



IEA 4E: Electric Motor Systems

**Task D Draft-Report:
Instruments for Coherent Motor Policy**

Motor Policy Guide

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Introduction

Project description:

Electric motor systems use 40% of global electricity. They are used in industry, infrastructure and large buildings to drive pumps, fans, compressors, traction systems and industrial handling & processing. With using best practice energy efficiency can be improved by 20% to 30% on average. Most improvements have a pay back time of 1 to below 3 years. This means a big potential impact on reduction of global greenhouse gas emissions.

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 is organized in tasks that will each contribute to a coordinated effort towards rapid transformation of global markets by:

- spreading good practice
- new improved technology
- positive policy experiences.

EMSA is treated in 8 Tasks from A to H. The overall coordination is the duty of the Operating Agent as coordinator and manager. Every Task identifies its scope and states its individual deliverables at the end.

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

H Total motor systems integration

Target

This document is a reference guide of successful programs and policies for implementing motor systems efficiency all over the world. It is the report of the Task D “Instruments for coherent motor policy” within the 4E Electric Motor Systems Annex EMSA. The aims of this task are to:

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

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

- minimum energy performance standards - MEPS (legal or voluntary),
- labels,
- energy management schemes and audit programs,
- rebate programs,
- training and education programs,
- financial incentives (taxes, funding schemes, credits...),
- white certificates,
- public awareness raising programs,
- projects of energy service companies,
- co-operations such as energy agencies with production or energy service companies,
- information platforms.

Methodology

The regions for the policy analysis included: USA, China, Australia, Europe, some European member countries and Switzerland.

For the policy description a template for description for the policy measures were distributed between the EMSA participating countries (Australia, Austria, Denmark, Netherlands, UK and Switzerland). EMSA participants selected the relevant programmes in their countries.

The Austrian Energy Agency analyzed the relevant programs for all countries and made a draft description of the policy measures within their country. Activities consisted of the collection of material for all countries including US, China and Europe (as a whole). Sources were: web, articles, conference proceedings, interviews, public statistics. Overall approximately 10 case studies were prepared.

A standardized reporting structure was then developed, aspects to be considered included enforcement, compliance, calculation methods, evaluation of the success (e.g. energy savings) of the programs), financial considerations.

In addition all policy instruments were summarized and the most relevant elements were described. Furthermore recommendations for programme planning were identified.

1 Australia

Key words: MEPS, Compliance Testing

Name of Program	Equipment Energy Efficiency (E3) Program
Framework	National Framework for Energy Efficiency
Start of Program	1999; 2001 (for motors)
Geographical Area	Australia, New Zealand
Enforcement	MEPS by government regulation
Financing	Australian Government, state and territory governments, New Zealand government
Costs	Registration costs for motor suppliers (depending on where the motor is registered)
Management	E3 Committee
Key Participants	Australian Government, state and territory governments, New Zealand government
Technology covered: Motorsystem approach /focus	Electric Motors from 0.73 to 185 kW (2, 4, 6 and 8 poles)
Sector	All sectors
Main Instruments	MEPS, voluntary High Efficiency Performance Standards (HEPS), compliance testing
Other Program Elements	Webpage
Saving Calculation	
Success Criteria	Motors offered for sale are all registered, motors meeting MEPS 2 levels, HEPS 2 motors available in the market
Other main Results	Most motors are passing check tests and meeting MEPS 2 levels.
Subjective: Main Success	Most motors are passing check tests and meeting MEPS 2 levels. Nearly 6,000 motors have been registered for MEPS 2 and about 20% of these are for voluntary HEPS levels.
Subjective: Main disadvantage	Education for importers can be difficult to achieve.

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 program 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 program. 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.

Program-Description

MEPS

MEPS has applied to three-phase electric motors since October 2001 (MEPS 1) and was 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 and they must meet the mandatory MEPS levels as documented in AS/NZ 1359:2004 before they can be sold in Australia and New Zealand. Nearly 6,000 motors have been registered for MEPS 2 and about 20% of these are for voluntary 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 can 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, 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 was 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). 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 example for motors with ratings up to and including 50 kW this tolerance is -15% of $(1-\eta)$, but 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 website has published a guide to electric motors best practice on its website. This includes information on the selection process, system optimization issues, control strategies etc.

Government Leadership Programs

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 1200 subsidiaries) registered for the Energy Efficiency Opportunities program. This program is managed by the Department of Resources, Energy and Tourism.

References

www.energyrating.gov.au

<http://www.climatechange.gov.au/en/what-you-need-to-know/appliances-and-equipment/electric-motors.aspx>

<http://www.ret.gov.au/energy/efficiency/eeo/contact/Pages/default.aspx>

2 Austria

Key words: awareness raising, Public Relation, audit tools, trainings, pilot audits, co-financed audits

Name of Program	klima:aktiv energy efficient company Program
Framework	Climate strategy
Start of Program	2005, ongoing
Geographical Area	National
Enforcement	Voluntary, not directly / co-financed energy audits (via. regions and national via other programme)
Financing	Financed by government / Ministry of Environment, annually
Costs	300.000 EUR / p.a.
Management	National energy agency (management)
Key Participants	Energy auditors, technology partners, chamber of commerce (partly)
Technology covered: Motorsystem approach /focus	Yes (CAS, Pumps, Fans, Motors)
Sector	production companies
Main Instruments	audit guidelines, tools, trainings, information, co-financed audits via regional programmes
Other Program Elements	workshops, conference, newsletter, award ceremony
Saving Calculation	Yes, suggestion within guidelines
Success Criteria	60 GWh energy savings p.a. (not only motor systems!) (mainly via award ceremony, audits not directly reported to Programme Management)
Other main Results	200 different persons trained (1-4 times) Training days per year: around 10-15 Conferences feedback: 100-200 persons per conference 72 Best Practice cases
Subjective: Main Success	Very good feed-back to trainings
Subjective: Main Drawback	Not evaluated directly on company and measure level (e.g. for audits incl. measures) Audits or energy concepts not stipulated by law, therefore difficult to evaluate effect on national level

