NON-PEER-REVIEWED PAPER

Engaging Dutch industry in implementing efficient motor systems with the Green Deal Program

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Abstract

In industry the electricity use for electric motor systems amounts to 70 % and the associated economically feasible savings total from 20 % up to 30 %. Motor systems cover pumps, fans, compressors and industrial production systems, including motor, drive, transmission and driven application.

However implementation appears not to be a 'done case'. Many different aspects play a role in this, i.e. in the supply chain itself, and in the way industrial organizations work in respect to analyzing and implementing energy efficiency measures.

Representatives of the Dutch supply chain of motor systems and the government have joined forces in starting a Green Deal Program on efficient motor systems in Dutch Industry.

Key aspects of this program are three fold. 1) Developing a standard method for the analysis of opportunities for efficiency improvements in motor systems. 2) Developing sound business cases on efficient motor systems, delivering concrete energy savings. 3) Knowledge transfer and communication to end users and the supply chain to create leverage in terms of working methods, capacities and energy savings. The program runs from 2012 up to 2015. At the moment of writing 12 projects have been initiated and are in different phases of execution. At the time of presenting more specific information over the results and lessons learned (so far) will be available.

A quick dodge will be made to the contribution of three other Dutch initiatives on energy efficiency. These are the VA-program (voluntary agreements), where energy management forms a strong supporting element; the motor technology network (or bridge), helping to identify the needs and opportunities for the supply chain of motor systems, with an emphasis on knowledge and capacity building; and the international implementation program EMSA, as part of IEA task 4E, developing and bringing experience, standardization (on IEC and ISO level) and tools to the participating parties.

Introduction

Electric motor systems use up to 69 % of electricity in Dutch industry. Research and (international) projects show that system optimization and best available drive technology can deliver reductions of 20–30 % energy use in pumps, fans and compressors in heating, cooling and ventilation systems, and industrial handling, processing and production systems. Thus lowering the national electricity bill by 5–8 %. However obstacles in the Dutch marketplace and a low awareness of best practice and technology in the supply chain and with end users hamper market penetration [1].

Complexity of the issue, unfamiliarity with best practices and the best available technology (BAT), the limited use of life cycle cost principles, the lack of funding and the heterogeneity of the supply chain make that possible savings are implemented only partially or in the long term.

For industrial users optimizing motor systems means a direct cost savings and the ability of using the resulting funds in another way. This translates into a 1 on 1 enhance competitiveness. In addition, the focus on efficient drive systems offers the companies/equipment builders' commercial opportunities as well as opportunities to (internationally) distinguish themselves.

In 2005 the European Directive (2005/32/EC) came into force with requirements on the minimum efficiency of energy using products, including electric motors. This Directive, further explained in the Regulation EC 640/2009 dated July 22, 2009, offers an excellent opportunity to apply the effective system approach directly and optimize the motor systems. The Directive includes 3 steps, starting in 2011 up to 2015. In early 2014 an amendment was put into place with stricter limit values for special motors [2].

Government and the Dutch motor systems industry have started the Green Deal Efficient Electric Motor Systems to accelerate the market penetration, in alignment with other initiatives like the transition within industry towards the energy management system standard ISO 50001.

Bottlenecks on the implementation of Efficient Motor systems

In the introduction several causes for the slow implementation of efficient motor systems were mentioned, like obstacles in the Dutch marketplace and a low awareness of best practice and technology in the supply chain and with end users. Many different aspects play a role in this, i.e. in the supply chain itself, and in the way industrial organizations work in respect to analyzing and implementing energy efficiency measures.

(Inter)national studies, projects and practical experiences confirm the bottleneck associated with market players in the supply chain, such as the manufacturers/suppliers of electric systems, installers and maintenance providers, original equipment manufacturers (OEM) and end-use industries (manufacturing).

Analysis of the market of electric motors supply and maintenance in the Netherlands, and the practices of the OEM and industrial end-users show that for a successful acceptance of efficient motor systems all market parties have to get involved.

Figure 1 shows these barriers for each supply chain party involved, starting with the suppliers and – via the installers and OEM coming at the end-users. Some main barriers are:

- the focus on lowest investment cost; the OEM and the end user's main interest is to buy the motor at the lowest price possible,
- the split in allocation of investment and operational cost with the end user. At the end user the employee that is responsible for buying the motor is usually not the one that holds the energy budget,
- focus on motors only, instead of system benefits,
- low knowledge of opportunities for system efficiencies [4, 5].

