EMSA- Policy Guidelines for Electric Motor Systems

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Abstract

An important insight into energy efficiency policy around the globe is that there is no single instrument that is able to bring alone energy savings swiftly. Also, the most cost efficient solution will not automatically be adopted in the industrial context because other elements influence decision making like risks and value attributed to energy efficiency. Therefore a mix of policy instruments is needed to overcome the barriers for energy efficiency.

Within the IEA 4E Project Electric Motor Systems Annex the EMSA Task “Motor Policy” will design and propose a global policy guideline for exploiting efficiency potentials in motor driven systems - consisting of mandatory, voluntary and financial measures as well as procedures for monitoring and compliance. The publication targets policy makers both in industrialized and in developing countries.

Examples of mandatory policies and related issues are international energy efficiency standardization, testing procedures and based on that mandatory national minimum energy performance standards, product certification and registration programs and compliance aspects.

Examples of voluntary measures are labeling programs, voluntary agreement schemes, energy management and energy audit programs, several awareness raising instruments (incl. training, guides, tools, benchmarking, etc.).

Financial instruments are for example tax allowances, grants and rebates, soft loans, guarantees for credits, contracting, etc.

International exchange is another important issue, therefore conferences, events and international initiatives will be described.

This paper presents an overview of the content of the publication (now in draft stage) and shows a few examples of mandatory and voluntary policies to give a current insight.

Introduction

The IEA Implementing Agreement "Efficient Electrical End-Use Equipment" (4E) is driving governments and industry to higher concerns for energy to be saved. Within 4E the "Electric Motor Systems Annex" (EMSA) steers the motor technology world towards the necessary knowledge and empowerment to reap the fruits of energy savings promised by new technology and better design and the economy of higher fuel and electricity prices.

EMSA has been engaged in motor policy since its outset in 2008. A first analysis was published in 2009 as "Motor MEPS Guide" [1] profiting mainly from the US experience in setting mandatory standards. In 2011 a second volume followed: "Motor Policy Guide, Part 1: Assessment of Existing Policies" [2] analyzing motor policy instruments in nine countries/regions. Now the "Policy Guidelines for Electric Motor Systems" is proposed that summarizes the experience in various countries with mandatory and voluntary schemes, with or without financial incentives and a multitude of information elements.

The goal of the planned Policy Guidelines for Electric Motor Systems is to propose guidelines for policy makers both in industrialized and in developing countries on which policy instruments shall be applied to reach market transformation of motor systems (a sort of "cook book") and what needs to be taken into account when implementing such policy instruments. The publication will show successful examples deemed worthwhile to follow.

The Policy Guidelines for Electric Motor Systems shall be ready as a complete draft by the end of 2013, to be reviewed and edited for publication by mid-2014. The report will be published online (www.motorsystems.org) and will be announced to an interested larger audience through EMSA newsletters and at international conferences (eceee Industrial Summer Study, Motor Summit, etc.).

Switzerland (represented by A+B International) and Austria (represented by the Austrian Energy Agency) are responsible for the first drafts. During 2013 more international experience and expertise will be invited to contribute substantially to this document. The following text shows an overview and some examples of the current status (May 2013) of the document.

Overview of contents

In the Policy Guidelines for Electric Motor Systems policy instruments are grouped into three main categories of policy measures (mandatory, voluntary and financial measures) and international exchange is handled in an own chapter (see table below).

Overview of the table of contents of the Policy Guidelines for Electric Motor Systems

Chapter no.	Main chapters
1	**Executive summary**
2	**Introduction**
3	**Organisational structure of national motor policy implementation**
4	**Mandatory measures**
4.1.	International standards for efficiency testing and efficiency classes for motors and systems
4.2.	Build-up of necessary testing capacity and quality (training, accreditation, round robin)
4.3.	Mandatory national efficiency requirements
4.4.	Product certification
4.5.	Product registration
4.6.	Compliance (monitoring, verification & enforcement)
4.7.	Mandatory audit programs
5	**Voluntary measures**
5.1.	Labelling
5.2.	Product certification (IECEE)
5.3.	Voluntary agreements with industry
5.4.	Awareness raising
5.5.	Company motor policy
6	**Financial incentives**
6.1.	Potential sources of funding programs
6.2.	Tax allowances for energy-efficiency investments
6.3.	Grants for optimization of old and new systems
6.4.	Soft loans
6.5.	Guarantees for credits
6.6.	Contracting
6.7.	Electricity tariff benefits for energy-efficiency-investment
7	**International exchange**
7.1.	Initiatives
7.2.	Institutions, organizations
7.3.	Events
8	**Conclusions and recommendations**
9	**List of abbreviations**
10	**References**

