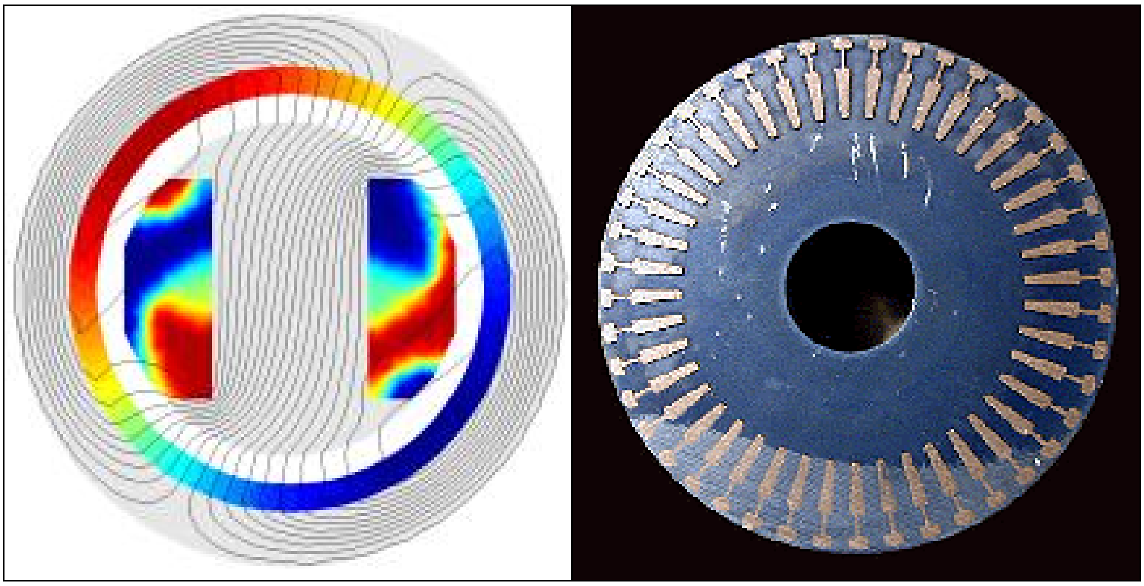
SEEEM
Standards for Energy Efficiency of Electric Motor Systems

SEEEM Launch Paper

Market Transformation to Promote Efficient Motor Systems

To be presented and discussed at the SEEEM launch event on June 20th 2006 in London.



20 June 2006 Zurich, Switzerland

Market Transformation to Promote Efficient Motor Systems

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Executive Summary

Industrial electric motors and motor systems in industry and the tertiary sector are responsible for roughly 40% of electricity consumed worldwide. The energy efficiency of motor systems typically can be improved by 20 to 30%, representing a huge, untapped potential for cost effective energy savings and greenhouse gas emission reductions (of the order of 740 million tons CO_2 equivalent per year).

Motor system components are widely-traded commodity goods that are currently subject to different testing standards and performance and labeling requirements. As a result, there are large variations in the market penetration of high-efficiency motors and motor systems around the globe. Countries that have implemented minimum energy performance standards at relatively high efficiency levels have market shares for high-efficiency motors of over 70%, whereas the market share in countries without them hovers below 10%, despite voluntary programs.

Under the SEEEM (Standards for Energy Efficiency of Electric Motor Systems) initiative, governments, electric utilities, energy efficiency experts and agencies, industry and business representatives and end-users are calling for governments and other stakeholders to:

- Initiate a comprehensive market transformation strategy to promote efficient motor systems in industry and the tertiary sector worldwide
- Harmonize energy efficiency testing procedures, efficiency classes and marking schemes for motors
- Introduce a timeline for mandatory minimum energy performance standards for motors and harmonize them at a high efficiency level
- Support and engage in the SEEEM community of practice to share experience, derive best practice and coordinate measures to promote efficient motor systems.