The energy costs associated with the motor's lifetime operation are estimated to be around 95 % of the total cost, while initial purchase price and maintenance account for the remaining 5 %.

Green Deal Program

The Dutch governments recognises that in the development of sustainable initiatives companies, civil society organizations and others face barriers. For example, if they want to run a project to generate energy or to use less water. The barriers can have various causes. Sometimes the laws and regulations are causing delays. Another time the initiators have trouble finding suitable cooperation partners. And sometimes they're not succeeding in getting enough money together.

For those cases, the Dutch national government has started a program which offers help, through a "Green Deal". Figure 2 shows a simple scheme with the parties involved, i.e. the Submitter, the Government and the Green Deal Results.

The Netherlands wants to move towards an economy where sustainability and economic growth go hand in hand. Growth is not at the expense of the environment, but takes into account the environment and the needs of future generations. The Green Deals fit within it. They provide short-term outcome for all. This effect is even greater, as other parties will follow the Green Deal.

In this case the figure includes the participating parties at the specific Green Deal project called the Green Deal Efficient Motor Systems. This project is one in a series of – at early 2014 – 150 different Green Deal projects on all types of subjects and parties.

Green Deal Efficient Motor Systems

The initiators of this specific Green Deal project the Green Deal Efficient Motor Systems are the FEDA and the Uneto-VNI. FEDA is the Federation of suppliers of Electric Motors, Drives and Automation Engineering, and Uneto-VNI is the trade as-

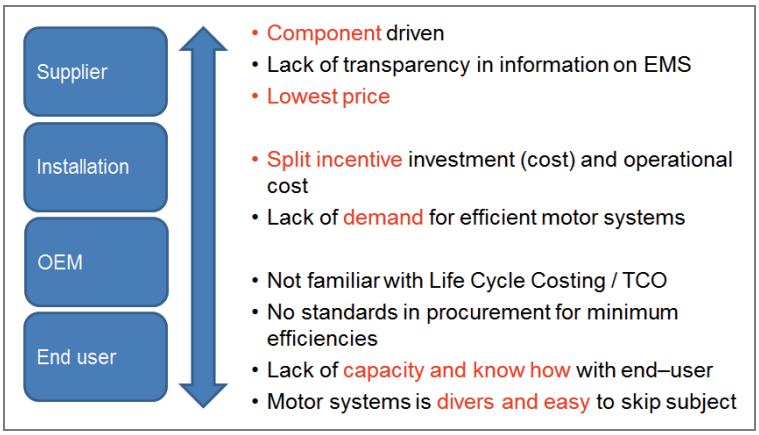

Figure 1. Barriers hindering implementation of Efficient Motor Systems.

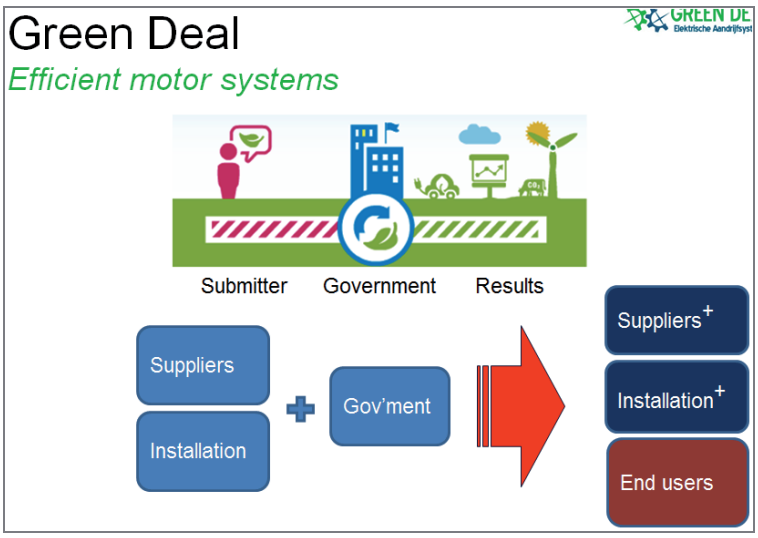

Figure 2. From Submitter with Government to Results.

