of products, e.g. three phase electric motors. This website seeks to encourage purchases at the top end of each product category.

The Department of Climate Change and Energy Efficiency has published a guide to electric motors best practice on its website (see References). This includes information on

the selection process, system optimisation issues, control strategies, etc.

Government Leadership Programmes

The Energy Efficiency Opportunities program encourages large energy-using businesses to improve their energy efficiency. It does this by requiring businesses to identify, evaluate and report publicly on cost effective energy savings opportunities. Energy Efficiency Opportunities is designed to lead to:

- improved identification and uptake of cost-effective energy efficiency opportunities
- improved productivity and reduced greenhouse gas emissions
- greater scrutiny of energy use by large energy consumers.

Participation in Energy Efficiency Opportunities is mandatory for corporations that use more than 0.5 petajoules (PJ) of energy per year. There are more than 220 corporations (incorporating around 1,200 subsidiaries) registered for the Energy Efficiency Opportunities program. This programme is managed by the Department of Resources, Energy and Tourism.

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- Personal corrections, done by Sarah Hatch, Lighting and Equipment Energy Efficiency Team, Australian Government Department of Climate Change and Energy Efficiency, Australia during Jan. Feb, 2011
- www.energyrating.gov.au
- www.climatechange.gov.au/en/what-you-need-to-know/appliances-and-equipment/electric-motors.aspx
- www.ret.gov.au/energy/efficiency/eeo/contact/Pages/default.aspx

Keywords: awareness raising, public relations, audit tools, trainings, pilot audits, co-financed audits

Programme Name	klima:aktiv, energy efficient company programme
Web	www.eebetriebe.klimaaktiv.at
Implementation Framework	Austrian Climate Strategy
Programme Start and Duration	2005, ongoing
Geographical Coverage	Austria
Enforcement/Compliance	Voluntary
Financing	Government: Ministry of Environment (annual budget decision), co-financed energy audits (via regions and national via other programmes)
Costs	300,000 EUR / year
Management	National energy agency
Target Group	Energy auditors, technology partners (e.g. manufacturers, service companies), production companies
Technology covered	Compressed air systems, pumps, fans, motors
Sector	Industry
Main Instruments	Audit guidelines, tools, trainings, information dissemination, co-financed audits via regional programmes
Other Programme Elements	Workshops, conference, newsletter, award ceremony
Saving Calculation	Specific suggestions in the audit guidelines
Success Criteria	<ul style="list-style-type: none"> ■ Energy savings (50 GWh p.a.) ■ Number of training and conference attendees ■ Number of best practice case studies produced
Main Results	<ul style="list-style-type: none"> ■ 60 GWh energy savings p.a. (not only motor systems) ■ 200 different persons trained (yearly 1–4 trainings, 10–15 training days, more than 500 participants) ■ 100–200 attendees per conference ■ 72 best practice cases
Main Success	Highly positive feed-back to trainings

Main Disadvantage

- Savings are not evaluated on company and measure level (e.g. for audits incl. measures)
- Audits or energy concepts not stipulated by law, therefore difficult to determine programme impacts

Framework

In 2004 the Ministry of Agriculture, Forestry, Environment and Water Management launched the klima:aktiv programme for active climate protection. The programme combines various market-based measures in line with the Austrian Climate Strategy and leads to target-oriented implementation. One of several Austrian klima:aktiv programmes within the Austrian Climate Strategy is the national programme for increasing energy efficiency in companies, which started end of 2005 under the management of the Austrian Energy Agency on behalf of the Ministry of Environment. The target group of the energy efficiency programme is production companies (SMEs, industry) in the whole region of Austria. Its major target is to reduce energy consumption in industry by at least 50 GWh per annum (each year). Target-oriented information and specialised consulting are the main instruments to raise the awareness of energy saving measures in companies.

Programme Description

Target-oriented Marketing

A wide range of marketing activities are used to make industrial companies interested in reducing energy costs, including direct contact and site visits, a newsletter for energy managers, a webpage with all relevant information (www.eebetriebe.klimaaktiv.at) and best case studies, articles, organisation of seminars in cooperation with the chamber of commerce and different branch associations. Other activities are an award ceremony at the annual energy efficiency conference for production companies, target agreement of companies for committing to implement economic saving measures, benchmarking (on a company level) and cooperation with suppliers of efficient technologies.

Tool Development and Trainings

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

For the different steps in the audit process different tools have been developed, as follow:

An **Energy Check Simple** is based on questions regarding all technologies and gives a first idea of possible saving options in all areas within a company (from lighting, IT to steam systems, incl. all motor systems).

An excel tool (**Pro Tool**) has been developed to assist consultants to identify the major possibilities for energy savings and to define the area for further detailed energy audits.

The **detailed approach** is dedicated to motor driven systems. At the moment three technologies are highlighted: compressed air, pump and ventilation systems. For each technology the following tools have been developed together with supplier companies:

- guidelines for the auditing process focused on the evaluation of the top saving measures, datasheets for on-site visits and a calculation methodology for the evaluation of saving measures;
- folder for decision makers with main arguments for saving measures in the relevant areas;
- training of consultants all over Austria (around 60–80 participants each year for each technology);
- a standard template for reports.

Consultants make a system audit and send the report to the Austrian Energy Agency. Those consultants have been listed on the website, e.g. as klima:aktiv compressed air consultants.

For the different technologies the programme seeks cooperation with the main technology and service providers, such as:

- KAESER, SMC Pneumatic and OETIKER, Atlas Copco, Druckluftoptimierung for compressed air
- Grundfos, Technical University Graz, Andritz, WILLO, Technical University Graz for pumps
- Ziehl Abegg, Bösch for fans
- Danfoss, Schneider Electric pdrive for motors and frequency converters

Some of these are also klima:aktiv energy-efficient company programme technical partners (and have the right to use the klima:aktiv logo).

Recent Developments

Improving the efficiency in electric motor systems is one part of the Austrian energy concept (national energy strategy) for industrial users. The goal is to give fiscal incentives for investments in efficient motors and frequency converters (investment support). The national subsidy bank (Kommunalkredit Public Consulting – KPC) has developed a subsidy scheme for the purchase of efficient electric motors and frequency converters.

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- www.eebetriebe.klimaaktiv.at

Keywords: MEPS, compliance testing, financial subsidy, workshops

Programme Name	China's energy efficiency labelling program (other programmes described in full text see below)
Web	n.a.
Implementation Framework	Energy Conservation Plan
Programme Start and Duration	n.a.
Geographical Coverage	China
Enforcement/ Compliance	By law / Check Testing
Financing	Government
Costs	Producers register their products free of charge in the labelling scheme
Management	<ul style="list-style-type: none"> ■ China National Institute of Standardization (CNIS) ■ Other Participants: National Development and Reform Commission (NDRC), Administration of Quality Supervision (AQSIQ), Certification and Accreditation Bodies (CNCA)
Target Group	Motor manufacturers, importers
Technology covered	Motors, pumps, fans, air compressors
Sector	All sectors
Main Instruments	MEPS, labelling, testing, lab registration
Other Programme Elements	Awareness raising, trainings (China Motor System Market Transformation Programme, China Motor Challenge)
Saving Calculation	Efficiency gain between different motor grades
Success Criteria	<ul style="list-style-type: none"> ■ Market share of grade 1 (IE2) motors
Main Results	<ul style="list-style-type: none"> ■ Share of grade 1 motors registered: around 30% ■ High response to motor user workshops
Main Success	n.a.
Main Disadvantage	Compliance checking will always be the most challenging task

Regulatory Framework

Electric motor systems are responsible for 60 % of China's total industrial electricity consumption. The Chinese government has formulated a number of policies, laws and regulations on energy conservation since 2000, and those particularly relevant to motors and motor systems include:

- The **11th Five Year Plan** for National Economic and Social Development has set the goal of cutting energy consumption per unit of GDP by 20% by 2010 (compared to 2005 levels).
- In 2006 the National Development and Reform Commission (NDRC) initiated the ten major energy conservation projects of the **China Medium and Long-Term Energy Conservation Plan**, including motor driven systems. The plan requires for example accelerated elimination of inefficient motors or use of variable speed drives (VSD). During the five-year plan period operating efficiency of motor systems will be raised by two percentage points.
- Article 31 of the **Energy Conservation Law of the People's Republic of China** (2008) provides that the state encourages industrial enterprises to adopt efficient and energy-saving motors, fans, pumps and other equipment.
- The crucial points in the 2008 Decision of the State Council on **Further Strengthening Energy Conservation of Oil and Electricity** are: inventory of to-be-eliminated motors and motor-driven equipment, **policy incentives to be introduced**.
- In 2008, the Ministry of Finance (MOF) and NDRC introduced a **fiscal tax reduction** for manufacturers who produce highly efficient motors (and 12 other products).
- In 2009, the MOF and NDRC initiated the **China Energy Savings Program**, which provides subsidies for highly efficient products. Motors have been taken on the list of subsidized products in 2010.
- The second revision of the **motor energy efficiency standard GB 18613** is finished. The standard is expected to be published by the government at the end of 2011. It is the first standard which officially adopts **IE4** as one motor efficiency level.