SEEEM is an independent, multi-stakeholder effort to promote rapid market diffusion of high-efficiency motor component technologies and systems worldwide (see www.seeem.org for details). It was launched on 20 June 2006 in London. The SEEEM process will promote international agreement on testing procedures, efficiency classes and marking schemes that will make it possible to compare products globally. This, in turn, will allow for international benchmarking and steps to align requirements (e.g., minimum energy performance standards) and to design/implement cost-effective policies and incentives to promote the most efficient motor systems.

To achieve its overall objective, the SEEEM initiative has identified four areas for cooperative action:

- Efficiency testing procedures and tolerances
- Efficiency classes and marking schemes
- Mandatory and voluntary performance requirements
- Effective policies and incentives for energy efficient motor systems

The work under the first three areas will focus on motors and other system components, whereas the policy work will encompass motor systems as a whole.

Three Working Groups (Harmonization Issues, Policy Issues, Stakeholder Outreach & Support) will serve as open fora for SEEEM implementation in 2006-07. The SEEEM community will present its results at the 5th International Conference on Energy Efficiency of Motor Driven Systems (EEMODS'07), which will be held in June 2007 in Beijing, China.

1 Energy Efficiency of Industrial Electric Motor Systems

Electric motor systems account for roughly 70% of industrial and 35% of tertiary sector electricity demand worldwide (approximately 40% of total electricity demands across those two sectors, in the residential sector smaller motor systems are also relevant in many appliances such as refrigerators and air conditioners). Thus they are a major driver for electricity demand and associated local pollutant and greenhouse gas emissions from power plants, and there is significant scope for cost-effective reductions.

The electricity demand of industrial motor systems can be reduced by:

- Use of high-efficiency motors;
- Proper sizing of the motor to the load requirements (many motors are over-sized and thus run at sub-optimal load factors, which reduces efficiency and power factor drastically);
- Use of adjustable-speed drives, where appropriate, to match the speed and the torque to the load requirements; this allows in some cases the replacement of inefficient throttling devices and in other cases the simplification (or even avoidance) of wasteful mechanical transmissions;
- Optimize the complete system, including pipes, gears and efficient end-use equipment (fans, pumps, compressors, traction systems) to deliver the required energy service most efficiently;
- Proper maintenance and repair (e.g., poor rewinding practices can damage motors and lower their efficiency significantly);
- Maintaining acceptable levels of power quality.

Experiences with programs to promote efficient motor systems have shown that motor efficiency alone can only capture a small share of the overall energy saving potential of motor systems. In the recent IEA Industrial Electric Motor Systems Efficiency Workshop (15-16 May 2006, Paris) there was broad agreement among participating experts that a focus on systems is crucial and that:

- There is significant potential to improve the efficiency of industrial electric motor systems cost-effectively using existing technologies and practices. Of total industrial electricity demand 20.8 EJ (10^{12} Joules), electric motor systems account for about 14 EJ (70%). If we assume an energy-saving potential of 20 to 30%, based on experiences with previous motor programs, 2.8 to 4.2 EJ of electricity demand could be avoided (~ 2% total global primary energy demand) using existing technologies. This estimate does not include the sizable potential in the tertiary sector.

- High-efficiency electric motors and motor systems are cost effective. Experience from pilot studies for new and replacement motors worldwide report that the additional up-front investment cost of high-efficiency motors and motor systems is paid back within one to three years through savings in electricity bills. High-efficiency motors reportedly also work more reliably and are more durable (as they operate at lower temperature).

- The major barriers to market penetration of efficient motor systems are well documented and include: higher up-front capital investment required for efficient equipment; unclear motor efficiency standards, labels and efficiency classification; split incentives/ diverging motivations for purchasers (mostly Original Equipment Manufacturers) of motor system components vs. those who pay life-cycle energy bills (and hence a lack of awareness of energy-and cost-saving potential of high efficiency equipment); reluctance to replace operational systems with new equipment that might adversely affect operations; focus of policies and incentive programs on motors alone, rather than on systems.