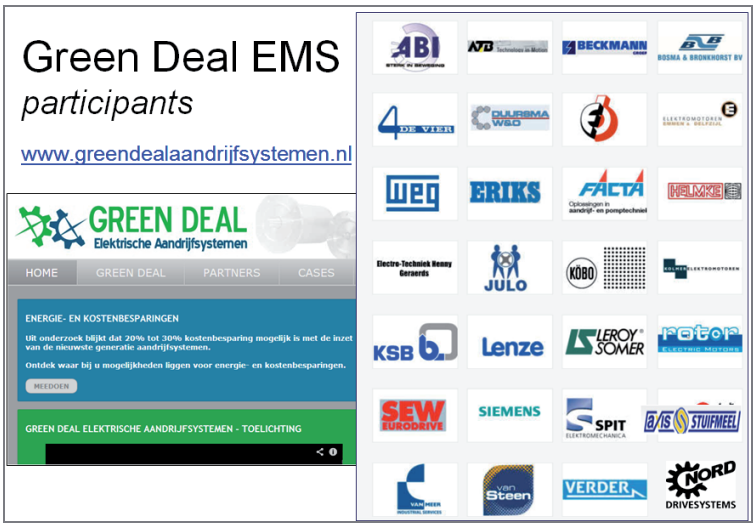

Figure 3. Partners Green Deal electric motor systems.

sociation of installation and electromechanical maintenance companies.

The two organizations together with their member-companies want to encourage a wider application of efficient electric motor systems by reducing some of the above mentioned issues. And so assisting the users of the motor systems in achieving direct energy savings, and strengthening their competitiveness by developing innovative products and services, as well as developing more activities by the energy suppliers and service providers. Which translates into growth in sales and employment.

FEDA and Uneto-VNI and twenty-eight companies from FEDA and Uneto-VNI have joined the Green Deal and are participant in the project. As well as two main pump and compressor suppliers. The project will be carried out by the 30 participants, see Figure 3. The program management is done by TPA consultants, in cooperation with FEDA and Uneto-VNI. The government is involved via the Netherlands Enterprise Agency as secretary of the project group and directly via the Ministry of Economic Affairs in a steering committee.

The project (Green Deal) consists of three components that aim at reducing some of the issues raised in the market, improving the conditions in the supply chain, and the realization of a number (example) projects by end users by which direct energy savings are realized, and following the examples is further stimulated in the market. The project duration is 2,5 to 3 years [6].

The project has the following project-activities: Preparation, developing standard methods, followed by execution of projects, analyses. Special research is in finance barriers and possible solutions and knowledge transfer. In Figure 3 the project partners are shown with their main role, responsibility. The main steps and crucial interest is in developing in each project one or more sounds business cases, followed by implementation, see Figure 3.

In cooperation with the partners of the Green Deal Efficient Motor Systems and the (some of the) end-users of motor systems a standard approach or working method is developed for analyzing and optimizing a specific motor system. The five basic steps are shown in Figure 4. The format of the business

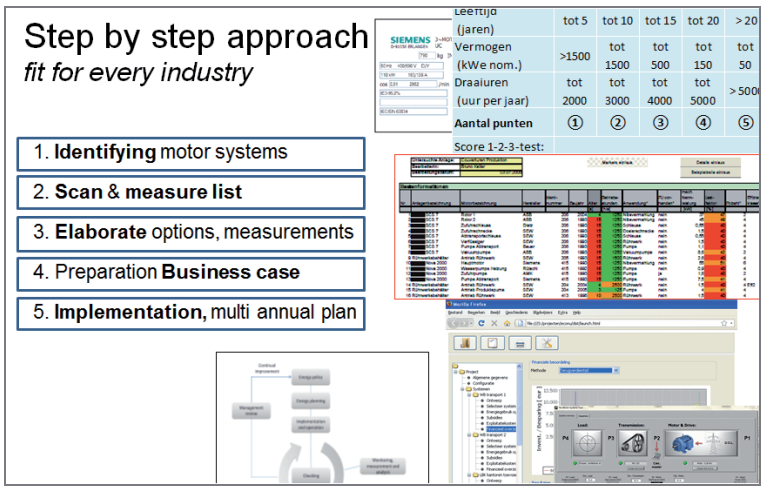

Figure 4. Step by step approach.