Framework

In 2004 the Ministry of Agriculture, Forestry, Environment and Water Management has launched the klima:aktiv program for active climate protection. The programme combines various market-constituent measures in line with the Austrian Climate Strategy and effectuates target-oriented implementation. One of several Austrian klima:aktiv programs within the Austrian Climate Strategy is the national program 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 program are production companies (SMEs and industry) in the whole region of Austria. Its major target is to implement energy saving measures in the industry amounting to 50 GWh p.a. and more. Target oriented information and specialized consulting are the main instruments and should provide a basis for awareness raising on the possibilities of energy saving measures in companies.

Program Description

Target oriented marketing

For making industrial companies interested in reducing energy costs a wide base of marketing activities are set: direct contact and site visits, newsletter for energy managers, webpage with all relevant information (www.eebetriebe.klimaaktiv.at) and best case studies, articles, organization of seminars in cooperation with the chamber of commerce and different branch associations. Other activities are: award ceremony together with annual energy efficiency conference in production companies, target agreement of companies for committing to implement economic saving measures, benchmarking (not for motor systems), 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 organizes training workshops and supports consultants in these regions with detailed tools for energy audits and reports, covering all aspects and technologies of energy supply and demand in companies.

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

An Energy Check Simple is based on questions to all technologies.

To assist consultants to find and point out the major possibilities for energy savings and to define the area for further detailed energy audits an excel tool (Pro Tool) has been developed.

The detailed approach is dedicated to motor driven systems, at the moment three technologies are covered: 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 top saving measures, datasheet for onsite visits and calculation suggestion for evaluation of saving measures
- folder for decision makers
- trainings of consultants all over Austria (around 60-80 each year for each technology)
- template for a standard report.

The consultants were invited to make a system audit and send the report to the AEA. Those consultants have been listed on the website as klima:aktiv compressed air consultants.

Cooperation with:

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

Some of them are also klima:aktiv energy-efficient company programme technical partners (with right to use logo)

Recent developments

Improving the efficiency in Electric Motor Systems are one part of the Austrian energy concept (national energy strategy) for industrial users: The target is to give fiscal incentives for investments in efficient motors and frequency converters (investment support). The national subsidy bank (KPC-Kommunalkredit Public Consulting) is currently working on a subsidy scheme for the purchase of efficient electric motors and frequency converters.

References

Kulterer, K; energy-efficient company programme, paper for the eemods 2009 in Nantes, France

www.eebetriebe.klimaaktiv.at

3 China

Key words: MEPS, Compliance Testing

Name of Program	China Energy Label and others
Framework	Energy Conservation Plan
Start of Program	n.a.
Geographical Area	China
Enforcement	Law
Financing	State
Costs	n.a.
Management	CNIS (China National Institute of Standardization)
Key Participants	NDRC (National Development and Reform Commission), AQSIQ (Administration of Quality Supervision), CNCA (Certification and Accreditation Bodies)
Technology covered: Motorsystem approach /focus	Motors, pumps, fans, small motors
Sector	Industry, Tertiary
Main Instruments	MEPS, Labelling, Testing
Other Program Elements	Awareness, trainings
Saving Calculation	Efficiency gain between diff. motor grades
Success Criteria	Number of grade 1 (IE2) motors in the market / registered: 30%
Other main Results	High response to Motor user workshops,...
Subjective: Main Success	
Subjective: Main disadvantage	

Regulation-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. Some Examples:

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% (2010 vs. 2005).

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**, incl. motor driven systems. The plan requires for example accelerated elimination of

inefficient motors or use of 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 Peoples 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
- Promotion of efficient motors by fiscal tax incentive
- Setting standards for high efficient motors

Program-Description

MEPS

China has a long history in setting minimum efficiency standards and started with households refrigerators and room air conditioners in 1990. In 2006 an updated version of the 2002 standard for three-phase asynchrony-motors was published. Grade 2 motors correspond to CEMEP eff1 or IE2 motors, grade 1 motors are the most efficient motors corresponding to the Australian standard, approx. IE3. The second revision of the standard took place in 2010, efficiency classification will be updated. The new 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 Energy Efficiency standards for small motors (e.g. fan motors for room air conditioner from 6 W) is in the process of notification.

Labelling

Chinas energy efficiency labelling program covers over 21 domestic, commercial, lighting and industrial products, incl. medium- and small sized three phase induction motors, electrical fans, air compressors, electric transformers, and ventilation systems.

For motors 658 enterprises and over 43,000 models are registered in the database of the China Energy Label System. In 2009 2.2% grade 2 motors (IE2) were registered, 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-declaration information from suppliers. The information came either from suppliers' own laboratories or bodies independent of suppliers.

The China National Institute of Standardization (CNIS) has improved the system by e.g. round tests between labs, checking consistency of testing results. In addition a lab accreditation program was implemented. Furthermore a China reference-lab was built up in recent years. Its main activities are comprehensive compliance product testing and empirical data research for energy efficiency standards formulation and energy efficiency labelling implementation.

Equipment for motor-testing is currently being built up. It serves also as arbitration lab in the context of testing results dispute.