Examples of Mandatory Measures

Under this heading mainly Minimum Energy Performance Standards (MEPS) are described in this paper, in the Policy Guidelines for Electric Motor Systems other instruments as international

standards for electric motor system, testing procedures and based on that mandatory national minimum energy performance standards, product certification and registration programs and compliance aspects will be included.

Minimum Energy Performance Standards

The concept of mandatory minimum energy performance standards (MEPS) is based on the experience that industry will rarely adopt new and higher efficiency technology if it involves higher purchase costs. Even if mainstream economic theory and industry itself suggests that cost-effective decisions and investments are made, the reality in many industry projects shows that the barrier for a life cycle cost based investment plan is too high and the concern for wasted energy is too low.

The USA National Electrical Manufacturers Association (NEMA)/American Council for an Energy-Efficient Economy (ACEEE) approach in setting up mandatory MEPS has proven this point and has shown a successful market transformation.

The policy approach for mandatory MEPS is manifold. It consists of a sequence of steps that are described in the table below:

Steps for introduction and renewal of MEPS

Step	Measure	Level
1	Set internationally harmonized standards for motor efficiency testing and efficiency classes.	International
2	Raise national awareness for importance of energy efficiency, electricity use in industry with electric motor systems.	National
3	Initiate legal process of having the authority to issue market transparency (energy labels) and market transformation (MEPS).	National
4	Assign authority to entity responsible for setting targets, issuing MEPS, define testing procedures, accredit testing laboratories, develop product registration and define sanctions for violating products and industry.	National
5	Set-up research team for market data and technology development, for research of environmental effects of more efficient products, on impact on market structure and burden for investments in industry.	National
6	Stake holder process to define time line for targeted values.	National
7	Issue legal document (national law) for setting the MEPS.	National
8	Start monitoring & verification program with check-testing of compliance. Publish annual report on process and progress.	National
9	Define update cycles of MEPS.	National

Minimum energy performance standards are set by national authority through national laws. The law requires usually a defined list of products, a methodology to set MEPS and a government entity charged with this procedure. Many countries with MEPS for electric motors have detailed legal procedures on negotiating with stakeholder groups and universities to agree on a precise level of MEPS plus a subsequent introduction and development plan to later increase the MEPS in a predefined sequence.

Industry is usually invited to collaborate with the responsible government agency and is then involved in the stakeholder consultation through their industry associations and some key manufacturers. In the European process also NGOs were invited for this stakeholder dialogue. This helps to formulate targets in a triangular configuration involving three major groups of stakeholders:

- Government, interested in a balanced approach to MEPS that can be successfully brought into law respecting parliamentary majorities and procedures. Governments do not want to privilege certain industries or "punish" other industries with severe burdens that they cannot carry easily. Governments want to have a positive impact of MEPS on the national employment situation and on international competitiveness of the domestic industry.

- Industry, interested in low interference into free markets and low responsibility of added mandatory restrictions for energy efficiency. Industry is afraid of low quality and cheap import products that take market shares away from national manufacturers. This is a strong argument for MEPS. Usually some of the leading industry will take the front runner approach and make energy efficiency its business model and its brand. Thus some leading manufacturers can influence the development in a positive way.

- NGOs, interested in long-term development, CO2 mitigation and energy savings. They can coordinate different NGOs and gain technical and policy know-how to influence the decision making process.

Based on sufficient technical evidence from independent research sources, mid- and long-range performance targets can be set. It is best if the methodology for setting targets and deciding on MEPS is transparent with a well-defined timeline and the research is based on national market surveys and recent technical developments.

The procedure for setting MEPS takes several years, allowing industry to prepare new product lines with high efficient products and to abandon older inefficient products from their production.