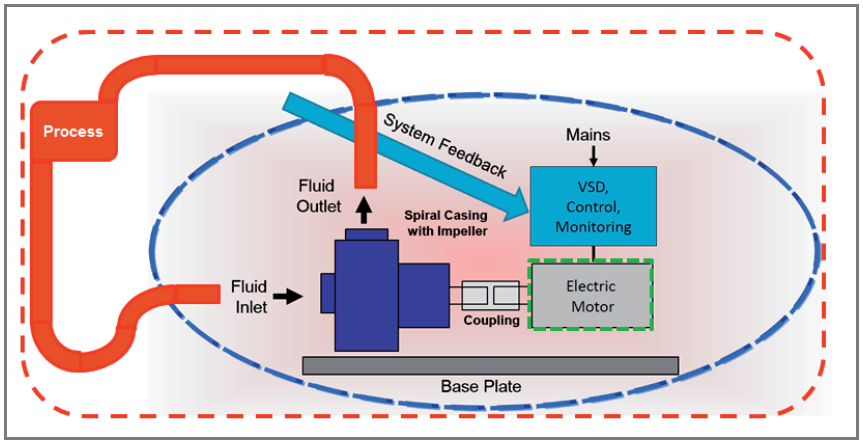

Figure 5. System borders electric motor systems.

case will be defined by the partners, with a number of objective criteria. Depending on the specific expertise and interest of the partners and the end-users, and on the available data at start as well as the ambition (or desired scope) of the end-user these five steps will be customized in every single project.

Several tools are available to calculate and present energy efficient motor systems, life cycle cost, and type of drive and control component. Via the participation of the Dutch knowledge network efficient motor systems in EMSA the Motor Systems Tool became available for analyzing and calculating the motor systems of the end user [7]. The tool is unique in its 'system approach' and is brand independent. See www.motorsystems.org for more information and download area. The Life Cycle Cost method is aimed at the end user's management and procurement department.

SYSTEMS APPROACH

The maximum savings potential of efficient motor systems can only be realized by following a systems approach. This is a term which hints at a systematic analyses of a motor system starting with the process or the drive-load.

Applying a state of the art efficient electric motor can bring efficiency improvements of 0,1 % to 10 % compared to the minimum standards in place. See the dot-line on the electric motor in Figure 5. Looking at improvements at the 'core motor system' (the oval dot-line in the figure) increases the savings potential considerately. Now also the control, the transmission and the component like a pump or compressor is part of the analyses for an optimal motor system. Potential savings are now increased up to 20–30 %. The best approach however in terms of efficiency improvements is at making an analyses of the complete motor system, i.e. including also the ducting and the process (conditions) itself, see the outer dot-line in Figure 5.

PROJECTS

In 2013 several pilots have been started, in different industrial sectors: the dairy sector, the wastewater treatment sector, paper industry and the drinking water sector. Much focus is on pump systems, and the first analyses come to a short list of potentially promising systems.

Within one project the first challenge is to make the analysis of the installed base in cooperation with the personnel on the work floor (maintenance). One objective of this particular project is to make a coupling with the maintenance and investment program for the short and midterm.

In another project the analyses will target at an integrated analysis of the process itself, i.e. analyzing the aeration process

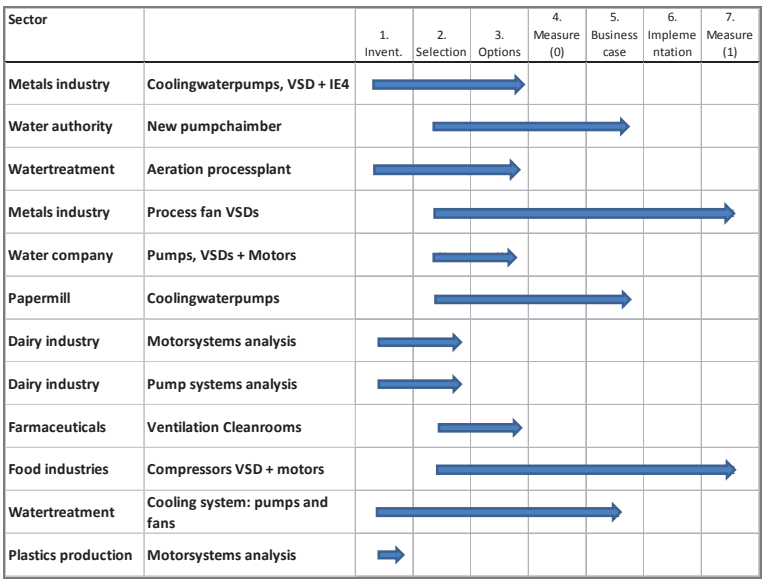

Figure 6. Green Deal Projects.