Programme Description

1. MEPS

China has a long history in setting minimum energy efficiency standards and started with household refrigerators and room air conditioners in 1989. In 2006 an updated version of the 2002 standard for three-phase asynchronous motors set MEPS levels corresponding to CEMEP EFF1 or IE2 motors, and identified grade 1 motors as the most efficient motors corresponding to the Australian standard (approximately IE3). A second revision of the standard in 2010 updated the efficiency classification so that grade 3 will directly correspond to IE2 and grade 2 to IE3. Grade

1 will be reserved for IE4 (IE3 with 15 % loss reduction). Other energy efficiency standards in the field of industrial equipment are for pumps (2008), for air compressors and fans (2009). The final draft of the energy efficiency standard for small motors (e.g. fan motors for room air conditioner from 6 W) is in the process of notification.

2. Labelling

China's energy efficiency labelling programme covers 23 domestic, commercial, lighting and industrial products, including medium- and small-sized three-phase induction motors, electric fans, air compressors, electric transformers and ventilation systems.

For motors, 658 suppliers and over 43,000 models are registered in the database of the China Energy Label System. In 2009, the share of registered grade 2 motors (IE2) was 2.2%, in 2010 this share increased to 30%. The number of grade 1 motors increased from 0.1 % in 2009 to almost 1 % in 2010.

Originally the scheme was based on self-declared information from suppliers. The information came either from suppliers' own laboratories or from independent bodies.

The China National Institute of Standardization (CNIS) has subsequently sought to improve quality of technical information by undertaking round robin tests between laboratories, checking the consistency of testing results, and implementing an accreditation programme for laboratories. China has also developed a national reference laboratory to provide comprehensive compliance product testing and empirical data research in support of energy efficiency standards and labelling. It serves as arbitration lab in the context of testing results dispute. The capacity for motor testing is currently being built up.

3. Other Support-Mechanisms

The large national **financial subsidy** programme, China Energy Savings Program, was launched in June 2009. The programme will provide financial subsidies to cover the price difference between high and low efficiency products. The goal is to encourage product manufacturers to promote highly energy efficient products and give consumers an additional financial incentive. Motors have been included since June 2010. Manufacturers shall establish a reporting system to enable monitoring of market transformation.

Enterprises are entitled to **income tax concessions** in accordance with the tax law if they buy and use efficient motor technology or other products included in the Corporate Income Tax Concession Inventory of Energy and Water-Saving Equipments (2008).

Government procurements must be made in line with the Government Procurement List of Energy-Saving Products, where 34 product categories are listed, from which 9 product category recommendations are compulsory.

The **China Motor System Market Transformation Program** supports four motor system energy conservation service agencies in capacity building, equipment procurement,

technical training, plant assessment and case studies to build up their capacity to provide better services to companies. The programme has developed optimisation design codes, supported standard development, provided training and education in 7 provinces and cities.

A programme for establishing mechanisms for the **adoption of highly efficient motor systems** will include measures like awareness raising of decision makers, developing practical tools for evaluation and analysis, proposing innovative financing mechanism through Clean Development Mechanism (CDM).

The **China Motor Challenge** project is co-funded under the SWITCH-Asia Programme of the European Commission. The project will establish a national information platform for Chinese motor system users, energy service companies (ESCOs), electric motor manufacturers and energy-saving administrations. The main activities are the establishment of a motor systems challenge club, organisation of eight large end user workshops, holding annual award ceremonies, ESCOs training, policy workgroup meetings and the promotion of the new motor energy efficiency label. The programme facilitates improving the motor systems of 400 major industrial electric motor users.

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Keywords: deduction of profit tax, measure list, user groups

Programme Name	Long Term Agreement (LTA) Energy Investment Allowance (EIA)
Web	www.agentschapnl.nl
Implementation Framework	Agreement between government, industry and (industrial) branch organisations
Programme Start and Duration	2003 to 2010/2011
Geographical Coverage	Netherlands
Enforcement/ Compliance	Voluntary on branch level
Financing	Government
Costs	150 FTE (Full time equivalent) staff, Energy and Climate programme funded by NL Agency
Management	NL Agency, Ministry of Economic Affairs
Target Group	Industrial companies with energy consumption above 140 GWh or 280 GWh per year for branch organisations
Technology covered	Motor systems (included in measure list)
Sector	Industry, transport, service sector
Main Instruments	Energy efficiency plan, efficiency targets, commitment for implementation of measures, measure list, energy management system, annual monitoring
Other Programme Elements	User groups, energy investment allowances
Saving Calculation	No
Success Criteria	<ul style="list-style-type: none"> ■ Number of participating companies ■ Energy savings
Main Results	<ul style="list-style-type: none"> ■ 900 companies participating ■ 55 TWh energy saved up to now ■ Average efficiency gain 2.1 % p.a.
Main Success	Broad outreach to Dutch companies, anchoring energy efficiency approach in energy management system
Main Disadvantage	n.a.

Framework

Long Term Agreements have become the main policy instrument for industrial energy conservation and CO₂ emission reduction in the Netherlands. The objective of these agreements is to improve industrial energy efficiency without a negative effect on economic growth or the competitiveness of Dutch trade and industry. The executive responsibility of the programme has been delegated to the Dutch Energy Agency. By signing an LTA, the industrial branches (or individual companies) agree to achieve a specified percentage improvement in energy efficiency. Every company or institution that takes part in a LTA sets out its energy efficiency targets in an Energy Efficiency Plan (EEP), linked to specific measures and a schedule for the realisation of these targets. The plan also shows how the company determines its energy efficiency index. With these measures the company creates the basis for the development of the energy paragraph in the environmental licence. NL Agency performs an assessment to determine whether the EEP meets the requirements. Companies are also required to submit yearly progress reports including details on the implementation of systematic energy management.

For every sector the Dutch Energy Agency (under the Dutch Ministry of Economic Affairs) has developed a specific list of energy efficiency measures. The contents of the Motor Challenge Programme modules (see page 14 European Union) are integrated in the new measure list for the LTAs. To develop further measures for motor systems within the EEP, a system efficiency quick-scan is undertaken to identify options.

User Groups

User groups are a support instrument within the LTA programme in which different companies from one sector are brought together in order to improve the energy efficiency of a pre-selected subject, like compressed air. The aim is to share and exchange information on the subject and to work together towards energy efficient solutions. An experienced energy consultant supports the group. A user-group runs for one to two years and has three to five meetings.

Energy Investment Allowance

This tax relief programme gives a direct financial advantage to Dutch companies that invest in energy-saving equipment and sustainable energy. 44 % of the annual investment costs of such equipment (purchase costs and production costs) are deductible from fiscal profits over the calendar year in which the equipment was procured.

The «Energy List» determines which types of equipment qualify for this programme. The programme includes the costs of obtaining energy advice, provided that the advice

results in an investment in energy-saving equipment. The report detailing the action plan for electric motors, following the example of the European Motor Challenge Programme, is also included in this list (see section European Union).

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Sweden

Keywords: electricity tax relief, certified energy management system, energy audits, measure list, purchase of highly efficient motors

Programme Name	PFE – Programme for Improving Energy Efficiency in Energy Intensive Industries
Web	www.energimyndigheten.se/pfe
Implementation Framework	Electricity tax
Programme Start and Duration	2004, ongoing
Geographical Coverage	Sweden
Enforcement/ Compliance	Voluntary (but tax incentive to join)
Financing	Government
Costs	7 million SEK (approximately 640,000 EUR) p.a.
Management	Swedish Energy Agency, Swedish Tax Authority, Programme board (with branch associations and others)
Target Group	Energy-intensive production companies
Technology covered	Electricity using processes and systems, including motor systems
Sector	Industry
Main Instruments	<ul style="list-style-type: none"> ■ Energy audit, analysis, energy management, carrying out saving measures (with payback less than 3 years) ■ Purchasing criteria for equipment with high electricity consumption (especially motors)
Other Programme Elements	Handbooks on energy management systems, on energy audits and analysis, on routines for purchasing and planning, calculation of Life Cycle Costs (LCC)
Saving Calculation	Suggestion for LCC, handbook on analysis available
Success Criteria	<ul style="list-style-type: none"> ■ No clear target defined (tax incentive to join) ■ Targets for energy savings on company level (1.4 TWh p.a.)
Main Results	<ul style="list-style-type: none"> ■ Approximately 90 companies participating ■ Energy saved: 770 GWh p.a. saving reported in 2010

Main Success	<ul style="list-style-type: none"> ■ Energy becomes a topic for high-level management decisions, increased knowledge on energy use ■ Better understanding between companies and authorities
Main Disadvantage	Attracting large industrial companies only

Framework

On 1 July 2004, the tax on industrial process-related electricity was raised from 0 to 0.5 EUR per MWh. The tax rise does not affect manufacturing processes in the following sectors: metallurgy, electrolysis, chemical reduction. The Directive gives energy-intensive companies in manufacturing industry which are subject to the tax the opportunity of being granted tax exemption on their electricity consumption if they take action to improve their energy efficiency.