Other support-Mechanism

The large national **financial subsidy** program China Energy Savings Program, was issued in June 2009. The program will provide financial subsidy 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 taken into the scope 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)

The **Government Procurement** List of Energy-Saving Products implements compulsory government procurement to 34 categories of products, 9 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 program has developed optimization design codes, supported standard development, provided training and education in 7 provinces and cities.

A program for establishing mechanisms for the **adoption of high efficient motor systems** will include measures like awareness raising of decision makers, developing practical tools for evaluation and analysis, proposing innovative financing mechanism through CDM.

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

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Zhang Xin, CNIS, China Motor Standards and Labels, Zürich 2008

Xin Shen, Zhao Kai: Status and Outlook for Motor System Energy Conservation in China, eemods.09, Nantes, France

<http://www.motorsystem.org.cn/en/>

4 Netherlands

Key words: deduction of profit tax, measure list, user groups

Name of Program	LTA (Long Term Agreement) and EIA (Energy Investment Allowance)
Framework	Covenant: Agreement with government, industrie and Branch organisations
Start of Program	2003 ongoing
Geographical Area	National
Enforcement	Voluntary (but branch level), environmental licence
Financing	Government support program and knowledge transfer
Costs	150 FTE (Full time equivalent) Energy and Climate program by Agency.nl
Management	NL Agency, Ministry of Economic Affairs
Key Participants	Branch Organisations, Ministries, Companies
Technology covered: Motorsystem approach /focus	Lists incl. motorsystems (via MCP documents in measure list)
Sector	Companies with energy consumption above 0,5 PJ (140 GWh) or 280 GWh for branches
Main Instruments	EEP (Energy Efficiency Plan), Efficiency Targets, commitment for Implementation of Measures, Measure List, Energy Managementsystem, Annual Monitoring
Other Program Elements	User Groups, Energy Investment, Allowances
Saving Calculation	No
Success Criteria	900 companies participating, 55 TWh energy within the programme
Other main Results	On average 2.1% efficiency gains p.a.
Subjective: Main Success	
Subjective: Main disadvantage	

Framework

Long Term Agreements have become the main policy instrument for industrial energy conservation and CO₂-emission reduction. The objective of the agreements is to improve industrial energy efficiency without a negative effect on economic growth or 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 an energy efficiency improvement of, e.g. 20% in year XY compared with the level of 2008.

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 realization 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 EEP meets the requirements. Companies are also required to submit yearly reports on the progress made and the practice of systematic energy management.

For every sector the Dutch Energy Agency (a branch of the Dutch Ministry of Economic Affairs) has developed a specific list of energy efficient measures. The content of the Motor Challenge Programme modules (see Europe-MCP) are integrated in the new measure list for the LTAs.

The motor system efficiency quick-scan consists of scanning a part of the motor system within a company exploring energy efficiency options, measures are formulated and added to the EEP.

User Groups

User groups are a support instrument within the LTA Programme in which different companies from a 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 the fiscal profit over the calendar year in which the equipment was procured, subject to a maximum of EUR 113 million.

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. This includes a report detailing the action plan for electric motors, as described in the EU Motor Challenge Programme.

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SEnterNovem: Long-Term Agreement on Energy Efficiency for ETS Enterprises (LEE), <http://www.senternovem.nl/LTA/publications/index.asp>, abgerufen am 6.8.2010

SenterNovem: Long Term Agreements on energy Efficiency in the Netherlands, Results of 2006, Nov. 2007

SenterNovem: Long Term Agreements on energy Efficiency in the Netherlands, Results of 2008, Okt. 2009

5 Sweden

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

Name of Program	PFE - programme of improving energy efficiency in energy-intensive companies
Framework	Electricity Tax
Start of Program	2004, ongoing
Geographical Area	National
Enforcement	Voluntary, tax incentive to join
Financing	Government
Costs	7 MSEK p.a./ 640.000 EUR
Management	National Energy Agency
Key Participants	Swedish Tax Authority, Programme board (with branch associations and others) energy auditors
Technology covered: Motorsystem approach /focus	Yes (all)
Sector	Energy intensive production companies
Main Instruments	Energy audit, analysis, energy-management, carrying out saving measures (payback less 3 years) purchasing high-consumption equipment
Other Program Elements	Handbooks on energy management systems, on energy audits and analysis, on routines for purchasing and planning, calculation of LCC
Saving Calculation	Suggestion for LCC, handbook on analysis
Success Criteria	No clear target defined Saved energy: 1,4 TWh p.a. target of comp., 770 GWh reported 2010
Other main Results	Approx. 90 companies participating
Subjective: Main Success	Energy becomes a topic for high level management decisions, increased knowledge on energy use Better understanding between companies and authorities
Subjective: 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 of improving energy efficiency in energy-intensive companies) . The programme period for participating companies is five years. During the first two years of the programme period, the company must introduce and obtain certification for a standardized energy management system.

An energy audit 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. Furthermore the companies must follow specified routines for planning and purchasing electrical equipment. (Calculation of life cycle costs, high efficient electric motors)

When a company has participated in PFE for two years, it is required to submit a report on the energy audit, the energy management system, and the list of measures. The report is to be submitted via the Swedish Energy Agency's e-services. 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), mainly of the sectors pulp and paper, wood product, chemical, food and beverages, steel, iron and metallurgy, ore and mining have joined the programme. 860 measures were reported within the mid-term reports (for SEA 2009, results for 2008), saving 726 GWh. Among the measures, around 25% are within the production processes (accounting for 50% of the savings) and 75% are within surrounding systems, such as pumps, fans, compressed air systems, lighting and ventilation, as the programme focuses on electricity (Results 2009).