	Oud	Nieuw
Toevoer motor	4 x 75kW	4 x 55kW
Start systeem	DOL	Frequentie regeling
Overbrenging	Meerdere V-snaren	Polychain
Rendement	(ongeveer) 89%	95%
Afvoer motor	8 x 18,5kW	8 x 15kW
Start systeem	DOL	Frequentie regeling
Overbrenging	Meerdere V-snaren	Polychain
Rendement	(ongeveer) 86%	92,50%
Operationele uren	4000 uur @ hi speed	2000 uur @ hi speed, 2000 uur @ low speed
Energiebesparing jaar 1	70%	
Kostenbesparing jaar 1	30%	
ROI	9 maand	
Geschatte kostenbesparing jaar 2	40%	

Figure 7. Example results of an efficient ventilation system renovation.

(process control for oxygen demand in the waste water), and the efficiency of motor, the drive, transmission and the design of the aerator itself. This will be done in cooperation with the OEM, supplier, installer and engineers.

During 2013 more projects have been initialized. Figure 6 shows an oversight of some 12 projects, all in different states of progress, and Figure 7 shows the possible measures of an example project.[1]

Synergy with other Dutch initiatives on efficient motor systems

INTRODUCTION ON EMSA

The Netherlands is participating in the 4E Electric Motor Systems Annex (EMSA), which is part of the IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E).

The joint experience of the six member countries is applied to provide technical guidance, capacity building and knowledge on performance and IEC/ISO standards [8]. EMSA provides an excellent forum to develop and assess possible policies, strategies and actions to speed up the implementation of highly efficient motor systems, on a national, international and global level.

The 4E EMSA program runs till Q4 2014 and a new three years program is in preparation. The Netherlands participates in several areas of interest of EMSA including International Standards. EMSA works for globally harmonized and robust technical standards for the classification and testing of motors and variable frequency drives through representation in standards working groups, and for implementing motor systems management as part of the energy management systems standard ISO 50001.

INTRODUCTION ON DUTCH VOLUNTARY AGREEMENTS ON ENERGY EFFICIENCY

There has been a succession of three Dutch Voluntary Agreements on Energy Efficiency implemented in the form of covenants, starting in 1992 at the initiative of the Ministry of Economic Affairs. Under this covenant, the Government established a voluntary, though binding upon signature, agreement on energy efficiency improvement targets with industry partners and institutions. The objective was to reduce the quantity

1. At the eceee 2014 Industrial Summer Study more results will be presented.

of energy used per unit of product or service delivered through a 2 per cent per annum improvement in energy efficiency. The programme is being operated via the Netherlands Enterprise Agency [9].

The participating companies have to implement a three-fold set of activities: (1) making an Energy Efficiency Plan every four years, (2) yearly monitoring of production levels and energy use and (3) having an up and running energy management system.

The Energy Efficiency Plan describes the energy saving measures that are to be implemented over a period of 3 years, an assessment of the expected energy saving and the appurtenant time line. With these measures, the company or institution also creates the basis for the development of the energy paragraph in the environmental license (which is issued by local, regional or national government depending on the environmental impact of its products and processes). The Netherlands Enterprise Agency performs an assessment to determine whether an Energy Efficiency Plan meets the requirements of a Voluntary Agreement. On the basis of the individual plans, the Netherlands Enterprise Agency has produced aggregate projections of the expected joint improvement in energy efficiency or the ambition of the companies.