Programme

For tax exemption, companies can voluntarily join the PFE (Programme for Improving Energy Efficiency in Energy Intensive Industries). The programme period for participating companies is five years, and over the first two years, the company must introduce and obtain certification for a standardised energy management system.

Energy audits and analysis are used to generate a list of measures to improve energy efficiency, which the company then implements during the remaining three years of the programme. Since PFE focuses on electricity-efficiency, the priority is to list measures to improve the efficiency of electricity use. Companies must follow specified routines for planning and purchasing electrical equipment, such as the calculation of life cycle costs and the selection of highly efficient electric motors.

When a company has participated in PFE for two years, it is required to submit a report via the Swedish Energy Agency's e-services on the energy audit, the energy management system, and the list of measures. By the end of the programme period, the companies have to show that they have achieved an improvement in the efficiency of their electricity consumption.

Results

117 companies out of 1200 energy intensive companies in Sweden have joined the programme. Participants mainly represent the following sectors: pulp and paper, wood product, chemical, food and beverages, steel, iron and metallurgy, ore and mining. A total of 860 measures were reported within the mid-term reports, achieving savings of 726 GWh. Among the measures, around 25% are within the production processes (accounting for 50% of the sav-

ings) and 75 % are within surrounding systems, such as pumps, fans, compressed air systems, lighting and ventilation. The results from 2009 indicate that:

- Optimisation of pump systems accounted for the largest part (23 %) of the measures, 90 % of them were reported by pulp- and paper companies. Oversized and unnecessary pumps were the main cause of energy loss. The share of reported savings is 18 %.
- Detection of leakages, removing of compressing equipment and usage of waste heat from compressors represented the fourth biggest savings area (after processes, pumps and others). The share of savings, including vacuum systems is 10 %.
- Change of motors with higher efficiency and control of motor driven equipment account for 6 % of the savings.
- Measures in fans and other motor driven systems mostly involved the installation of variable speed drives (VSD) and accounted for 3 % of savings.

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Keywords: branding initiative, voluntary agreement

Programme Name	European Motor Challenge Programme (MCP) Promoted by two European projects: Dissemination, Extension and Application of the Motor Challenge Programme (DEXA-MCP) Energy Efficient Electric Motor Systems in New Member and Candidate Countries (4EM-MCP)
Web	http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/index.htm
Implementation Framework	<ul style="list-style-type: none"> ■ MCP: Programme of the European Commission ■ DEXA-MCP, 4EM-MCP: Projects under the Intelligent Energy–Europe programme
Programme Start and Duration	<ul style="list-style-type: none"> ■ MCP: 2003, ongoing ■ (DEXA-MCP: 2005-2007, 4EM-MCP: 2006-2008)
Geographical Coverage	Europe
Enforcement/Compliance	Voluntary/Reporting
Financing	European Commission, Intelligent Energy – Europe programme
Costs	Current (running) costs not available; Costs of IEE projects supporting implementation: <ul style="list-style-type: none"> ■ DEXA-MCP: EUR 1,836,524 ■ 4EM-MCP: EUR 670,110
Management	<ul style="list-style-type: none"> ■ Joint Research Centre, Institute for Energy ■ National Contact Points
Target Group	European industrial companies
Technology covered	Compressed air systems, pump systems, fan systems, refrigeration systems, drives (electric motors and speed controllers), electrical distribution
Sector	Industry
Main Instruments	Action plan, promotion plan
Other Programme Elements	<ul style="list-style-type: none"> ■ Award ceremony ■ Further elements depending on national context, e.g. action plans within national programmes can be used as MCP plans, financing of consultancy for MCP Action Plans

Saving Calculation	Some principals in module documents
Success Criteria	<ul style="list-style-type: none"> ■ Number of participants ■ Energy saved
Main Results	By the end of 2009: <ul style="list-style-type: none"> ■ 93 Partners ■ 93 Endorsers (2010) ■ 289 measures reported ■ 185 GWh annual savings ■ Programme logo widely known
Main Success	<ul style="list-style-type: none"> ■ Network of National Contact Points established ■ Motor efficiency integrated in national frameworks (own financing and programmes)
Main Disadvantage	<ul style="list-style-type: none"> ■ No continuous financing ■ Not as well-known as the European GreenLight Programme or the European GreenBuilding Programme

The **European 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.

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.

The Motor Challenge Programme is designed to be:

- flexible and open, so as to be applicable to the great variety of user situations;
- sufficiently precise to ensure that companies that carry out the commitment will achieve a significant part of potential energy savings;
- adaptable to the large variety of national programmes and agencies.

The Motor Challenge Programme is based on voluntary commitments, defined by each participating enterprise and organisation, on the basis of recommendations put forward in the «Motor Challenge Module Documents» treating different aspects of Motor Driven System energy efficiency.

An organisation wishing to become an **Endorser** of the Motor Challenge Programme formulates a «MCP Promotion Plan». This plan specifies actions to disseminate information on the MCP; to encourage user enterprises to become MCP Partners and aid MCP Partners in putting into practice the recommendations of the relevant MCP «Module» documents. This plan is approved by the Commission and Endorser status is granted. Endorsers are also required to

provide an annual report on activities. The endorser concept is open to organisations that intervene in some aspect of the design, building or operation of Motor Driven Systems, e.g. manufacturers, engineering consultancies, trade associations, training institutions, etc.

Companies that use Motor Driven Systems can request **Partner** status. Through the Motor Challenge Programme, they will receive:

- aid in defining and carrying out an Action Plan, to reduce energy related operating expenses, while maintaining or improving reliability and quality of service;
- public recognition for their contribution to achieving the objectives of the European Union's energy policy.

A Partner has to formulate an Action Plan defining the scope and nature of the enterprise's commitment. This Action Plan contains measures that are linked with the separate «Module» documents for compressed air systems, pump systems, fan systems, refrigeration systems, drives (electric motors and speed controllers), electrical distribution and a transversal module covering management policies for all the above components of motor systems.

Endorsers, in co-operation with their Partners, will be invited to provide documentation of showcase installations that the European Commission will publicise, providing details on energy savings realised by the installation. Each participating country has a National Contact Point, which gives information and support on the MCP.

Results

In total, the 93 MCP Partners stated 289 different energy efficiency measures related to areas relevant for motor systems. The area with the highest number of measures was the genuine MCP core area of «drives» (motors and variable speed drives), followed by «compressed air» and «fans and ventilation».

In total, all MCP measures resulted in an estimated annual energy saving of 185 GWh and savings of 87 thousand tons of CO₂ emissions per year, representing an estimated 0.02% reduction of the total electricity consumption by industry in the EU 27.

The highest energy savings yielding single measure was «pump selection», in the area of pumps. The second and third most successful measures were implemented in the area of drives, including the upgrading of motors from lower to higher (to CEMEP EFF1 or EFF2) efficiency classes. The top three measures alone account for 48% of the estimated total savings.

Selected partners and endorsers were given MCP awards at the Energy Efficiency in Motor Driven Systems (EEMODS) conferences in 2005 and 2009. A network of National Contact Points has been built up within two European projects (DEXA MCP, 4EM-MCP) and these have integrated the main elements of the MCP tools and principles into their national programmes.

Based on the evaluation of a written questionnaire by MCP Partners, the scheme received a highly positive feedback from the Motor Challenge Partners. 41% of the respon-

dents saw the Motor Challenge Programme as instrumental in convincing the company to implement energy efficiency measures.