- A suite of policies and measures is required to overcome the known barriers. These can be broadly characterized as:
    - Mandatory minimum energy performance standards
    - Measures to improve access to information and market transparency (e.g., labeling schemes, standard harmonization efforts)
    - Financial and non-financial incentives (e.g., audit programs, calculation tools)
    - Training and education

- o Organizational innovation by companies (e.g., introduction of energy management systems).

A number of national and international activities to promote energy efficient motors and to provide standards are going on: IEC (International Electrotechnical Commission), IEEE (Institute of Electrical and Electronics Engineers) and other standard organizations have provided standards for testing the energy efficiency of electric motors (refer to Section 2.2 of this report for details). CEMEP (European Committee of Manufacturers of Electrical Machines and Power Electronics) in Europe, NEMA (National Electrical Manufacturers Association) in the USA, CNIS (China National Institute of Standardization) in China and many other organizations have launched labeling schemes and voluntary standards for high efficiency motors. Mandatory minimum energy performance standards have been enacted in Australia, Brazil, Canada, China, Mexico, New Zealand, Poland (later repealed) and the USA. The Motor Challenge campaign has increased awareness, competence and acceptance of efficient electrical motors in the USA and Europe. Similar campaigns have been (or will be) started in Australia, China, etc. CLASP (Collaborative Labeling and Appliance Standards Program) and APEC-ESIS (Asia Pacific Economic Cooperation - Energy Standards Information System) have worked on harmonized and effective energy efficiency standards in Asian countries.

The G8 Gleneagles Summit in 2005 launched a dialogue on Climate Change, Clean energy and Sustainable Development. In the context of its G8 Gleneagles Programme "Aiming at a clean, clever and competitive energy future", the International Energy Agency will undertake a comprehensive overview of existing and potential efficiency performance in industry and will identify areas where intensified efforts could add value in both industrialised and developing countries. As part of this work, the IEA recently hosted an Industrial Electric Motor Systems Workshop (mentioned above), at which the SEEEM initiative was presented, and a special report on industrial electric motor systems is planned.

Motor system components are widely-traded commodity goods. Yet there are large variations in the market penetration of high-efficiency motors and motor system components around the globe. Countries that have implemented minimum energy performance standards at relatively high efficiency levels, such as Canada and the United States, have market shares for high-efficiency motors of over 70%, whereas the market share in countries without them, such as European countries, hovers below 10%, despite voluntary programs.

The SEEEM process will promote international agreement on testing procedures, efficiency classes and marking schemes that will make it possible to compare products globally (even with different labeling schemes in place). This, in turn, will allow for international benchmarking and steps to align requirements (e.g., minimum energy performance standards) and to design/implement cost-effective policies and incentives (such as standards-based CDM) to promote the most efficient motor systems.

2 Global Cooperative Action under SEEEM

2.1 Introduction

SEEEM (Standards for Energy Efficiency of Electric Motor Systems) is an independent, multi-stakeholder effort to promote rapid market diffusion of high-efficiency motor component technologies and systems worldwide, in order to reduce industrial and tertiary sector electricity demand and greenhouse gas emissions from electric power generation (see www.seeem.org for details). To achieve this objective, the SEEEM initiative will facilitate:

- Greater alignment of international testing procedures, performance requirements and marking/labeling schemes and
- Collaboration on the design and enforcement of effective policies and incentives.

Preparations for SEEEM were initiated in late 2005 by A+B International (Sustainable Energy Advisors) after an informal workshop at the 4th International Conference on Energy Efficiency of Motor Driven Systems (EEMODS'05). The idea for SEEEM was presented at that meeting in response to the invitation by Dr. Paolo Bertoldi (European Commission Joint Research Center, Ispra) to exchange views on how to advance motor harmonization. The proposal was well received and during the first half of 2006, preparatory work laid the institutional and financial foundation for the implementation of SEEEM.