- Optimization 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 area. The share of savings, incl. 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 were mostly about installation of frequency inverters (VSD) (3.1% of savings).

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6 European Union-Motor Challenge Programme

Key words: Branding initiative, voluntary agreement

Name of Program	Motor Challenge Programme
Framework	Voluntary Agreement
Start of Program	2003
Geographical Area	Europe
Enforcement	Voluntary
Financing	European Commission Funding, Project Financing: DEXA MCP (2005-2007), 4 EM (till 2006-2008)
Costs	
Management	JRC (Joint Research Center-Energy Institute)
Key Participants	Endorsers, Partners, National Contact Points
Technology covered: Motorsystem approach /focus	Motor Systems
Sector	Not sector specific
Main Instruments	Action Plan, Promotion Plan, Measure Lists
Other Program Elements	Award Ceremony; Further elements: depending on national context, e.g. national plans as MCP plans, financing of consultancy for MCP plan, when investments are made
Saving Calculation	Recommendations for specific measurements
Success Criteria	Number of Participants: 95 Partners 93 Endorsers (2010) 289 Measures reported 185 GWh Savings:
Other main Results	MCP is known as Logo,
Subjective: Main Success	Network of national contact points established, Motor efficiency integrated in national frameworks (financing, programmes,...)
Subjective: Main drawback	No continuous financing Not so famous as green lightning or green building

The **Motor Challenge Programme (MCP)** is a voluntary programme of the European Commission (launched in February 2003) through which industrial companies receive assistance in improving the energy efficiency of their motor driven systems.

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 "Motor Challenge Module Documents" treating different aspects of Motor Driven System energy efficiency.

An organisation wishing to become an Endorser of the Motor Challenge program 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. Also annual reports are necessary. The endorser concept is open to organisations that intervene in some aspect of the design, building or operation of Motor Driven Systems. (manufacturers, engineering consultancies, trade associations, training institutions...)

Companies that use Motor Driven Systems can request "**Partner**" status. Through the Motor Challenge, 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.

An enterprise wishing to join the Motor Challenge programme as partner has to formulate an Action Plan defining the scope and nature of the enterprise's commitment. These Action Plan contains measures that are linked with the separate Module documents for Compressed Air Systems, Pump Systems, Fan System, Drives (electric motors and speed controllers), 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 so called National Contact Point, which gives information and support on the MCP. In Austria this is the Austrian Energy Agency.

In the frame of international conferences (e.g. eemods 05, 07, 09, or the 08) MCP awards were given to the selected companies and endorsers. Within two European projects (DEXA MCP, 4 EM) a network of national contact points were built up. Furthermore new guidelines were developed (cooling systems, electric distribution network) and a technical guideline was developed. In addition the national contact points integrated main elements of the MCP tools and principles within national programmes.

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”. 48% of the total estimated savings were implemented in the area of motors and drives.

In total all MCP measures resulted in an estimated annual energy saving of 185,104.5 MWh and savings of 87,250.8 tons of CO₂ emissions per year, which represents an estimated 0.02 % reduction of the total electricity consumption in EU 27's industry.

The most successful implemented single MCP measures concerning the estimated energy savings however is not in the area of drives, but “pump selection” in the areas of pumps. The second most successful MCP measures is “not specified” action in the area of “drives” followed by the upgrading of motors from lower to higher (CEMEP eff1) efficiency classes also in the area of “drives”. The top three measures alone account for 48.33% of the estimated total.

Based on the evaluation of a written questionnaire by MCP Partners, the scheme received a highly positive judgement by MCP Partners itself. 41% of the responses saw MCP as instrumental in convincing the company to implement energy efficiency measures.

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7 Switzerland

Key words: awareness raising, information exchange

Name of Program	Topmotors
Framework	SwissEnergy, Swiss Federal Office of Energy
Start of Program	2007
Geographical Area	Switzerland
Enforcement	Voluntary
Financing	SwissEnergy, Swiss Federal Office of Energy
Costs	200 k €p.a (2010)
Management	S.A.F.E. Swiss Agency for Efficient Energy Use
Key Participants	Manufacturers, OEMs, importers, and organisations from industry, infrastructure plants, large building owners. Universities for applied sciences and testing labs.
Technology covered: Motorsystem approach /focus	Electric motors and motor systems. Motor-Check for existing systems.
Sector	Industry, infrastructure, large buildings
Main Instruments	Advisory service, education/training, best practices and pilot audits. Tools and software for audit. Website, workshops, training of energy auditors
Other Program Elements	Bi-annual international Conference (Motor Summit), motor measurement program with testing labs.
Saving Calculation	Excel tools for savings potential evaluation (SOTE) and for motor stock analysis (ILI)
Success Criteria	<ul style="list-style-type: none"> • Number of objects (plants, buildings) with energy efficiency measures implemented • Number of training and information material downloadsInterest towards workshops organised (number of participants, need for further workshops)

Other main Results	GWh saved
Subjective: Main Success	Build up of knowledge network of motor users and service companies in Switzerland.
Subjective: Main disadvantage	

Framework

45% of Swiss electricity consumption is used by electric motors (26 TWh). The overall electric energy saving potential is around 20% (5 TWh). The economic saving potential is estimated about 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 program (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/training. Minimum energy performance standards (MEPS) are implemented as separate legal act, e.g. for electric motors and other appliances, see energy ordinance.

Program Description

The Swiss Agency for Efficient Energy Use (a non-governmental organization) started the Implementation programme "Topmotors" in 2007 – 2010 and will continue for the second period from 2011 – 2013.

Topmotors targets organizations 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.