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Switzerland

Keywords: awareness raising, information exchange

Programme Name	Topmotors
Web	www.topmotors.ch
Implementation Framework	SwissEnergy, Swiss Federal Office of Energy
Programme Start and Duration	2007, ongoing
Geographical Coverage	Switzerland
Enforcement/Compliance	Voluntary
Financing	SwissEnergy, Swiss Federal Office of Energy
Costs	Euro 200,000 p.a. (2010)
Management	Swiss Agency for Efficient Energy Use (S.A.F.E.)
Target Group	<ul style="list-style-type: none"> ■ Manufacturers, Original Equipment Manufacturers (OEMs), importers, industrial and infrastructure plants, large building owners ■ Universities for applied sciences and testing labs
Technology covered	Electric motors and motor systems
Sector	Industry, infrastructure, services
Main Instruments	<ul style="list-style-type: none"> ■ Advisory service, education/training, best practices and pilot audits ■ Tools and software for audit ■ Website, workshops, training of energy auditors
Other Programme Elements	Bi-annual international conference (Motor Summit), motor measurement programme with testing labs
Saving Calculation	Excel tools for savings potential evaluation (SOTEA) and for motor stock analysis (ILI+), software tool OPAL for cost-effective energy consumption reduction of motor-driven pump systems
Success Criteria	<ul style="list-style-type: none"> ■ Number of pilot projects (plants, buildings) with energy efficiency measures implemented ■ Number of newsletter recipients ■ Number of conference and workshop participants ■ Number of software tool and training and information material downloads

Main Results	By early 2011: <ul style="list-style-type: none"> ■ 17 pilot objects ■ Over 1 000 newsletter recipients ■ Total 350 participants in Motor Summit 2008 and 2010 and at Topmotors workshops ■ A total of almost 8 000 downloads (software tools, information sheets, etc.)
Main Success	Build-up of knowledge network of motor users and service companies in Switzerland
Main Disadvantage	Difficult to evaluate energy savings (no direct contact with pilot objects, no follow-up on energy savings at pilot projects)

Framework

45% of Swiss electricity consumption is used by electric motors, equivalent to 26 TWh. The overall electric energy saving potential is around 20% (5 TWh), while the economic saving potential is estimated at 2 TWh.

The overall Swiss energy strategy is based on four pillars, defined by the Federal Council:

- Energy efficiency;
- Renewable energy;
- New large power plants;
- International energy policy.

The national programme (for energy efficiency and renewable energy) is called SwissEnergy and is run by the Swiss government, represented by the Swiss Federal Office of Energy (SFOE). It comprises the elements: labelling, information dissemination, awareness raising, advisory service, education and training. Minimum energy performance standards (MEPS) are implemented as separate legal act, e.g. for electric motors and other appliances (see energy ordinance 730.01).

Programme Description

The Swiss Agency for Efficient Energy Use (a non-governmental organisation) started the implementation programme «Topmotors» in 2007, and will continue for the second period from 2011 – 2013.

Topmotors targets organisations using electric motor driven systems in industry, infrastructure and large buildings. The goal is to reduce their energy consumption by improving motor system efficiency. The main content of the programme is: information dissemination, advisory service, education/training, best practice and pilot audits.

As a voluntary programme, Topmotors provides information and methodologies for participants to use. Power utilities (BKW, EKZ), industry associations (Swissmem, SwissTnet, ProKlima), non-governmental organisations

(EnAW) and OEM manufacturers are involved as partners. One goal is to set up a network of testing laboratories. Swiss companies can enter into a voluntary agreement with EnAW, committing to reach certain energy saving targets by implementing energy efficiency measures. The goal is to reduce their CO₂ emissions. Any company engaging in this activity can benefit from lower CO₂-taxes. Topmotors organised trainings for the EnAW moderators who are key multipliers in the implementation of these voluntary agreements. In addition, special trainings for motors and pump checks, training for energy consultants and a workshop for on-site measurements were organised. The following tools and information material were developed so far:

- List of manufacturers providing efficient motors;
- Price list (frequency converters, IE1, IE2, IE3 motors);
- Information on partial load and motor efficiency;
- Software for evaluation of energy savings in motor systems:
 - SOTEA («Software Tool für effiziente Antriebe»): top-down estimation of energy efficiency potential;
 - ILI+ («Intelligente Liste»): lists electric motors in operation for detailed analysis of energy efficiency potential;
- Development of a mobile package for on-site measurements;
- Stationary test lab of IE3 motors.

Results

In three years of the first phase of the programme efficiency improvements have commenced and are ongoing in 17 pilot projects.

The major findings are that motor systems are typically old and inefficient, and motors are often oversized. It is difficult to motivate organisations for an investment into efficient motor systems for the following reasons:

- energy efficiency issues are of marginal importance;
- disruptions in the production process are avoided;
- lack of trust in new technologies;
- highly efficient products can be difficult to obtain from suppliers;
- expensive and time-consuming analyses need to be carried out prior to implementing the effective efficiency measures.

To complement Topmotors, a financial incentive programme («Easy») has been introduced in late 2010, aiming to increase motivation for such investments. Easy is financed by the Swiss government with 1 million CHF and is committed to deliver total savings up to 70 GWh in 11 years at one Eurocent subsidy per kWh saved.

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- www.motorsummit.ch
- www.faktor.ch booklet Faktor Motor (published in October 2010)
- www.prokilowatt.ch
- <http://opal.semafor.ch>

United Kingdom

Keywords: Carbon Trust, first year allowance, loans, scenario

Programme Name	Enhanced Capital Allowance (ECA) scheme
Webpage	www.eca.gov.uk/etl/default.htm
Implementation Framework	Climate Change Levy
Programme Start and Duration	2001, ongoing
Geographical Coverage	United Kingdom
Enforcement/ Compliance	Voluntary, fiscal incentive (first year allowance)
Financing	Financed by government
Costs	n.a.
Management	Carbon Trust on behalf of government, Her Majesty's Revenue and Customs, Department of Energy and Climate Change
Target Group	Industry, services
Technology covered	Compressed air systems, pumps, fans, motors, VSD
Sector	Companies, public (via procurement)
Main Instruments	Provides 100 % first-year capital allowances on investments in energy-saving equipment against taxable profits of the period of investment. Only equipment on the criteria list is eligible.
Other Programme Elements	Motor system guidelines: purchase, installation, use
Saving Calculation	n.a.
Success Criteria	Shift in sales share toward more efficient motors and use of VSDs
Main Results	<ul style="list-style-type: none"> ■ Share of IE2 motors up from 5 % (2001) to 15 % (2009) ■ 90 % (2009) of ventilation systems equipped with VSD
Main Success	n.a.
Main Disadvantage	No incentive for pumps or fans

Framework

The Market Transformation Programme (MTP) supports the development and implementation of UK Government policy on sustainable products. In 2010 it provided the technical analysis of what can be achieved by improving the energy-efficiency of a range of domestic and non-domestic appliances in pursuit of the UK's energy and climate change ambitions, as set out in the 2007 Energy White Paper and the 2009 Low Carbon Transition Plan.

The MTP produces four Government Standard Briefing Notes per product (or product area), containing: Key Inputs, with summary figures and reference sources used in the modelling; Reference Scenario, a projection of the energy consumption without new policies implemented; (New) Policy Scenario; Best Available Technology Scenario; Key Outputs, a summary of standards and related energy and emission savings.

The Annex 8 paper on «Motors & Circulators» estimates that energy consumption due to motors will increase by 1 % (1.21 TWh) between now and 2020 without further policy intervention. By implementation of cost-beneficial policies energy consumption in 2020 could be reduced by 1 % (0.73 TWh).

The key policies projected to have an impact on the motors area are the Energy-using Products Directive (European Union), the Enhanced Capital Allowances (ECAs), Government Buying Standards and the Building Regulations. For circulators also other policies like the Carbon Reduction Commitment and the Energy Saving Recommended Scheme (ESR) may have an impact. Currently there are no measures applicable to pumps.

Programme Description

The Carbon Trust provides specialist support to businesses and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. It publishes guidelines in the field of motor driven systems, e.g.: variable speed driven pumps, energy savings in fan systems, motors and drives and many others.

The Carbon Trust also manages the Enhanced Capital Allowance for energy saving-technologies (ECA) scheme. This enables businesses to claim 100 % of first-year capital allowance on investments in energy-saving equipment, against the taxable profits of the period of investment. The general rate of capital allowances is 20 % a year, so ECAs bring forward the time that capital allowances are available for spending on plant and machinery thereby providing a cash flow advantage. Enhanced Capital Allowances (ECAs) can only be claimed on energy-saving products that meet the relevant criteria for their particular technology group – as detailed on the Energy Technology Criteria List (ETCL). This list is periodically reviewed and comprises a wide range of technologies from boiler equipment to solar thermal systems. The products meeting the criteria are

listed in the Energy Technology Product List (ETPL). The ECA scheme covers compressed air equipment, HVAC and motors and drives. Within motors and drives the following sub-technologies are listed: integrated motor drive units (combination of VSD and AC induction motor), permanent magnet synchronous motors meeting the listed performance thresholds, single speed AC induction motors (meeting IE2 standards, 2009), switched reluctance drives and variable speed drives. For compressed air systems flow, master controller and control for dryers are included. In addition, the Carbon Trust offers interest free Energy-Efficiency Loans for the purchase of energy-saving equipment. Loans and ECA can be used together. SMEs can borrow from GBP 3,000 to 100,000 on an unsecured basis, repayable over a period of up to four years.