The work of SEEEM is guided by an international, multi-stakeholder Steering Committee. Its membership includes:

- Professor Anibal de Almeida, University of Coimbra, Coimbra, Portugal
- Dr. Paolo Bertoldi, EC Joint Research Center Ispra, Italy
- Robert B. Boteler, NEMA/Emerson, Gallatin MO, USA
- Shane Holt, Australian Greenhouse Office, also representing CLASP, Sydney, Australia
- Benoît Lebot, UN Development Program/Global Environment Facility, Paris, France
- Aixian LI, China National Institute of Standardization, Beijing, China
- John Malinowski, Baldor Electric Company, Fort Smith AR, USA
- John Mollet, International Copper Association, New York NY, USA
- Steven Nadel, American Council for an Energy Efficient Economy, Washington DC, USA
- Jürgen Sander, VEM Motors, also representing CEMEP, Wernigerode, Germany
- George Alves Soares, Eletrobras, Rio de Janeiro, Brasil

In addition, a Technical Advisory Group (TAG) of renowned international experts supports SEEEM in its work, by providing advice on technical issues surrounding harmonization:

- Austin Bonnett, independent consultant for NEMA, IEEE, EASA and Emerson Electric, USA
- Anibal de Almeida, Professor, University of Coimbra, Portugal
- Qin He, Professor, Shanghai Electrical Apparatus Research Institute, China (supported by Xin Zhang, China National Institute of Standardization, China)
- Brenton Watkins, independent consultant and Chair EL 14 Standards Committee, Australia

The initiative enjoys the support of a diverse set of institutions around the globe, including the American Council for an Energy Efficient Economy (ACEEE), the Australian Greenhouse Office (AGO), the Austrian Energy Agency (EA), the China National Institute of Standardization (CNIS), the Collaborative Labeling and Appliance Standards Program (CLASP), the International Copper Association (ICA), the International Institute for Energy Conservation (IIEC), the New Zealand Electricity Commission, the Swiss Agency for Efficient Energy Use (S.A.F.E.), the Swiss Federal Office of Energy (SFOE), the UK Market Transformation Programme (MTP), the Union of the Electricity Industry (Eurelectric) and the United Nations Development Programme (UNDP/GEF).

Initial funding for SEEEM has been provided by the Australian Greenhouse Office, the International Copper Association, the Swiss Agency for Efficient Energy Use, and the UK Market Transformation Programme.

2.2 Areas of Cooperative Action

To achieve its overall objective, the SEEEM initiative has identified four areas for cooperative action:

- Efficiency testing procedures and tolerances
- Efficiency classes and marking schemes
- Mandatory and voluntary performance requirements
- Effective policies and incentives for energy efficient motor systems

The work under the first three areas will focus on motors and other system components, whereas the policy work will encompass motor systems as a whole. The work underway in each of these areas is described in the following sections.

2.2.1 Harmonization of Efficiency Testing Procedures and Tolerances

It is imperative that agreement is reached on accepted methods of verification of motor efficiency through standard testing procedures and tolerances.

Based on the advice of the SEEEM Technical Advisory Group, SEEEM has chosen to define the field of asynchronous induction motors that it will consider as follows:

- Purpose General purpose
- Operation mode Continuous (S1)
- Phases 3-phase motors
- Size 0.55 kW to 370 kW
- Poles 2, 4, 6 (only Australia considers also 8 pole; in the EU and USA the market share is minimal)
- Cooling Enclosed and open
- Voltage 200 V to 690 V
- Frequency 50 Hz and 60 Hz

This means that SEEEM will have to consider efficiencies for two different electrical frequencies, four different numbers of poles, and two different cooling designs, resulting in 16 basic data sets covering the range of motor sizes from 0.55 kW to 370 kW. Whether the entire scope will be maintained for standards as the project goes forward remains to be determined.

A number of international standards for motor efficiency testing are currently in widespread use. The most widely adopted at present are IEEE 112 B (1996/2004) and IEC 60034-2 (1972/1996). Application of their testing procedures delivers significantly different efficiency levels for the same motor (see Annex for details), which represents a barrier to free trade and makes it extremely difficult for end-users to compare the efficiency characteristics of motors produced by different manufacturers in different markets.