Topmotors is an information and methodology source. There is no enforcement: participation means using the materials and method offered. Power utilities (BKW, EKZ), industry associations (Swissmem, SwissTnet, ProKlima), non-governmental organisations (EnAW) and OEM manufacturers (Bühler) are involved as partners. One goal is to set up a network of testing laboratories.

The programme organized trainings of the EnAW moderators as key multipliers in the implementation of the voluntary agreements and reaching energy saving targets for Swiss companies (this instrument is coupled to reduced CO₂-taxes.) In addition special trainings for motors and pump checks, training for energy consultants and account manager and a workshop for on-site measurements were organized.

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 program phase efficiency improvements have been commenced and are ongoing in 15 pilot objects.

Lessons learned: Motor systems are typically old and inefficient, motors are oversized. It is difficult to motivate organizations for an investment into efficient motor systems. Reasons are:

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

To complement Topmotors, a financial incentive program (“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 Eurocent subsidy per kWh saved.

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8 United Kingdom

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

Name of Program	Enhanced Capital Allowance (ECA) scheme
Framework	Climate Change Levy Programme
Start of Program	2001, ongoing
Geographical Area	National
Enforcement	Voluntary, fiscal incentive (first year allowance)
Financing	Financed by government
Costs	
Management	Carbon Trust on behalf of government
Key Participants	HM Revenue and Customs, Department of Energy and Climate Change
Technology covered: Motorsystem approach /focus	Yes (CAS, 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.
Other Programme Elements	Lot of guidelines (purchase, installation, use) of motor systems
Saving Calculation	Criteria list for products, no
Success Criteria	Proportion of IE2 motors up from 5% (2001) to 15%, 90% (2009) of ventilation systems equipped with VSD
Other main Results	CO ₂ savings estimated
Subjective: Main Success	
Subjective: Main drawback	No incentive for pumps or fans (in ECA), no pumps (in building regulation)

Framework

The Market Transformation Programme (MTP) supports the development and implementation of UK Government policy on sustainable products. 2010 it managed the second consultation that sets out 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 Market Transformation Programme produces 4 Government Standard Briefing Notes per product (or product area): 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;

In the Annex 8 paper of the consultation paper “Motors & Circulators” it is expected 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 (Europe), the Enhanced Capital Allowances (ECA), Quick Wins and the Building Regulations. For Circulators also other policies, like the Carbon Reduction Commitment and the Energy Saving Recommended Scheme (ESR) may also have an impact. Currently there are no measures applicable to pumps.

Program description

The Carbon Trust provides specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies and published a lot of guidelines in the field of motor driven systems, e.g.: variable speed driven pumps, energy savings in fansystems, how to implement VSDs.

The Carbon Trust also manages the Enhanced Capital Allowance for energy saving-technologies (ECA) scheme. It enables businesses to claim 100% 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 on a reducing balance basis. ECAs bring therefore 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 lot of technologies from boiler equipment to solar thermal systems.

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 3,000 to 100,000 Pounds on an unsecured basis and payable over a period of up to four years.

For the use of VSD the Building Regulations are very important, as they 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 eff1 (IE2) is required. In addition this scheme is aligned with the products included in the List of the ECA.

Results

Current performance level (2009) is set at IE2. This is estimated to have resulted in an increase in sales of 5% per annum in 2001 to 15% per annum 2009.

Estimated 90% of mechanical ventilation systems are now supplied with VSDs (correlating with 21% of motor sales).

2010 revision of the Building Directive is expected to introduce recommendations encouraging the use of VSD in variable duty pump applications.

In 2008 in an evaluation of the ECA scheme it was estimated that CO₂ savings resulting from purchases of four technologies (boiler, lighting, refrigeration and motors and drives) resulted in 600,000 t of CO₂ in the first year or 2,800,000 t of CO₂ over the life of equipment. (for all technologies the values are 1.700 kt and 9,450 kT)

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HM Revenue and Customs, with HM Treasury and Defra: Evaluation of Enhanced Capital Allowance for Energy Saving Technologies, May 2008

9 United States

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

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

Keywords: MEPS, trade mark, financial incentives

Name of Program	NEMA Premium ®, MEPS
Framework	Energy Policy Act
Start of Program	1992---1997: (EPAAct), 2001: NEMA Premium (Voluntary); 2007—2010 (EISA)
Geographical Area	US, Canada
Enforcement	Law, voluntary (NEMA Premium)
Financing	
Costs	
Management	Government, National Electrical Manufacturers Association (NEMA)
Key Participants	Government, NEMA, motor manufacturers
Technology covered:	Motors 1-200 hp (EPAAct)
Motorsystem approach /focus	Motors 1-500 hp (EISA)
Sector	Industry, Commercial, Agricultural
Main Instruments	MEPS, trade mark
Other Program Elements	Financial incentives by utilities
Saving Calculation	
Success Criteria	Market share of Premium Efficiency motors: NEMA Premium 27% market share in sales (2006) due to voluntary program coupled with utility incentives
Other main Results	
Subjective: Main Success	
Subjective: Main drawback	At the moment no motor system approach

Minimum Efficiency Standards (Epack), (EISA)

The Energy Policy Act of 1992 (EPAct) imposed mandatory minimum full-load energy efficiency standards on 1-200 horsepower (hp) (0.75 kW to 375 kW) general purpose 60 Hz integral horsepower 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 applied to imported motors and motors purchased as components of other pieces of equipment.

The implementation of the MEPS went into effect in 1997. The transition to Epack 92 was responsible for transforming the market so that approximately 65% of all integral horse power motor sales 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 were: agreed test standards and methods, test lab accreditation process, labelling standards, compliance procedures, and cooperation with manufacturers association and non-profit organizations (ACEEE).