Other measures such as Building Regulations also encourage greater use of variable speed drives in mechanical ventilation systems (which use fans and electric motors). In addition, minimum energy performance standards (specific fan power) are defined.

Government Buying Standards (formerly known as Buy Sustainable Quick Wins) are designed to make it easier for government buyers to buy sustainably. They include official specifications that all government buyers must follow when procuring a range of products. In this scheme an energy rating for motors of IE3 is recommended as best practice. In addition, the buying standards are aligned with the criteria and products within the ECA scheme.

Results

An evaluation of the ECA scheme in 2008 estimated that CO₂ savings resulting from purchases of four technologies (boiler, lighting, refrigeration and motors and drives) resulted in a reduction of 600 kt of CO₂ in the first year or 2,800 kt of CO₂ over the life of equipment.

By 2009, the share of sales of IE2 motors (the performance level supported by ECA) had risen to 15% per annum, compared to 5% in 2001.

It is estimated that 90% of mechanical ventilation systems are now supplied with VSDs (correlating with 21% of motor sales). The 2010 revision of the Building Regulations introduced recommendations encouraging the use of VSDs in variable duty pump applications.

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United States

Energy Policy Act of 1992 (EPAAct), Energy Efficient Motor MEPS

Energy Independence and Security Act of 2007 (EISA), Premium Efficiency Motor (MEPS)

Keywords: MEPS, trademark, financial incentives

Programme Name	NEMA Premium®
Web	www.nema.org/gov/energy/efficiency/premium/
Implementation Framework	Energy Policy Act
Programme Start and Duration	1992 – 1997: (EPAAct), 2001: NEMA Premium (Voluntary); 2007 – 2010 (EISA)
Geographical Coverage	USA, Canada
Enforcement	a) Law b) Voluntary (NEMA Premium)
Financing	n.a.
Costs	n.a.
Management	Government, National Electrical Manufacturers Association (NEMA)
Target Group	Motor producers, buyers
Technology covered	■ Motors 1-200 hp (EPAAct) ■ Motors 1-500 hp (EISA)
Sector	Industry, Commercial, Agricultural
Main Instruments	a) MEPS b) Trademark (NEMA Premium)
Other Programme Elements	Financial incentives by utilities
Saving Calculation	MotorMaster+
Success Criteria	Market share of Premium Efficiency motors
Main Results	NEMA Premium 27 % market share in sales (2006) due to voluntary programme coupled with utility incentives
Main Success	Well-known trademark, worldwide influence on standard development and MEPS
Main Disadvantage	At the moment no motor system approach

Minimum Energy Performance Standards (EPAAct), (EISA)

The Energy Policy Act of 1992 (EPAAct) imposed mandatory minimum full-load energy efficiency standards on 1-200 horsepower (hp) (0.75 kW to 375 kW) general purpose 60 Hz integral motors with synchronous speeds of 1,200, 1,800, and 3,600 RPM, that operate with 230 or 460 Volt

power supplies, and that are equipped with open drip-proof (ODP) and totally enclosed fan-cooled enclosures (TEFC). The Act also applied to imported motors and motors purchased as components of other pieces of equipment.

The implementation of the MEPS went into effect in 1997 and was responsible for transforming the market so that approximately 65% of all integral horsepower motor sales in the 1–200 hp polyphase category were at the Energy Efficient (IE2) efficiency level.

In 1993, NEMA revised its set of energy efficient motor performance standards to include motors rated between 201 and 500 hp. Compliance with the expanded standards was voluntary.

Key elements of the initiative were: agreed test standards and methods, test lab accreditation process, labelling standards, compliance procedures, and cooperation with manufacturers association and non-profit organisations (e.g. ACEEE).

In 1996, the Consortium for Energy Efficiency (CEE) launched its Premium Efficiency Motors Initiative to develop a new minimum-efficiency «reach» standard. The initiative provided a common definition of «premium efficiency», including a set of specifications that were 1–4 % higher than the EPAAct requirements.

In 2001, the U.S. electric motor industry reached consensus on a specification defining premium efficiency motors (motors with efficiency levels exceeding EPAAct 92) and agreed to include the definition (NEMA Premium¹) in NEMA's industrial electric motor performance and application standards. The Premium Efficiency standards apply to low voltage (<=600 Volt) general purpose motors in the 1 to 500 hp size range that operate with synchronous speeds of 1,200, 1,800, and 3,600 RPM (see NEMA MG1 Table 12-12). The standards also cover medium voltage (<=5,000 Volt) open or enclosed motors rated between 250 and 500 hp (see NEMA MG1 Table 12-13). Furthermore, the trademark NEMA Premium® (approximately IE3) was developed for the exclusive use of manufacturers signing a memorandum of understanding. Demand for NEMA Premium efficiency motors increased to approximately 27 % by 2006 of all integral polyphase motor sales in the U.S.

The Energy Independence and Security Act of 2007 (EISA) raised the MEPS for low voltage motors running at 1,200, 1,800, and 3,600 RPM and with power ratings up to 200 hp to the NEMA Premium efficiency (IE3) levels. In essence, the NEMA Premium Efficiency MEPS replace the IE2 EPAAct 1992 levels as the minimum efficiency baseline for these motors. EISA also extended the NEMA Energy Efficient (IE2) MEPS to cover general purpose motors be-

1 NEMA Premium™ is a registered trademark of NEMA licensed to manufacturers for their use to identify compliant products in the North American markets.

tween 201 and 500 hp and included several categories of previously exempt 1 to 200 hp motors (U-Frame, Design C, close-coupled pump, footless, vertical solid shaft normal thrust, 900 RPM, 200 Volt, and 575 Volt motors). In 2010, the EISA MEPS changes were implemented as law.

Utility Programmes

In the 1990s electric utilities throughout the U.S. began aligning their motor rebate or incentive programmes to meet the CEE Premium Efficiency Motors specifications. For example Austin Energy provides Premium Efficiency Motor discounts to their customers.

Many utilities offer incentives for installation of adjustable speed drives (ASDs) in fan and pumping systems. Most offer «custom» incentives for ASD and other energy-saving measures with the incentive amount based upon verified energy savings. A few utilities offer pre-calculated incentives per unit horsepower controlled by the ASD, provided certain criteria are met. Act On Energy (a service of Ameren Illinois) gives financial incentives to new projects that add variable frequency drives to motors or pumps, by offering USD 75 per horsepower controlled.

Results

Due to utility incentives and information dissemination, the market share of NEMA Premium motors of all integral polyphase motor sales in the U.S. has increased to approximately 27 % by 2006.

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U.S. Motor Systems Initiative

Keywords: premium motors, support for national and utility programmes, system approach, tailor-made tools

Programme Name	Motor Systems Initiative
Web	www.cee1.org/ind/mot-sys/mtr-ms-main.php3
Implementation Framework	Initiative of a non-profit corporation for its members
Programme Start and Duration	1999
Geographical Coverage	USA, Canada
Enforcement/ Compliance	Voluntary
Financing	Non-profit organisation, utilities' programmes and others
Costs	n.a.
Management	Consortium for Energy Efficiency, Participants: utilities, national programmes
Target Group	Industrial companies
Technology covered	Motor systems
Sector	Industry, commerce
Main Instruments	Awareness raising programme, tools, premium efficiency motor list, brochures
Other Programme Elements	Training sessions
Saving Calculation	n.a.
Success Criteria	n.a.
Main Results	82 % of US and Canadian programme administrators indicated that motors are included in their programmes
Main Success	n.a.
Main Drawback	n.a.

Initiatives of the Consortium for Energy Efficiency

The Consortium for Energy Efficiency (CEE), a non-profit public benefits corporation, develops initiatives for its North American members to promote the manufacture and purchase of energy-efficient products and services. CEE's industrial programmes include three initiatives (premium-efficiency motors, motor systems, and transformers) as well as supporting activities like Motor Decisions Matter and the Compressed Air Challenge.