In the past few years specific attention has been paid to motor system efficiency within the Voluntary Agreements-approach. Working together with other countries in the Motor Challenge Program project [10], all known measures from the Motor Challenge Program are listed on the Voluntary Agreement measure lists as described above for use in formulating the Energy Efficiency Plans. The Motor System Action plan and IE3-motors from 7.5 kW up to 375 kW has been put on the Energy List of the Energy Investment Allowance. This is a tax relief programme which gives a direct financial advantage to Dutch companies that invest in energy saving equipment and sustainable energy. The net profit (on their investment in energy efficiency equipment) can amount up to 11 %. Companies may also apply for Energy Investment Allowance support to cover the costs of an 'action plan' for electric motors. However, these costs are only eligible for Energy Investment Allowance support if you have actually implemented the recommended energy measures.

The instrument of Voluntary Agreements engages the companies with energy efficiency related activities like thematic workshops, pilot projects, energy audits and technology roadmaps. Participating companies operate a required energy management system, based on (elements of) ISO 14001, which is being transformed towards standards such as ISO 50001 and new methods such as the CO_2 performance indicator. Electric motor systems are addressed within this framework and clear links towards organization, procurement and sustainability issues are being developed.

INTRODUCTION OF THE KNOWLEDGE NETWORK ON EFFICIENT MOTOR SYSTEMS (KEMS)

In cooperation with the Netherlands Enterprise Agency the motor systems industry has started a 'knowledge network' to support the implementation of Efficient Electric Motor Systems and raise the awareness of its potential. Three Dutch sector associations, the motor systems suppliers (FEDA), the installation companies (Uneto-VNI), and the pump manufactures (Dutch Pump Association) have joined the network [11].

Some activities include the production of a short film on efficient electric motor systems to introduce the new EU regulation for efficient electric motors. The network assists in organizing workshops specific for industrial companies on the opportunities of efficient electric motor systems. This is an extra effort to bring efficient electric motor systems to the attention of companies and make a start with the transition towards motor management as an regular activity. The network also works on capacity building in the market as well with the end-users themselves. This will not only appeal to the technical representatives, but also the financial and general management representatives.

The KEMS will also develop knowledge related efficient electric motor systems activities for sectors which have incorporated efficient electric motor systems in their technology roadmap for 2030. These are being developed for: several food sectors – dairies, meat and vegetables; the metallurgical sector; the paper industries; and the foundries and surface treatment companies. Examples include application of variable speed drives for motors used for cooling and ventilation, a more efficient cooling cycle for motors, fans and pumps; the replacement of motors, fans and pumps by well-fitted systems used in a process or installation; optimization of cooling and process set-up, as well as optimization of drives for utility-processes like pumps, compressors and equipment.

Conclusion

The Green Deal and the three other lines of activity of the Dutch government and the Dutch motor systems industry are very complementary to each other and bring more focus and attention towards the adoption of efficient electric motor systems in industry. Representatives participate in these activities to enable an effective and efficient means of operation and to utilize the opportunities for synergy between the three approaches.

Glossary

OEM	original equipment manufacturer
VA	Voluntary Agreement (long term)
LTA	Long term agreement
EMSA	Electric motor systems annex (of IEA task 4E)
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
BAT	best available technology
TCO	total cost of ownership
FEDA	Federation of suppliers of Electric Motors, Drives and Automation Engineering
Uneto-VNI	the trade association of installation and electromechanical maintenance companies

References

[1] Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems, International Energy Agency, Paul Waide and Conrad U. Brunner, 2011.
[2] Amendment to 640/2009.
[3] Efficient Electric Motor Systems, Krachtenveldanalyse (in Dutch); Netherlands Enterprise Agency, 2010.

[4] Industrial Motors & Drives: A Global Market Update, Alex Chausovsky, IMS Research, EEMODS 2013, Brazil.
[5] ISO 50001 Energy Management and Electric Motor Driven Systems, M. van Werkhoven TPA consultants, Motor Summit 2012, Switzerland.
[6] Green Deal, Projectplan Green Deal Efficient Electric Motor Systems (in Dutch), GDEEA & Uneto-VNI, 2012.
[7] Motor systems tool, S. Nielsen, EMSA, www.motorsystems.org.
[8] EMSA overview Policy Brief, Rita Werle, 2012, www.motorsystems.org.
[9] Results of 2010, Covenants results brochure Long-Term Agreements on energy efficiency in the Netherlands VA/LEE, Ministry of Economic Affairs, Agriculture and Innovation, 2011.
[10] European Motor Challenge program: http://www.motor-challenge.eu/.
[11] Knowledge network on Efficient Electric Motor Systems (in Dutch), 2011/2012.