This unsatisfactory situation is broadly acknowledged among standard organizations and motor manufacturers. In Australia, a pioneering effort was made to create a table of equivalences between efficiency levels derived by applying the two testing standards indicated in the previous paragraph. However, this is only a transitional solution. In 2002, the IEC adopted the standard IEC 61972, which contains two methods, one of which is very similar to the IEEE 112 B standard. This standard, however, was never adopted by CENELEC in Europe. Now IEC is in the final stages of approving a new standard (IEC 60034-2, Edition 4) that will contain three testing methods, one of which is very similar to the IEEE 112 B standard. Once implemented, this new standard can pave the way for international harmonization.

SEEEM will analyze the equivalence of the testing methods in the new IEC 60034-2 standards and make recommendations to regulators on method(s) that deliver tested efficiencies that are comparable with the IEEE 112 B standard. Experiences from testing laboratories worldwide will be compiled and compared.

Harmonized testing standards will ease the pressure on manufacturers to provide testing certificates and to invest in the necessary equipment for several standards in order to be able to sell their products in different markets. More precise testing facilities have the additional benefit for the motor manufacturers of improving motor quality and energy efficiency.

2.2.2 Harmonization of Efficiency Classes and Marking Schemes

It is necessary to have a harmonized system of motor efficiency classes. This involves agreement on the range of motor sizes (including the respective increments of motors and frames), the values of the different energy efficiency curves (based on harmonized testing procedures) and their respective names (referred to as a “marking scheme”).

Existing energy efficiency regulatory & labeling programs (e.g., USA Energy Policy Act; EU energy label) use different testing methods (see above) and marking schemes (e.g., Premium vs. EPAct in the USA; Eff1 – Eff2 – Eff3 European motor classes). One objective of SEEEM is to converge on a common designation of efficiency levels and an associated international marking scheme that can provide consistent motor efficiency information worldwide, regardless of the regulatory and other programs in place in a given market. Based on advice from the SEEEM Technical Advisory Group, SEEEM specifies the criteria for an acceptable future motor marking scheme as follows:

- Not conflicting/confusing with respect to existing label systems
- Easy to understand in all languages and character sets
- Possible to mark clearly on nameplates of motors
- Maximum of four levels (preferably three)
- Scale should not be shifted when new top ratings are included (i.e., a given efficiency level will always be associated with the same mark).

At present, SEEEM TAG believes that the marking schemes in the second and third columns of the following table best satisfy the above conditions.

	SEEEM Proposals		
Efficiency Class	**Roman Numerals[1]**	**Stars**	**IEC NP 2/1392**
Future best	III	****	
Premium/Reach	II	***	A
EPAct/Eff 1	I	**	B
Eff 2		*	C
Below Eff 2			D

[1] Roman numerals are only easy to read from I to III, the number 4 (IV) is not easily understood.

The last column is the current basis for discussion under IEC New Work Item 2/1392/NP (start at end of 2006 till 2008, see Annex). A final SEEEM recommendation will be made after more discussions.

In addition, SEEEM will work to ensure that consistent information is required on motor nameplates. The clear identification of testing method and measured efficiency for the motor at nominal load (or at least its efficiency level, based on a marking scheme) should be given on the nameplate, as well as printed in motor documentation and advertisements.

Finally, it would be desirable in terms of market transparency to achieve harmonization of energy labeling schemes (other than the nameplate). However, this might be difficult to achieve. SEEEM will provide a forum to share ideas on this issue.

2.2.3 Mandatory and Voluntary Performance Requirements

There is great diversity around the globe on the status of mandatory and voluntary energy performance requirements for industrial motors. Countries that have implemented minimum energy performance standards at relatively high efficiency levels, such as Canada and the United States, have market shares for high-efficiency motors of over 70%, whereas the market share in countries without them, such as European countries, hovers below 10%, despite voluntary programs.