Premium Efficiency Motors Initiative

The Premium Efficiency Motors Initiative supports the ongoing promotion of premium efficiency motors in the marketplace.

Motor Systems Initiative

In 1999, CEE launched its Motor Systems Initiative to improve the adoption of energy efficiency opportunities in the commercial and industrial sectors. CEE provides a forum for members to consider current state of drive technology and to explore utility incentive programme strategies. In 2004, CEE launched a Water and Wastewater Facilities Initiative as one of several sector-specific strategies. The Motor System Tools and Resources initiative provides a forum for distribution of credible tools and resources for the improvement of motor-driven system efficiency. For example, CEE publishes:

- Premium Efficiency Motor List
- Selection and Application Considerations Brochure

The Motor Systems Initiative is developing a tool kit to help motor programme representatives and contractors promote a variety of motor-related efficiency improvements. In its final form, the tool kit will include both technical tools (software, checklists, guidelines etc.) and promotional tools targeting the interests of a variety of audiences, such as maintenance, operation and management personnel.

Motor Decisions Matter (MDM)

In 2001, CEE along with industry (motor manufacturers, motor service providers, trade associations) and government launched a national awareness campaign named MDM which aims to create national awareness about «Good Motor Management». Developed tools are the 1*2*3 Approach to Motor Management, and the Motor Planning Kit. In addition, motor system management workshops are organised, the «MotorUp» publication is distributed to publicise utility rebate programmes and success stories, and the website www.motorsmatter.org is maintained.

Compressed Air Challenge

The mission of the Compressed Air Challenge is to provide resources that educate industry about optimising their compressed air systems and thereby increasing net profits. The Compressed Air Challenge (CAC) functions through a Board of Directors, comprised of representatives of contributing sponsor utilities, energy service companies, compressed air equipment manufacturers and distributors, compressed air systems auditors and servicing groups and end users. The CAC offers training on fundamentals and advanced management of compressed air systems, and in concert with the U.S. DOE, offers Qualified AirMaster+ specialist training. AirMaster+ is a DOE-supported software tool used to systematically analyse industrial compressed air systems. It is intended to enable users to model existing and future improved system operation, and evaluate savings from many energy efficiency measures. CAC also publishes the Best Practices for Compressed Air Systems Manual and the CAC Sourcebook, case studies and fact sheets. Production floor training, offering a concise primer on the importance of compressed air efficiency, is also under development.

US & Canadian Energy Efficiency Measures for Motors and Drives

The 2009 CEE Evaluation of U.S. and Canadian natural gas and electrical energy efficiency initiatives reported that 82 % of US and Canadian programme administrators indicated that motors are included in their programmes, 76 % of them have motor drives in their programmes.

Other Ongoing Initiatives

Green Motor Initiative (GMI www.greenmotors.org)

Green Motor Initiative (GMI) is the first initiative of its kind, offering financial incentives to Green Motors Practices Group (GMPG) members (and its customers) for rewinding motors to their original nominal efficiency values. NEMA horsepower rated motors from 15 hp to 5,000 hp, without core damage rewound to their original nominal efficiency values are known as a «GREEN REWIND» and qualify for incentives: GMPG member service centres will receive USD 2 per horsepower for each GREEN REWIND. The service centre must pass along an instant rebate credit of at least USD 1 per horsepower to their customer on the rewind invoice.

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- <http://tonto.eia.doe.gov/cneaf/electricity/esr/table2.html>

U.S. Motor Challenge Program/Ongoing DOE Programs

Keywords: system approach, tools-development, partner integration

Programme Name	Motor Challenge Program
Webpage	New webpage: www1.eere.energy.gov/industry/
Implementation Framework	Promotion of voluntary industry/government partnership
Programme Start and Duration	1993; 1999 consolidated into Best-Practices
Geographical Coverage	USA
Enforcement/Compliance	Voluntary
Financing	U.S. Department of Energy
Costs	USD 29.2 million
Management	U.S. Department of Energy Participants: Utilities, motor system suppliers
Target Group	Motor System User
Technology covered	Motor Systems (Pumps, Fans, CAS)
Sector	Industrial, commercial
Main Instruments	Information, tools, workshops, conferences
Other Programme Elements	Partner agreements
Saving Calculation	Within tools (e.g. efficiency level of motors)
Success Criteria	(Originally) savings of 5,000 GWh per year by 2000
Main Results	<ul style="list-style-type: none"> ■ 520 GWh saved (by end of programme) ■ 4,536 participants at workshops ■ 208 Allied Partners (by end of 1998) ■ 23,000 copies of MotorMaster + distributed ■ High response, increased awareness
Main Success	n.a.
Main Disadvantage	n.a.

The Motor Challenge Program

The U.S. Department of Energy (DOE) initiated in 1993 the Motor Challenge Program as part of DOE's effort to promote voluntary industry/government partnerships to improve energy efficiency, economic competitiveness and the environment.

The programme is an industry/government partnership that promotes industrial energy efficiency through the use of energy-efficient electric motors, drives and driven equipment, and effective motor-driven system integration and optimisation.

The programme offerings are: the Information Clearinghouse (now called the EERE Information Center), which provides up-to-date information about the practicality and profitability of electric motor system strategies, including having experts available by toll-free telephone; design decision tools, such as MotorMaster+ software; showcase demonstration projects; training; workshops, conferences and newsletter.

To deliver the programme message, Motor Challenge recruits suppliers, distributors, utilities, state agencies, consulting engineers and others as Allied Partners. This effort has been highly successful as it provides an added benefit to their customers. Motor Challenge Partners are motor system users, consulting engineers or utilities that promote motor efficiency within their agency; excellence partners are large industrial users that commit to continual improvement of their systems; industry partners are, for example, industrial associations or utilities consortia that develop new programme offerings. The programme so far published reference books on energy efficiency, so called «Sourcebooks for Industry» for pumping systems, fans, steam systems, process heating systems and compressed air.

Results of the Motor Challenge Program

Over the 6-year life of the Motor Challenge Program, it encouraged and enabled industrial facility operators to reduce energy consumption by 520 GWh per year (the original target was to save 5 billion kWh or 5,000 GWh per year by the year 2000). About 18% of users of the MotorMaster+ decision support tools reported that they implemented changes to motor system design, purchase and maintenance practices. 24% of end users who participated in the ASD training programme and 48% of those who participated in the Pump System training programme reported that they implemented improvements to the efficiency of their systems that they would not have made in the absence of the programme (for details refer to XEnergy, 2000, pp. 3-11).

Similarly, an assessment of end users who received the Energy Matters newsletter found that one third of the users reported that they have made changes in the way they purchased or managed motor systems as a result of reading the newsletter. Over 60% of Allied Partners had used Motor Challenge tools or materials to help customers with motor selection. Some evidence that neglected «systems

optimisation» of motors is now receiving increased attention by companies and in the marketplace. A lot of countries showed interest in the programme, and the European Union (see page 14) and China (see page 8) have already copied the programme.

Ongoing Department of Energy Programmes

The Industrial Technologies Program (ITP), part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, leads the national effort to reduce energy use and carbon emissions from U.S. industry. Through BestPractices, ITP helps industry save energy, by implementing proven technologies and energy management practices and offers resources such as software tools, training and technical information and resources for corporate executives, plant managers, technical staff and the general public.

Free software tools offered are AirMaster+, MotorMaster+ and tools for the assessment of fan, pumping, compressed air, steam, process heating, combined heat and power and chilled water systems. For motor system technologies and related tools different trainings are offered. Participants in the 3½ day compressed air workshop and the Compressed Air Challenge® are recognised as Qualified AIRMaster+ Specialists and are listed on the webpage.

Government Procurement

The Department of Energy's Federal Energy Management Program (FEMP) has issued product procurement recommendations for federal agencies requiring that they specify premium efficiency motors based on the NEMA Premium efficiency specifications.

U.S. Department of Energy Save Energy Now Initiative

In October 2005, the U.S. Department of Energy launched its Save Energy Now initiative with the goal of providing steam and process heating assessments at 200 of the largest U.S. manufacturing plants. Due to the success of the assessments conducted in 2006, the programme was expanded in 2007 to perform at least 250 assessments. The assessment focus was also expanded to include use of the DOE's decision software tools for conducting pumping, compressed air and fan system assessments. The 95 fan, compressed air, and pumping system assessments conducted in 2007 identified an aggregate savings potential of USD 28.2 million.

LEADER Companies and Superior Energy Performance

The DOE's Industrial Technologies Program (ITP) is partnering with industrial companies voluntarily pledging to reduce their energy intensity by 25% or more in 10 years. DOE gives priority for Save Energy Now assessments to LEADER companies. Due to requests by industries, DOE will begin to offer motor assessments in 2011.