In 1996 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 EPAct requirements.

In 2001 the U.S. electric motor industry reached consensus on a specification defining premium efficiency motors (motors with efficiency levels exceeding Epack 92) and agreed to include the definition in NEMA industry 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. The standards also covers medium voltage ($\leq 5,000$ Volt) open or enclosed motors rated between 250 and 500 hp. Furthermore the mark NEMA Premium ® (approx. IE3) was developed for the exclusive use of manufacturers signing a memorandum of understanding. Demand for NEMA Premium efficiency motors increased to approximately 27% 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 1200, 1800, and 3600 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 EPAct 1992 levels as the minimum efficiency baseline for these motors. EISA also extended the NEMA Energy Efficient (IE2) MEPS to cover general purpose motors between 201 and 500 hp and includes 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 Programs

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

Many utilities offer incentives for installation of 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 VFDs to motors or pumps, by offering \$75 per horsepower controlled.

Results

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

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9.2 US Motor Systems Initiative

Key words: premium motors, support national and utilities program, system approach, tailored made tools

Name of Program	Motor Systems Initiative
Framework	Initiative of a non profit corporation for its members
Start of Program	1999
Geographical Area	US
Enforcement	Voluntary
Financing	NPO (utilities programs and others)
Costs	
Management	Consortium for Energy Efficiency
Key Participants	Utilities, national programs
Technology covered: Motorsystem approach /focus	Motor systems
Sector	Industry, commercial user
Main Instruments	Awareness Programme, tools, premium efficiency motor list, brochures
Other Program Elements	Training sessions
Saving Calculation	
Success Criteria	82% of US and Canadian program administrators indicated that motors are included in their programs
Other main Results	
Subjective: Main Success	
Subjective: Main drawback	

Consortium for Energy Efficiency Initiatives

The Consortium for Energy Efficiency (CEE), a nonprofit 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 programs include three initiatives (premium-efficiency motors, motor systems, and transformers) as well as supporting activities like Motor Decisions Matter and the Compressed Air Challenge.

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 Initiatives 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 program 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.

CEE publishes for example:

- Premium Efficiency Motor List
- Selection and Application Considerations Brochure

The Motor Systems Initiative is developing a tool kit to help motor program 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 launched along with industry (motor manufacturers, motor service providers, trade associations) and government forms a national awareness campaign named MDM which aims to create a 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 organized, the *MotorUp* publication is distributed to publicize utility rebate programs and success stories, and the website www.motorsmatter.org is maintained.

Compressed Air Challenge

The mission of the Compressed Air Challenge (CAC) is to provide resources that educate industry about optimizing 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 analyze 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.

Green Motor Initiative (GMI)

Green Motor Initiative (GMI) is the first initiative of its kind, offering financial incentives to Green Motors Practices Group members 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" qualify for incentives: GMPG member service centers will receive \$2.00 per horsepower for each GREEN REWIND. The service center must pass along an instant rebate credit of at least \$1.00 per horsepower to their customer on the rewind invoice.

(www.greenmotors.org)

Investments in Energy Efficiency Measures

U.S. and Canadian natural gas and electrical energy efficiency budgets for the ratepayer funded energy efficiency industry grew to \$7.5 billion in 2010---a 23% increase over 2009 budgets. In 2009, the annual CEE Evaluation reports estimated electrical energy savings of 104,000 GWh in the US and Canada. 82% of US and Canadian program administrators indicated that motors are included in their programs, 76% of them have drives in their programs.

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9.3 U.S. Motor Challenge Program

Keywords: System approach, tools-development, partner integration, mother of MCPs

Name of Program	Motor Challenge Program
Framework	Promotion of voluntary industry/government partnership
Start of Program	1993; 1999 consolidated into BestPractices
Geographical Area	US
Enforcement	Voluntary
Financing	U.S. Department of Energy
Program Costs	\$29.2 million USD
Management	U.S. Department of Energy
Key Participants	Utilities, motor system supplier
Technology covered: Motor/system approach /focus	Motor Systems (Pumps, Fans, CAS)
Sector	Industrial, commercial
Main Instruments	Information, tools, workshops, conferences,
Other Programme Elements	Partner agreements
Saving Calculation	Yes, in tools (e.g. efficiency level of motors)
Success Criteria	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
Other main Results	High response, increased awareness
Subjective: Main Success	
Subjective: Main drawback	

Department of Energy Programs

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 3 ½ day compressed air workshop DOE and the Compressed Air Challenge® are recognized 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.

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 program 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 optimization.

The Program 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 program message, Motor Challenge recruits suppliers, distributors, utilities, state agencies, consulting engineers and others as Allied Partners. This effort has been highly successful to provide 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 program offerings.

The program published reference books on energy efficiency, so called Sourcebooks for Industry for pumping systems, fans, steam systems, process heating systems and compressed air.

Results

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 program and 48% of those who participated in the Pump System training program reported that they implemented improvements to the efficiency of their systems that they would not have made in the absence of the program.

Similarly, an assessment of end users who received the Energy Matters newsletter found that one-third reported that they had 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 optimization" of motors is now receiving increased attention by companies and in the marketplace. A lot of countries showed interest in the program, e.g. Europe and China already copied the program.

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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 calendar year 2006, the program 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 \$28.2 million USD.

References

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U.S. Department of Energy LEADER Companies and Superior Energy Performance

The DOE's Industrial Technologies Program (ITP) is partnering with industrial companies with the 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, and pumping system assessments etc..

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). 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 program in this area (ISO 50001).