As a general principle, a minimum energy performance standard (MEPS) should be implemented worldwide to prohibit low-efficiency motors from entering the market and thereby to stimulate the manufacture and sales of higher efficient motors. The SEEEM Technical Advisory Group discussed the question of the necessity of mandatory minimum energy performance requirements vs. voluntary requirements. The TAG cited experience throughout the 30 OECD (Organisation for Economic Co-operation and Development) countries that demonstrates that the market can only be moved above roughly 10 to 20% market share for high-efficiency motors when a mandatory minimum energy performance level is established by law.

Ultimately, MEPS have proven to be beneficial to all stakeholders, including electric utilities (reduced energy demand, peak load and need to construct expensive new capacity), motor manufacturers (greater market for high-efficiency, high-margin motors), original equipment manufacturers (OEMs) and end-users (short pay-back period).

SEEEM will also consider how to promote state-of-the-art equipment. Unless markets are competitive and incentives to go beyond compliance with MEPS are offered, there is a danger that the introduction of mandatory MEPS could actually slow the continuous innovation to improve motor efficiency. One approach involves the designation of premium efficiency performance levels, which can send a signal to manufacturers about future MEPS levels and can serve as a basis for voluntary participation in incentive programs. The US NEMA Premium, the Australian A3 and the Chinese 2010 reach standard all take this approach. Marking schemes should be designed to support such schemes, and additional incentives have to be provided to increase this market share (see next section).

It is important to note that harmonization would not limit the freedom of individual nations with respect to policies and measures such as adoption of minimum energy performance standards (MEPS), setting dates for compliance and introducing sanctions for non-compliance, or designing effective incentive schemes for higher efficiency levels. On the contrary, SEEEM will provide a multi-stakeholder forum to exchange experience and benchmark best practice. There was agreement in the SEEEM Technical Advisory Group that the timetable for the introduction of a given MEPS must reflect the market conditions and status of development of each country. It is important to announce MEPS ahead of time to give industry sufficient time to make the necessary adjustments to their manufacturing programs and to do so without loss.

2.2.4 Effective Policies and Incentives for Energy Efficient Motor Systems

There is broad agreement among all SEEEM stakeholders that major energy savings will need to include the entire motor system, since only about 10% of energy saving potential can be achieved with high-efficiency motors alone. Proper dimensioning of the motor, appropriate use of adjustable speed drives, efficient end-use equipment, good power quality and good system design & housekeeping all contribute significantly to motor system efficiency improvement.

SEEEM concluded that motor systems (like pumps, fans, compressors, and traction both in integrated and separate systems) and their components (like adjustable speed drives, gears, belts, etc.) plus their design features (like power quality, proper sizing, etc.) should be addressed. However, the initial SEEEM Technical Advisory Group discussion was inconclusive on whether technical harmonization of motor systems (e.g., testing standards; labels) and/or work on less technical approaches, such as design quality guidance, planning tools, capacity building efforts, and collaboration on policies & measures to promote high-efficiency motor systems should be pursued under SEEEM.

The discussion on how best to support the uptake of efficient motor systems will be a major topic for SEEEM going forward.

3 Initial SEEEM Recommendations to Policymakers and Other Stakeholders

Based on the work in the preparatory phase of SEEEM (including advice from the Technical Advisory Group and consultations with SEEEM supporters and other stakeholders) – and in order to realize the potential energy savings and greenhouse gas emission reductions that can be achieved by promoting efficient industrial motor systems – SEEEM recommends that policymakers and others in a position to do so:

- Initiate a comprehensive market transformation strategy to promote the uptake of efficient motor systems worldwide (measures to improve access to information and market transparency; regulation; financial and non-financial incentives; technical support, training and education; organizational innovation by companies)
- Harmonize efficiency testing procedures, efficiency classes and marking and labeling schemes for motors (target motor population: asynchronous 3-phase, general purpose induction, rated power from 0.55 kW to 370 kW, both 50 Hz and 60 Hz frequency, continuous use)
- Introduce mandatory minimum energy performance requirements (MEPS) for motors and harmonize them at a high efficiency level (EPAct / Eff 1)
- Engage in the SEEEM community of practice to share experiences, derive best practices and coordinate measures to promote efficient motor systems.