Participating industrial plants would be expected to conduct steam, process heating, compressed air, pumping system assessments, etc.

ASME Energy Assessment Guidance Documents

DOE-sponsored BestPractices committees have worked to produce documents that describe what an energy assessment is i.e.: Energy Assessment for Pumping, Compressed Air, Process Heating and Steam Systems (ASME EA-1 through 4-2008). The American Society of Mechanical Engineers (ASME) is now developing Guidance Documents for conducting these assessments. The Industrial Technologies Program (ITP) also encourages U.S. industry to implement energy management practices within industrial plants and their supply chain and will launch a programme in this area (ISO 50001).

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3 Policy Summary

3.1 Overview of Described Programmes

Country Programme	Financing, Management	Programme Elements			Results
		Mandatory actions	Information & education	Financial incentives	
Australia Equipment Energy Efficiency (E3) Program	<ul style="list-style-type: none"> ■ Australian Government ■ State and Territory Governments ■ New Zealand Government 	<ul style="list-style-type: none"> ■ MEPS, voluntary High Efficiency Performance Standards (HEPS) ■ Compliance testing in accredited laboratories ■ Sanctions for non-compliance: deregistration 	Awareness raising: www.energy-rating.gov.au		6,000 motors registered for MEPS 2, 20% of these meet HEPS
Austria klima:aktiv energy efficient companies program	<ul style="list-style-type: none"> ■ Financing: Ministry of Environment ■ Management: Austrian Energy Agency ■ Financing: Regional public administration (for energy audits) 		<ul style="list-style-type: none"> ■ Training of energy auditors ■ Audit guidelines for motor systems (compressed air systems, fans, pumps), template for audit reports ■ Awards, workshops, conferences 	<ul style="list-style-type: none"> ■ Regional subsidies for energy audits ■ Financial subsidies for purchase of IE3 motors nationally 	Total programme savings around 60 GWh p.a. (not only motor systems)
China <ul style="list-style-type: none"> ■ China Energy Label ■ China Energy Savings Program ■ China Motor System Market Transformation Program ■ Motor Systems Challenge 	Chinese Government	<ul style="list-style-type: none"> ■ MEPS ■ Labelling ■ Lab accreditation programme 	<ul style="list-style-type: none"> ■ Information exchange ■ Awareness raising 	<ul style="list-style-type: none"> ■ Financial subsidy (for highly efficient motors) ■ Income tax concessions 	30% of registered motors are IE2 level (corresponding to CEMEP EFF1 level)
Netherlands Long Term Agreements (LTA)	<ul style="list-style-type: none"> ■ Financing: Ministry of Economic Affairs ■ Management: NL Agency 		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)

Country Programme	Financing, Management	Programme Elements			Results
		Mandatory actions	Information & education	Financial incentives	
Sweden Programme for Improving Energy Efficiency in Energy Intensive Industries	<ul style="list-style-type: none"> ■ Financing: Government ■ Management: Swedish Energy Agency 		<ul style="list-style-type: none"> ■ Energy audit, list of measures, purchasing recommendation (life cycle costing) ■ Reporting on energy management 	Electricity tax exemptions	Targeted savings: 1.4 TWh p.a. (75 % within surrounding systems, 25 % in production processes)
European Union Motor Challenge Programme	<ul style="list-style-type: none"> ■ Joint Research Centre ■ National Contact Points 		<ul style="list-style-type: none"> ■ Voluntary motor measure list (Action Plan) ■ Use of programme logo, awards 		By 2009: <ul style="list-style-type: none"> ■ 95 Partners ■ 93 Endorsers ■ 185 GWh/a savings
Switzerland Topmotors Easy	<ul style="list-style-type: none"> ■ Financing: Government ■ Management: Swiss Agency for Efficient Energy Use (non-governmental organisation) 		<ul style="list-style-type: none"> ■ Awareness raising: www.topmotors.ch ■ Training for energy advisers ■ Software tools for audits 	Incentives for audits and efficiency measures	<ul style="list-style-type: none"> ■ 17 pilot objects ■ 1,000 newsletter recipients ■ 350 conference & workshop participants ■ 8,000 downloads (software tools, information sheets, etc.)
UK Enhanced Capital Allowance scheme	<ul style="list-style-type: none"> ■ Financing: government ■ Management: Climate Change Levy, Carbon Trust 	Government procurement	Information, guides (Carbon Trust)	<ul style="list-style-type: none"> ■ 100 % first-year capital allowance on energy-saving equipment ■ Energy-efficiency loans 	Market share of IE2 motors increased from 5 % in 2001 to 15 % in 2009
USA <ul style="list-style-type: none"> ■ Epact92, EISA ■ NEMA Premium ■ Utility rebates 	<ul style="list-style-type: none"> ■ Financing: government ■ Management: National Electrical Manufacturers Association (NEMA) 	<ul style="list-style-type: none"> ■ MEPS ■ Labelling 		Fiscal incentives for VSD and highly efficient motors (utilities)	In 2006 NEMA Premium sales share 27 %
USA <ul style="list-style-type: none"> ■ Motor Systems Initiative ■ Motor Decisions Matter ■ Compressed Air Challenge ■ Green Motor Initiative 	Consortium of Energy Efficiency (Non-profit)		<ul style="list-style-type: none"> ■ Forum for members ■ Awareness raising ■ Best practices ■ Trainings 	Financial incentives for rewind motors	104 TWh electrical savings, in US and Canada (not only motors)

Country Program	Financing, Management	Programme Elements			Results
		Mandatory actions	Information & education	Financial incentives	
USA ■ Motor Challenge Program ■ Industrial Technologies Program ■ Save Energy Now, LEADER	Department of Energy's Office of Energy Efficiency and Renewable Energy		■ Information, training, conferences ■ Best practices ■ Free software tools ■ Government procurement recommendations ■ Guidance documents, assessments		Motor Challenge Program: 520 GWh savings (in 6 years)

3.2 Programme Elements

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

Legally Enforced Minimum Efficiency Standards for Motor System Components

Legally binding standards for efficiency of electric motors are becoming more popular and have been implemented in the USA, the European Union, China, Australia, Korea, Brazil and others. Additionally, standards are set for other motor system components, such as pumps, fans and compressors in China and the 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

Programmes for government procurement (UK, US, others) or the recommendation for purchasing highly efficient motors within programmes for energy management systems (Sweden) can help to get highly efficient motors in the market. This also applies to efficient design and installation services.

Financial Incentives for Higher Efficient Motors and 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 programme in Sweden);
- Rebates (e.g. utility incentives for highly efficient motors in the US);
- 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 programmes 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, programmes 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 programme 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 Programmes 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 programme. For motor systems electricity targets are relevant. Within these programmes other elements are integrated e.g. energy audits, energy saving targets and programme monitoring, including measure list, and/or purchase criteria for highly 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 programmes, purchase criteria, maintenance and repair strategy, trainings, suggestion schemes.

Once again standardisation (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 programmes 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 and 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.

Measures Not Found Amongst Survey Participants

Other types of measures that were not described by participants in this survey but which form part of a comprehensive motor system policy framework in some countries include:

- white certificates;
- projects of energy service companies;
- co-operations, such as between energy agencies and production facilities or energy service companies.

3.3 Recommendations for a Successful Programme

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

1. Programme Planning

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

- What are the aims of the programme and the intended duration;
- What can be learnt from other programmes with similar objectives;
- How the programme will be managed;
- Who is the main target group or groups;
- How the success of the programme will be evaluated;
- How the achievements of the programme will be measured;
- What financial and human resources will be required to deliver the programme;
- Are there any capacity constraints that will limit the effectiveness of the programme, 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 programme and what role will they have;
- How will a communications strategy be developed and implemented.

2. Programme Duration

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

3. Programme Management and Recognition

Programme management should be neutral and independently financed to be recognised as an unbiased source of information.

Information provided by the programme 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 Programme (European Union, USA) and klima:aktiv (Austria).

4. Partnerships

It is of great importance to integrate market actors to achieve the greatest possible programme 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 programmes. Trade associations, chambers of commerce and industry organisations can also be useful partners. 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 programme design and management. Regular monitoring provides feedback on progress with implementation and enables the early detection of any problems or issues that require addressing.

Programme evaluation, particularly when undertaken by an independent authority, is usually required to secure funding streams, or to support a case for the programme to expand or be extended. Publicly reporting programme results is also important to increase programme recognition. Most monitoring systems will require close contact with programme 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.