Examples of Voluntary Measures

Before choosing the right policy instrument out of a broad branch of possibilities careful analysis is needed, which should include the identification of the market forces (all actors in the market chain to implement energy efficiency measures) that have to be strengthened.

Differentiated policy strategies are needed to provide incentives as well as support both in the long-term and the short term perspective. Existence of and possible interaction with other energy/CO2 related policy instruments should be evaluated. “Normally a policy instrument will need to be part of a package of instruments in order to increase the combined efficiency and effectiveness and overcome all market barriers” [3, p. 18]

Therefore the first step is to involve relevant stakeholder and market actors in the design and the construction of the policy instrument. Usually these are: industrial associations, chambers of commerce, ministries for environment, relevant regional and local partners (e.g. energy agencies), and financial institutions (banks, e.g. for subsidies).

A difficult step is the estimation of the expected impact and cost-efficiency of the policy instruments. Usually studies on this issue are done before implementing the policy package.

Another part is the definition of the target of the instrument. It should be: specified (concrete as possible: what is aimed for, who is targeted), measureable (measureable objectives), ambitious (targets should go beyond business as usual), realistic (with respect to desired effect, available

budget and timeframe), time framed (when should results be achieved). [3, p 19]. Also, already in the planning status monitoring activities have to be considered.

Under the heading voluntary measures mainly labeling, energy audit and energy management program and tools are described in this paper, in the “Policy Guidelines for Electric Motor Systems” other instruments as voluntary agreement schemes, benchmarking, guides, databases, trainings and companies motor policy will be included.

Labeling

Energy efficiency labels are well known internationally to show energy efficient products to end consumers. They exist in different shapes and classifications within various national programs for a multitude of products: electric appliances, electronics, electric motors, pumps, cars, etc.

An energy label for electric motors must be based on two basic pre-requisites:

- An international (or national) testing standard for the energy efficiency of a product.
- A national labeling directive that sets the thresholds between each label class; IEC 60034-30-1 for electric motors defines these thresholds already and gives an indication for the information on the motor rating plate.

National legislation is necessary to implement mandatory labelling for a given product with a precise scope, to define whether the label is to be displayed at the place of sales (or permanently to be displayed on the product) and to give the authority to laboratories in industry or third-parties to assign a label to a product.

Energy Audit Programs

Energy audit programs are a very cost efficient way to reach national targets on greenhouse gas reduction or increase in energy efficiency.

An audit program is not a single instrument but a policy package consisting usually of:

- an informative instrument (recommending energy saving measures through audits)
- a financial instrument (subsidy to companies in the industry and service sectors).

From the energy audits, saving potentials and saving measures are identified. The companies and organisations then decide whether to carry out saving measures or not. [3]

From the policy design point of view, an energy audit program usually consists of several elements:

- The implementing instruments: like the legislative framework, the subsidy/financial scheme and other incentives/promotion and marketing activities.
- The administration of the program with the interaction of the key players (the administrator, very often government level body, the operating agent (e.g. an energy agency), the auditors, and the participating organizations); the development of the energy audit models and the monitoring system.
- Quality assurance: comprises the training and/or the authorisation of the auditors and the quality control (checking of the reports).
- In addition different audit tools (excel sheets, report templates) are made available.

Energy audits are a quite unique instrument to tackle the real efficiency of already installed motor systems. They can give insight to the inter-correlations between the motor and the driven systems and the actual need of the process and therefore also consider sizing aspects and the running time of a particular motor and possibilities to switch it off.

For all steps/elements of energy audit programs energy efficiency in motor systems has to be considered. The main areas are:

- Definition of motor systems as specific area to be considered within energy audits
- Motor systems specific targets within the program (e.g. number of motor systems audited within one year)
- Training and qualification of energy auditors in this area (e.g. by training workshops on the different types of motor systems (motors and frequency drives, chillers, compressed air, fans and pumps).
- Development of tools specifically for energy audits for motor driven systems (e.g. energy audit guidelines, energy consumption calculation for specific systems, saving calculation methods for energy saving measures; energy audit reporting guidelines for different motor systems).