10 Policy Summary

10.1 Overview on described Programmes

Country-Programme-	Financing, Management	Programme Elements	Result
		Supportive Actions	
Australia Equipment Energy Efficiency Programme	Australian Government (Department of Climate Change and Energy Efficiency, et.al), E3 Committee	<ul style="list-style-type: none"> • MEPS • Accredited Laboratories • Compliance Testing • Sanctions 	<ul style="list-style-type: none"> • 6,000 motors • 20% Voluntary High Efficiency
		<ul style="list-style-type: none"> • Voluntary High Performance • Public-Awareness (web) • Government Procurement 	
Austria klima:active energy efficient companies programme	Ministry of Environment Austrian Energy Agency Regional energy audit support programmes	<ul style="list-style-type: none"> • Training of Energy Auditors • Audit Guidelines for Motor Systems (CAS, Fans, Pumps) • Template for Audit Report 	<ul style="list-style-type: none"> • 60 GWh p.a. savings (not only motor systems)
		<ul style="list-style-type: none"> • Award Ceremonies • Workshops • Conferences 	
China China Energy Label, et.a.:	National Government	<ul style="list-style-type: none"> • MEPS • Labelling • Lab Accreditation Programme • Financial subsidy (for high efficient motors) • Income tax concessions • China Market Transformation Programme • Motor Systems Challenge 	<ul style="list-style-type: none"> • Share of IE2: 30% of registered motors

Netherlands Long Term Agreements (LTA)	Ministry of Economic Affairs Dutch Energy Agency (former SenterNovem)	<ul style="list-style-type: none"> • Voluntary (on branch level), Target for energy efficiency improvement, • Measurelist with motorrelevance, Motor system quick scans 	<ul style="list-style-type: none"> • 2,2% p.a. energy efficiency gains (over all technologies)
		<ul style="list-style-type: none"> • User Groups • Investment Allowance 	
Sweden Programme of improving energy efficiency in energy-intensive companies	Government Swedish Energy Agency	<ul style="list-style-type: none"> • Voluntary • Tax incentive to join 	<ul style="list-style-type: none"> • 1,4 TWh Savings, (75% of savings within surrounding systems)
		<ul style="list-style-type: none"> • Energy management • Energy audit, saving measures • Purchasing recommendation (LCC for motors) • Conferences 	
Europe Motor Challenge Programme	Joint Research Center, National Contact Points	<ul style="list-style-type: none"> • Voluntary • Use of LogoSpecific Motor Measure List • MCP-Action Plan signed by management 	<ul style="list-style-type: none"> • 95 Partners, 93 Endorsers • 185 GWh
Switzerland Topmotors	SwissEnergy, Swiss Federal Office of Energy Swiss Agency for Efficient Energy Use	<ul style="list-style-type: none"> • Advisory service, Education/training • Tools and software for audits, Website 	
UK Enhanced Capital Allowance Scheme	Government Climate Change Levy Programme, Carbon Trust	<ul style="list-style-type: none"> • 100% first year capital allowance for motors, drives, PM-motors, CAS components • Carbon Trust (Information, guides), • Energy-efficiency loans 	<ul style="list-style-type: none"> • 15% IE2 Motors (2009) from 5% (2001)
US Epact92, EISA NEMA Premium Utility Rebates	Government, National Electrical Manufacturers Association (NEMA)	<ul style="list-style-type: none"> • MEPS • Standards 	<ul style="list-style-type: none"> • 27% NEMA Premium Market share in sales 2006

	US Motor Systems Initiative	Consortium of Energy Efficiency Initiatives (Non Profit)	<ul style="list-style-type: none"> • Forum for members • Motor system tools (Motor decision matters, Compressed air challenge) 	<ul style="list-style-type: none"> • 104,000 GWh electrical savings, in US and Canada (not only motors)
	US MCP Save Energy Now, LEADER	Department of Energy's Office of Energy Efficiency and Renewable Energy	<ul style="list-style-type: none"> • Free software tools, BestPractices. 	<ul style="list-style-type: none"> • MCP: 520 GWh savings: (for 6 years)
			<ul style="list-style-type: none"> • Awareness Raising • Assessments a.o 	

10.2 Programme-elements

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

Legal enforced Minimum Standards for Motor System Components

Legal binding standards for efficiency of electric motors are getting more and more spread around the world. (E.g. US, Europe, China, Australia, Korea, Brazil and others). Furthermore standards are set for other motor system components, as pumps, fans and compressors. (China, Europe). Those minimum standards take inefficient motors from the market.

National and international standardization was the key criteria for policy to set minimum standards. But even before e.g. US (public) energy utilities gave financial incentives for buying energy efficient motors and therefore had some criteria developed. Some questions, on market surveillance and certified testing centers or laboratories are still open and tackled by some countries, e.g. Australia and China and on international level.

Building Regulation

The UK encourages the use of frequency converters within the building regulation.

Labelling, Voluntary High Performance (NEMA Premium)

For getting high efficient motors in the market (beyond minimum standards) labelling is used.

Examples for labelling high energy efficient motors are: NEMA Premium (US), Voluntary High Performance Standards (Australia), IE3 (Europe), Grade 1 Motors (China)

Labelling is often used with financial incentives for the installation of high efficient motors.

Purchasing Recommendations (alternative LCC Analysis) for Efficient Motors

Programmes for Government Procurement (Australia, UK, US, others) or the recommendation for purchasing high efficient motors within programmes for energy management systems (Sweden) can help to get high efficient motors in the market. The same could be true for efficient installations and/or services.