Targets, criteria could be:

- CO₂ emission reductions and electricity savings;
- Sales share of highly efficient motors in the market;
- High efficient units or systems sold and/or installed;
- Number of people and companies reached with trainings and events;
- Number of energy audits based on a standard/guideline;
- Number of energy auditors trained;
- Number of supporting tools users;
- Number/increase of website visitors, downloads;
- Number of newsletter recipients;
- Market recognition of label or programme.

6. Compliance and Enforcement

MEPS and labelling programmes require the implementation of systems to ensure compliance and achieve the expected economic and environmental outcomes. Efforts to maximise compliance also safeguard 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 programme requirements. This requires the use of robust methods of test (where possible, internationally recognised) and measures to assure the availability and quality of 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 and Motor Summit conferences, other possibilities are the IEA Implementing Agreements (4E, IETS).

4 Conclusions

This guide has identified and described examples of motor systems related policy instruments implemented by major economies in North America, Asia, Europe and Australia. Based on the main successes and disadvantages of these instruments, the analysis of the programme elements (see page 27) and the recommendations for a successful programme (see page 28), the following conclusions have been drawn.

System Approach

Impressive improvements have been made in the efficiency of motors in most major economies over the past decade as the direct result of policies implemented by their respective governments. However, considerably greater financial and environmental savings are available by improving motor system efficiency, particularly in the driven pump, fan, compressor, the auxiliary components variable speed drive, gear, transmission belt and brakes. The challenge ahead is to direct national policy initiatives towards motor systems in order to realise these extremely substantial opportunities.

There are already some useful pointers on how to proceed, and many valuable lessons learnt from the experiences with policy implementation for motors.

The European Commission is publishing MEPS for core motor system components 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.

The UK and US give fiscal incentives for the purchase and/or installation of frequency converters. This measure focuses on one single, but in some cases the most relevant energy efficiency opportunity – adjusting the motor power demand to the actual demand of the system.

However, there are many other opportunities for increasing energy efficiency that need to be considered if end users are to maximise cost-effective energy savings. For example, the correct sizing of machines and motors is important, as is the use of control equipment (e.g. no machine operation on weekends, if not needed). Policy measures such as co-financed energy audits, guides and training for motor experts have been shown to be effective in tackling these issues. The Motor Challenge Programme 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 programmes for motor systems.

The Recipe

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

MEPS should be introduced for motors and motor systems (pumps, fans, compressors) 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). Policies are required to invest in the development of benchmarks and expertise to support improved system design and implementation.
- 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 realisation 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 these policy instruments need to fit coherently with national and international energy policy frameworks.

Outlook

It is not enough to create successful policy instruments on a national level. With motor manufacturers delivering their products across the globe, the needs and risks of a global market have to be faced:

- MEPS need to be introduced stepwise in all countries.
- The level of MEPS needs to be globally aligned to re-

duce compliance costs for industry and minimise the opportunity to dump inefficient products in countries with no or lower standards.

- Testing standards need to be globally harmonised and accepted. This process is already ongoing with more and more countries accepting the upgraded IEC standards.
- Motor systems audit schemes and specific performance standards for whole systems should be developed and integrated/combined with industrial energy efficiency programmes. These programmes should 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 accelerate market transformation on a global scale.

EMSA is engaged in the following activities:

- Updated overview of Minimum Energy Performance Standards worldwide on www.motorsystems.org
- Network of testing laboratories worldwide, explanatory guide to testing standards
- Technical guide for motor systems, motor systems tool, training instruments
- Energy management in industry
- Creation of appropriate standards for new motor technologies (switched reluctance, permanent magnet).

Further information on EMSA is available at the end of this document.

Next Steps

This document has identified and described examples of motor systems related policy instruments and provided guidelines for successful national policy design. The next step for EMSA 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 this guide.

List of Abbreviations

4E	Efficient Electrical End-Use Equipment
4EM-MCP	Energy Efficient Electric Motor Systems in New Member and Candidate Countries
ACEEE	American Council for an Energy-Efficient Economy
AC motor	Alternating Current motor
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine
ASD	Adjustable speed drive
ASME	American Society of Mechanical Engineers
BKW	BKW FMB Energie AG
CAC	Compressed Air Challenge
CAS	Compressed air systems
CDM	Clean Development Mechanism
CEE	Consortium for Energy Efficiency
CEMEP	European Committee of Manufacturers of Electrical Machines and Power Electronics
CNCA	Certification and Accreditation Bodies
CNIS	China National Institute of Standardization
DEXA-MCP	Dissemination, Extension and Application of the Motor Challenge Programme
DOE	U.S. Department of Energy
E3	Equipment Energy Efficiency
ECA	Enhanced Capital Allowances
EEMODS	Energy Efficiency in Motor Driven Systems
EEP	Energy Efficiency Plan
EIA	Energy Investment Allowance
EISA	Energy Independence and Security Act
EKZ	Elektrizitätswerke des Kantons Zürich
EMSA	Electric Motor Systems Annex
EnAW	Energie-Agentur der Wirtschaft
EPAct	Energy Policy Act
ESCO	Energy service company
ETCL	Energy Technology Criteria List
ETPL	Energy Technology Product List
GMI	Green Motor Initiative
GMPG	Green Motors Practices Group
GWh	Gigawatt hours (10 ⁹ Wh)
HEPS	High Efficiency Performance Standards
HVAC	Heating, Ventilation and Air-Conditioning
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IETS	Industrial Energy-related Technologies and Systems
ISO	International Organization for Standardization
ITP	Industrial Technologies Programme
KPC	Kommunalkredit Public Consulting
kt	kilo tons (1000 tons)
LCC	Life Cycle Cost
LTA	Long Term Agreement
MCP	European Motor Challenge Programme
MDM	Motor Decisions Matter
MEPS	Minimum Energy Performance Standard
MOF	Ministry Of Finance People's Republic Of China
Mt	Mega tons (million tons)
MTP	Market Transformation Programme
MWh	Megawatt hours (10 ⁶ Wh)
n.a.	Data not available
NEMA	National Electrical Manufacturers Association
NDRC	National Development and Reform Commission
OEM	Original Equipment Manufacturer
p.a.	Per annum
RPM	Revolutions per minute
S.A.F.E.	Swiss Agency for Efficient Energy Use
SFOE	Swiss Federal Office of Energy
SME	Small- and medium-sized enterprises
TWh	Terawatt hours (10 ¹² Wh)
VSD	Variable speed drive

Electric Motor Systems Annex (EMSA)

The EMSA focuses on improving the efficiency not only of motors themselves but also the core motor system such as the pumps, fans, compressors and auxiliary components – like variable speed drives, gears, transmission belts and brakes – to which they may be attached. Its goal is to increase the energy efficiency of motor systems by 20% to 30% within 20 years. As electric motor systems are responsible for over 40% of global electricity use, this represents a significant potential saving.

Working through its individual tasks, EMSA disseminates best practice information and aims to support standards and policy development processes to improve the energy performance of new and existing motor systems in both industrialised and developing countries.

By 2011 the work of EMSA has contributed to:

- An increasing number of countries with minimum energy performance standards for motors accounting for 70% of global electricity use (e.g. Australia, Brazil, China, Canada, Mexico, New Zealand, European Union, Switzerland, USA and others).
- The introduction of minimum energy performance standards for pumps and fans (e.g. the 27 countries of the European Union and China).
- Internationally harmonised standards for electric motors (IEC), including:
 - International efficiency classification standard IEC 60034-30: developing the IE-code (IE1, IE2, IE3, IE4), extending the standard's scope to include all kinds of motors between 0.12 and 800 kW.
 - Revision of testing standard IEC 60034-2-1: one preferred method for motors up to 1,000 kW (low uncertainty, segregated losses with stray load from residual loss, improvements for sequence of tests, seals, standard reporting format). EMSA collected national classifications and experience on the practical use of testing data in an international comparison and fed in the results in the revision of the testing standard.
- Round-robin Report parts 1, 2 & 3: covering 17 laboratories in 11 countries, and 75 motors with 194 tests.
- IEC 60034-2-3: progress with expanded motor and variable frequency drive standards.
- IEC 60034-31 Selection of energy-efficient motors including variable speed applications – Application guide.
- EMSA expanded the Global Motor Systems Network to over 2,000 representatives of governments, industry and research in 65 countries through systematic outreach: web, newsletter, workshops and international conferences for stakeholder interaction (EEMODS, Motor Summit).
- EMSA built up a global network of testing laboratories.
- EMSA developed a Motor Systems Tool for motor system optimization by engineers.
- EMSA publications: Electric Motor MEPS Guide (2009), Motor Policy Guide – Part 1 (2011).

**Further information on EMSA is available at:
www.motorsystems.org**