Example Austria energieeffiziente betriebe program as energy audit program

In Austria the voluntary program energy efficient companies focuses on Small and Medium Enterprises. The content of the program includes technological focus on motor driven systems (pumps, fans, compressed air and cooling systems), that are technologies used in very different sectors. The first two years (2005-2007) were used to build up the program and discuss details with the Environmental Ministry of Austria (BMLFUW) and the regional programs.

In Austria the energy audits are financially subsidized by national and regional sources. Regional program managers are in close contact with the auditors and the companies. They are responsible for the authorization of the energy auditors based on professional experience, technical education and further trainings.

Results of energy audits together with saving potentials are reported to the regional program managers responsible for quality assurance of the reports. In addition consultants in the regions document the implemented and planned measures in a partly public database, including the name of the company, the name of the consultant and details on activities as well as energy- and cost savings. This data is summarized and evaluated on regional level, incl. measures suggested and implemented. Furthermore, within the program all forms of national and regional activities for awareness raising are implemented. Motor systems aspects are integrated by a technological focus incl. trainings, tools (audit guides) and the build-up of an expert network.

Energy Management Programs

In many companies there is no structured approach to improve the energy performance. Although the possibilities to improve the energy performance may be known either identified within an energy audit or by internal staff, the measures are not implemented. This is due to several reasons, one being that the top-management or other key stakeholders oppose such measures or prefer other measures. In case the measures are implemented, often the energy consumption starts to rise again after a certain time because there are no responsible persons for maintaining the optimized systems.

Therefore a systematic approach is needed. First of all, energy must be a key topic in the company, from top-management down to all employees all relevant persons shall be engaged in saving energy. Clear target setting and the follow-up of saving measures ensure that energy efficiency steadily rises. Systematic energy management as systematic tracking, analysis and planning of energy use is one of the most effective approaches to improve energy efficiency in industries [4, p.5].

Energy management programs are policies and initiatives that encourage companies to adopt energy management. [4, p 10].

Recommendations for the integration of motor systems aspects in energy management programs are for example:

- Policy makers should build on the energy management standard ISO 50001 and develop programs to set incentives to encourage industrial and service sector companies to use this powerful tool.

- The implementation of energy management systems should be assisted by qualified consultants and tools. Examples of useful tools are e.g. for identifying the main users (energy balance, purchasing recommendations, etc.).

- A reference document (motor systems guide) for "motor policy" on company level should be developed. This document should show how motor efficiency is to be considered within an energy management system. This comprises the definition of purchasing criteria, motor inventory list, guidelines for replacement, requirement for installation or acceptance tests, requirements for repair.

- Energy management auditors (external, internal) and energy managers should be trained for the use of such a document.

- Purchasing recommendations should be published (cooperation with producer is needed); industrial associations should promote these recommendations (members should refer to these recommendations during sales process).

Tools

The term tools in this paper describes web- or Excel-based or other software applications which are intended to facilitate the estimation and quantification of energy saving possibilities in motor driven systems. The use of recommended calculation tools can help to standardize energy audit processes and enables energy efficiency programme managers to promote a uniform product. Usually motor system tools are designed to very specific purposes.

Examples of specific functions are:

- Calculation of energy savings when replacing an AC-motor with a higher efficiency one (therefore those tools have sometimes a database with new motors behind them)

- Installing a Variable Speed Drive on a pump or fan application

- Estimating heat recovery by a heat recovery system for an air compressor

Some examples of such tools are MotorMaster+International, EMSA Motor Systems Tool www.motorsystems.org, Airmaster, Fan and Pump System Assessment Tool.

Excel-based tools are also used to estimate the energy demand of electric motor systems in companies or generally for all electric users in a company and to identify the most relevant motors. Those tools work usually without metering of specific motors and need only estimations on running time and nameplate data of the motors installed within a company.