Financial Incentives for higher efficient motors and the purchase of other equipment

This element is widely used (China, UK..). Different approaches are:

- Capital allowances (e.g. 100% first-year capital allowance on investments in energy-saving equipment)
- Loans (interest free energy efficiency loans for the purchase of energy-saving equipment)
- Tax incentives (e.g. reduction of electricity-tax upon participation in energy-efficiency programme)
- Rebates (e.g. US\$/High efficient motor)

Energy Audits

Energy audits have generally the advantage, that the whole system (e.g. from compressor to the machine or tool) can be addressed. On the other hand it is not easy to define exactly what should be done during the audit and the price of a good audit may be too high. A focus on special technologies is therefore recommended. E.g. US, Europe's MCP and Austria energy efficiency programmes use this approach.

To assure high quality audits guidelines, training, tools, audit report templates in combination with financial support for energy audits are offered.

Training, Education

"Train the experts" concepts are sometimes used, e.g. in the US and China, to train experts in the field of energy efficiency (e.g. ESCOS). Education in University was not explicitly mentioned within the program descriptions.

Industrial Energy Efficiency Programmes with EE-Targets

Voluntary agreements programmes with binding efficiency targets include very often big industrial companies. 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, incl. measure list, and/or purchase-criteria for high-efficient motors (Sweden).

Energy Management

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

Once again standardization (EN 16001, ISO 50001) will improve motor system efficiency via wide-spread use of energy management. At the moment this approach is used e.g. in Netherlands and Sweden where purchasing criteria (e.g. CEMEP eff1) 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

This part is on the one hand self-evident on the other hand a little under-estimated. Getting public awareness may be rather expensive, nevertheless it is quite important.

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-Cases are used to transport the main message of saving electricity in motor-driven systems (e.g. Austria, US, UK, MCP Europe). For best-practice recognition award ceremonies are helpful, pilot projects are also sometimes used.

Tools for End-User

In combination with web-pages self-evaluation tools, system assessment guides and tip-sheets are published (US, UK, Switzerland). Another example are databases with software and/or user interfaces for the selection of energy-efficient motors (US, Europe). Sometimes specific benchmarking tools are published (e.g. for compressed air systems in Switzerland).

10.3 Recommendations for a successful programme:

Long lasting and independent

Carbon Trust (UK), Motor Challenge (Europe, US), klima:aktiv (Austria) are recognized brands that took several years to be built up. Program management should be objective and independent financed to be recognized as an unbiased source of information.

For gaining impact several years are necessary to fully roll-out the program and reach all relevant stakeholders and get public recognition.

Communication, Multipliers

A long lasting stable program-management can build up long lasting contacts to all relevant stakeholders: government, regional contacts, experts, manufacturers, installers, service companies, energy consultants. Similar relevant are good contacts to branch organisations, chamber of commerce, industrial organizations, manufacturers organizations...

Especially for full impact of the program and for further development it is of great importance to integrate market players, like producers of motor systems and sales companies.

For direct contact to motor-system users it is often helpful to work with regional contacts or local energy utilities.

Importance for Success Criteria, Monitoring

For motivation of all participants and for getting continuous financing, the definition of success criteria are helpful. Independent monitoring can increase this effect. These elements are not integrated in all the programs:

Targets, Criteria could be

- Share of high efficient motors in the market
- Sold units or systems installed
- CO₂, electricity savings
- Number of end-user and/or service/installation
- Companies reached via trainings, presentations etc.
- Number of energy audits, according to standard/guideline
- Number of energy auditors trained
- Market recognition of label or programme
- Number of support tools user

Monitoring, Compliance, Evaluation

A monitoring concept should be established. For successfully monitoring such a program, it is clear that a close contact to service companies, partly to the industrial companies is crucial. Therefore an energy efficiency reporting structure for reporting achieved savings should be implemented, e.g. via annual reporting within a voluntary agreement or via financial support of implemented saving measures.

Closely related to the issue of monitoring are procedures for the evaluation of the impact of the programme and or the definition of saving calculations. This process should be defined when success criteria are set-up.

For testing within MEPS- and labelling programs accredited test labs should test products according to a standard, in addition it should be defined according to which criteria products are tested.

Public Annual Reports

Some programs publish annual reports with monitoring results. This approach is depending on financial sources and strategic considerations. Who will read this report, which information is relevant?

What is left to do?

How exactly motor system aspects can be integrated in national financial and/or MEPS initiatives is not obvious.

The European Commission is publishing MEPS for machines like compressors, fans and pumps. These measures increase the energy efficiency of the single products and not of the whole system.

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

But in addition several other aspects are relevant, e.g. switching off on weekends or correct seizing of machine and motors. For this approach historical and current examples are co-financed audits, guides and trainings for motor experts. In addition the Motor Challenge program has given recognition on energy management aspects, e.g. measure list signed by the management of a company.

A combination of the following elements are crucial:

- Training of experts on-site, of installers, planners, maintenance engineers and of energy auditors;
- focus within energy management on motor systems (e.g. planning process, target setting);
- clear guidelines (e.g. assessment guides, decision making tools) for optimized installation of systems are highly relevant;

A number of proposals to further increase the efficiency of motor-driven systems were already introduced in the US but never incorporated into law. These proposals addressed motor repair/replace decision-making, increased use of adjustable speed drives (ASDs) and the adoption of new motor technologies. Specific measures considered:

- An early retirement rebate program to encourage end user to replace instead of repair failed motors (25 USD per horse power incentive)
- Tax-credit to OEMs or end-users for adoption of VSD in motor systems (terms and amounts not been completed)
- Tax credit for OEMs who adopt new future technologies (electronically commutated permanent magnet, interior permanent magnet and switched reluctance motors).

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