4 Next Steps through Mid-2007

Following the SEEEM Launch on June 20th 2006 at EEDAL'06 in London, SEEEM will move into the implementation phase. The following items are in the work plan for the coming 12 months:

- Expand and secure SEEEM support and funding through 2008
- Implement Phase 1 activities (concentrating on motors)
- Expand policy network and communicate SEEEM goals and intermediary results to interested stakeholders
- Work with partners to ensure full participation of non-OECD countries in SEEEM
- Prepare SEEEM event at Motor Summit 2007 in Zurich, Switzerland (early 2007)
- Prepare SEEEM event at EEMODS'07 in Beijing, China (10-13 June 2007).

At the SEEEM launch event, a series of three *ad hoc* Working Groups will be announced. These multi-stakeholder working groups are open to all qualified, interested individuals and institutions and will be the main fora for SEEEM work in 2006-07. It is foreseen that they will have the following scope and tasks:

WG 1: Harmonization Issues
Chair: Prof. Anibal de Almeida (University of Coimbra, Coimbra, Portugal)
Tasks:

- Evaluate existing and new energy efficiency testing standards and levels of tolerance for efficiency determination, and recommend procedures for use by regulatory programs that will promote international comparability
- Research and distribute results of comparative testing/calculation projects
- Recommend suitable energy efficiency classes and associated marking schemes (collaborate with IEC NP)
- Consider scope for harmonization of labeling scheme(s)
- Compile information on state-of-the-art motor technology and efficiency levels
- Ensure SEEEM input into relevant standard-making and regulatory processes

WG 2: Policy Issues
Chair: nn
Tasks:

- Recommend mandatory MEPS and timetables for compliance
- Recommend voluntary standards for state-of-the-art motors (coordination with WG1)
- Compile information and serve as a forum to exchange expertise on motor efficiency compliance regimes, incentive programs and procurement programs (coordination with WG3)
- Ensure SEEEM input into policymaking processes

WG 3: Stakeholder Outreach & Support
Chair: Hans De Keulenaer (Manager - Electricity & Energy, European Copper Association, Brussels, Belgium)
Tasks:

- Build a knowledge network of stakeholders
- Distribute news on relevant developments via the SEEEM website and email
- Publish relevant documents (downloads) and links to recommended training programs, auditing methods, tools and best practices on the SEEEM website
- Provide advice on the evolution of the SEEEM website
- Work with partner institutions to ensure full participation by non-OECD countries
- Ensure SEEEM representation in relevant events.

All the three Working Groups will be supported by the SEEEM TAG and the secretariat, as required.

The SEEEM launch event will provide a forum for stakeholders to discuss the SEEEM work program and to express their interest in participating in the Working Groups: To sign up for the Working Groups go to www.seeem.org. Comments and expressions of interest from other interested parties are always welcome and should be directed to the SEEEM coordinators at info@seeem.org.

Annex
State of IEC and IEEE Motor Efficiency Testing Standards and IEC Work on Efficiency Classes

IEEE 112 (1996/2004)

The standard defines 5 different methods (A, B, C, E and F); only B method is used for the power range under consideration:

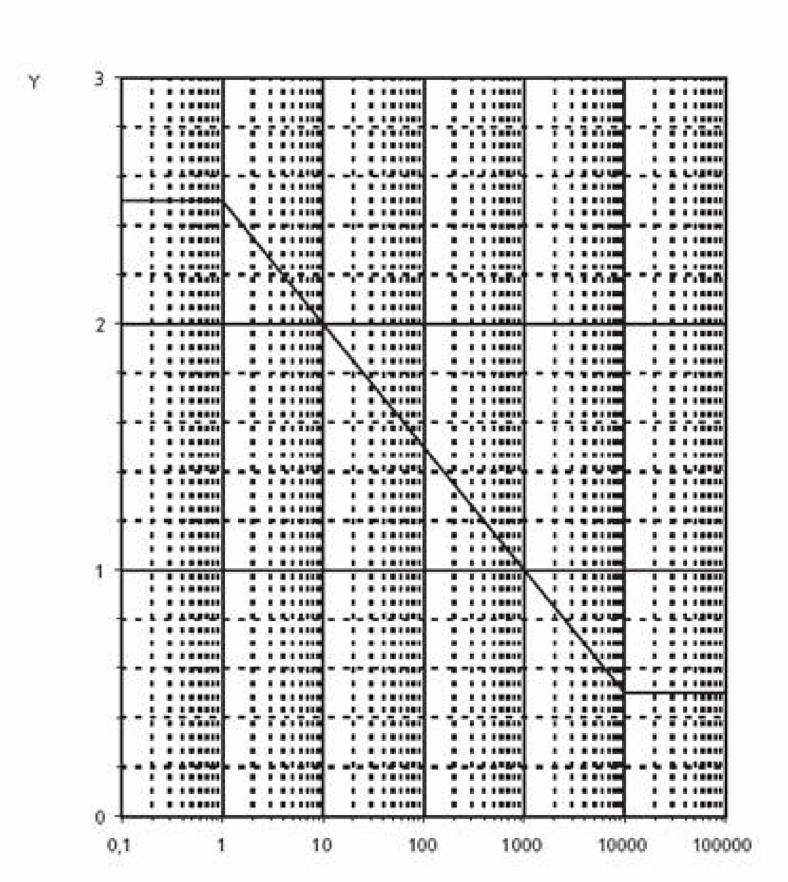
Method B: Input-output with loss segregation
The apparent total loss (input minus output) is segregated into its various components with stray-load loss defined as the difference between the apparent total loss and the sum of the conventional losses (stator and rotor I2R loss, core loss, and friction and windage loss). The value of stray-load loss thus determined is plotted vs. torque squared, and a linear regression is used to reduce the effect of random errors in the test measurements. The smoothed stray-load loss data are used to reduce to calculate the final value of total loss and the efficiency.

IEC 60034-2 (1972/1996)

This efficiency testing standard verifies indirectly the efficiency by measuring the different types of losses (Joule, magnetic plus mechanical) with the exception of the additional load losses which are assumed to be fixed (0.5% of the full-load input power). This assumption underestimates the real value of those losses, except for very large motors outside the range considered in this project.

IEC 61972 (2002 adopted by IEC, but not enforced by CENELEC)

- **Method 1: Similar to IEEE 112 Method B: Input-output with loss segregation**
- **Method 2: Indirect method similar to IEC 60034-2 with the additional load losses from assigned variable allowance** (see following graph)
  < 1 kW: 2.5%; 1..10'000 kW: 2.5% .. 0.5% (linear/log); > 10'000 kW: 0.5%.



IEC 60034-2 (ed. 4) (under revision 2006, CDV accepted March 2006)

- **Test for direct efficiency determination –** similar to IEEE Method B
- **Test for indirect efficiency determination –** similar to IEC 61972 – Indirect method
- **Test for indirect efficiency determination** - Similar to IEC 60034 -2 – Indirect method, but which the additional load losses are computed from the Eh-star[1] test method.

IEC 60034-XY: New Work Item 2/1392/NP (start at end of 2006 till 2008)

Efficiency classes of single-speed three-phase cage induction motors from 0.75 to 200 kW (PLL determined either from residual test or from Eh-star test) with distinguished values for 50 Hz and 60 Hz, 2-4-6 poles:

- **A: Premium efficiency** (new: 16…20% lower losses than class B, NEMA Premium)
- **B: High efficiency** (existing Eff 1, EPAct)
- **C: Improved efficiency** (existing Eff 2)
- **D: Standard efficiency** (existing Eff 3).

This document is under consideration: National IEC member countries can vote until July 28th 2006.

1 M'hamed Aoulkadi, Andreas Binder: The Eh-star Method for Determination of Stray Load Losses in Cage induction Machines, in: Peter Radgen (ed.) EEMODS'05 Conference Proceedings, Heidelberg/Germany, 2005