Example Switzerland Excel-based software tools alongside the motor efficiency decision process

In Switzerland, S.A.F.E. developed Excel-based software tools to help industrial users assess the savings potential of their existing motor systems:

1. SOTEA (Software Tool für effiziente Antriebe - software tool for efficient drives) is used to assess the efficiency potential of motor systems in one plant. The goal is to give the industrial user a rough number of possible savings which largely depends on the age of the installed motor stock.
2. ILI^{+} (Intelligente Liste - intelligent list) is used to compile a list of motors, from which motors with the highest savings potential can be chosen for retrofit. The Decision Maker of the tool helps users identify a relatively small number of motors representing a relatively large share of total possible savings.
3. The standardized template for a motor testing protocol helps to summarize motor test results and proposed motor systems efficiency measures together with the expected costs and savings.

These tools are directly linked to and applied as part of the Motor-Check (a motor systems energy audit methodology).

Potential of reduction according to criteria

Criteria		Default values	My values	Number of motors		Potential of reduction of energy		Potential of reduction of costs	
				absolute	in %	[kWh/a]	[kWh/LC]	[CHF/a]	[CHF/LC]
(1) Rate of realisation of the maximal saving potential in %		50	70	145	22%	480'838	7'341'977	60'105	917'747
(2) Age, older than x years		15	13	396	61%	599'043	8'450'073	74'880	1'056'259
(3) Operating hours per year > x Stunden		3000	5000	334	51%	468'685	5'726'851	58'586	715'856
(4) Dimension of motors > x kW		10	8	151	23%	443'558	6'980'616	55'445	872'577
(5) Motors without FC (frequency converter)		yes	yes	606	93%	701'838	9'273'035	87'730	1'159'129
(6) Application	Pump	yes	yes	0	0%	0	0	0	0
	Ventilator	yes	yes	144	22%	135'617	1'545'474	16'952	193'184
	Compressor air compr.	yes	yes	0	0%	0	0	0	0
	Compressor cold	yes	yes	0	0%	0	0	0	0
	Mechanical conveyor	yes	yes	0	0%	0	0	0	0
	Others	yes	yes	508	78%	645'643	8'924'267	80'705	1'115'533

ILI$^+$ Decision Maker, www.topmotors.ch (Source: S.A.F.E., 2013)

Conclusions

An important insight into the best practices in energy efficiency policy around the globe is that there is no single instrument that is able to bring alone energy savings swiftly. Also, the most cost efficient solution will not automatically be adopted in the industrial context because other elements influence investment decision making like risks, costs and value attributed to energy efficiency.

The policy needs a mix of several ingredients, in four main areas:

1. Mandatory performance standards are necessary because international experience shows that the life cycle cost approach is not generally used and that industry still will buy the cheapest (least efficient) product for a certain task. Mandatory Minimum Energy Performance Standards on the other hand - based on national law - keep cheap inefficient products from the market which can be reinforced through a rigorous compliance regime.

2. Voluntary measures include labeling, voluntary agreements and awareness raising. Qualified and focused information is necessary for motor manufacturers and motor users, training is also important for engineers who need also testing equipment for analyzing running stock and tools for the optimal design of new equipment.

3. Financial incentives help especially in industry to raise awareness for energy efficiency, to open the factory gates for expertise that will look at hidden improvement potentials and to convince management eventually to invest in regular efficiency improvements that keep the entire rolling stock up to date with modern efficiency technology.

4. International exchange is the most effective way for the design and implementation of successful policy instruments. Learning from the experience of other countries reduces the costs and risks of the envisaged policy instruments to the possible minimum.

EMSA has been engaged in motor policy since its outset in 2008. The "Policy Guidelines for Electric Motor Systems" will summarize the experience in various countries with mandatory and voluntary schemes and will therefore help policy makers to design efficiency policy instruments according to international standards.

References

[1] de Almeida, A., Boteler, R. Brunner, C., Doppelbauer, M. and Hoyt, W.: Electric Motor MEPS Guide, Zurich 2009. Can be downloaded at: www.motorsystems.org

[2] Kulterer, K. and Werle, R.: Motor Policy Guide, Part 1: Assessment of Existing Policies, Zurich 2011. Can be downloaded at: www.motorsystems.org

[3] Khan, J.: Guideline for the monitoring, evaluation and design of energy efficiency policies, Ecofys Netherlands, 2006. Can be downloaded at: www.aid-ee.org

[4] IEA, IPP: Energy Management Programmes for Industry, Paris, 2012