Implementing efficient electric motor systems and ISO 50001: opportunities for a 3 way approach in the Netherlands

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Abstract

Research and pilot projects show that system optimization and best available technology can deliver reductions of 20 - 30% in the electricity used within motor systems for industrial heating, cooling and ventilation systems and industrial production systems in the Netherlands. Obstacles in the marketplace and a low awareness of energy efficiency best practices and technologies are hampering their market penetration. Government and industry have started initiatives to overcome these barriers along the following lines of activity: energy management systems (EnMS) in voluntary agreement programmes, and participation in the IEA 4E Electric Motor Systems Annex (EMSA) combined with an electric motor systems (EMS) knowledge network. These activities are complementary to each other and bring more focus and attention towards the implementation of efficient electric motor systems in industry.

Large industrial companies engaged in voluntary agreements (VA's) with the government all have an EnMS in place. ISO 50001 provides a very good match with the Dutch standard that most of these companies already have in place; however, research shows that some aspects of the EnMS systems are not well implemented and that some of the main aspects of efficient electric motor systems within the EnMS applied are not covered in a satisfactory manner. Some new projects have been initiated to address these issues while assisting companies in their transition towards ISO50001 and supporting the implementation of electric motor systems.

NL Agency and the motor systems industry operate a 'knowledge network' to support the implementation of electric motor systems and to provide knowledge transfer and guidance on systems performance. Different activities, that include a quick-scan of electric motor systems, are being developed.

The Netherlands is also participating in the Electric Motor Systems Annex (EMSA) as part of the IEA 4E Implementing Agreement. The joint experience of the six member countries is applied to provide technical guidance, capacity building and knowledge transfer on performance and IEC/ISO systems standards.

Introduction

Electric motor systems (EMS) use about 69% of electricity in Dutch industry. Research and pilot projects show that system optimization and best available drive technology can deliver reductions in electricity demand of 20 - 30% in pumps, fans and compressors used in heating, cooling and ventilation systems and similar savings in industrial handling, processing and production systems; thus having a potential to lower the national electricity bill by 5 to 8% [1]. However, obstacles in the marketplace and a low awareness of best practice and technology are hampering the market penetration of these solutions. The Dutch government and motor systems industry have started initiatives to accelerate market penetration along three lines of activity: VA-programmes, technology network and EMSA.

1. Instrument of Voluntary Agreements

Series of 3 Voluntary Agreements on Energy Efficiency

There has been a succession of three Dutch Voluntary Agreements on Energy Efficiency (VA's) implemented in the form of covenants. VA1 began in 1992 as the first covenant on Energy Efficiency, 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 of energy used per unit of product or service delivered through a 2 per cent per annum improvement in energy efficiency. Under VA1, the focus was on process efficiency. The programme is being operated via the the Netherlands Agency for Energy and Climate Change, NLAgency.

After VA1 came to an end in 1998, the parties continued the covenant through VA2. The focus was still on process efficiency, but was broadened to include sustainable energy and chain efficiency[1], amongst other aspects.

In 2008, in view of the success of the previous VAs, the choice was made to intensify, extend and broaden the VA2 programme into the VA3 programme. Amongst others factors, the intensification requires businesses to exert efforts to attain an improvement in energy efficiency of 30 per cent over the period 2005–2020. Roadmaps have been introduced to support this transition. There is also a greater focus on chain efficiency and cooperation across sectors (see also the paragraph on KnEMS).

For large industrial companies the LEE covenant was signed in 2009 and is based on VA3 (LEE stands for Long-Term Agreement on Energy Efficiency for ETS). LEE is designed for large industrial companies that are obliged to participate in the Emissions Trading System of the European Union (ETS). The LEE participants are also committed to a scheme of energy efficiency goals and activities, comparable with that of the VA-scheme. The LEE participants come wholly or partly under the ETS.

The current programme runs up to 2015 and is currently being evaluated to assess its results and potential for continuation.

Results

A total of circa 1,000 energy intensive companies from 40 different sectors, improved their energy efficiency in 2010 jointly by an average of 1.4% (over one year compared to 2009, LEE and VA3 together) [2]. In 2011 the figure was 1.9% compared to 2010 [8]. Compared to 2009, the energy consumption increased by 99 PJ in 2010. In the case of LEE, this is mainly due to an increase in

[1] Chain efficiency in the context of efficiency gains within the supply chain starting from materials exploration, production of raw materials, semi-finished products and finished products, including distribution transportation and distribution activities.

production in almost all sectors. For VA3, that increase may also be attributed to an increase in production but also to the addition of some new sectors and companies.

The VA3-companies from industry, food and beverages and services sectors had an energy efficiency improvement of 2.3% in 2010. In comparison to 2005 the companies are 10.6% more energy efficient. This means that they are performing above the government target of 2%. They also conserved energy at an average rate of 2.1% a year. These results are due to measures made in the field of process and chain efficiency. By the start of 2012 the VA3 sectors will deliver their roadmaps, in which they define their energy efficiency strategy for 2030.

The LEE companies improved their energy efficiency by 1.1% in 2010, see Figure 1. This is due to the fact that this is the first full year for the LEE participants. They needed a starting period to start working with the methods of the new covenant. Besides this last year the production volume increased sharply and the companies partly delayed measures for energy efficiency improvement. By the end of 2012 these companies will be 8.2% more energy efficient compared to 2009 – based on the saving ambition in the Energy Efficiency Plans (EEP). These plans describe the energy saving measures that are to be taken from 2010 to 2012. In mid2012 the roadmaps of the LEE-sectors were prepared.

	Energy consumption 2010	Improvement in energy efficiency*
	PJ	%
LEE	626	1.1
LTA3	219	2.3
Joint result	**845**	**1.4**

*Savings resulting from measures in the production process and production chain within the Netherlands

Figure 1 Joint results VA and LEE in 2010 [2]

4 year cycle

The participating companies in VA3 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 (EEP) 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). NL Agency performs an assessment to determine whether an EEP meets the requirements of a VA. On the basis of the individual plans, NL 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 VA-approach. Working together with other countries in the Motor Challenge Program project (MCP) [9], all known measures from the MCP are listed on the VA 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 (EIA). 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 EIA support if you have actually implemented the recommended energy measures.

The instrument of VA´s 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) ISO14001, which is being transformed towards standards such as ISO50001 and new methods such as the CO2 performance indicator.

EMSs are addressed within this framework and clear links towards organization, procurement and sustainability issues are being developed.

Energy management system

Energy management was introduced within the Voluntary Agreement (VA) programme in the Netherlands at the beginning of this millennium. The VA programme had been established in the late 1980's as a policy instrument to increase energy efficiency in Netherlands' industry. The programme showed good progress in its early years: i.e. it led to a 22.3 % average energy efficiency improvement (defined as a reduction in specific energy consumption) over the period 1989–2000. However in more recent times some participating enterprises found that the result achieved in previous years was eroded. This is illustrated for a specific enterprise by an observed increase in the energy efficiency index used as an energy efficiency indicator, after a previous period of decrease, see Figure 2. In this specific case a member of the board, who was very active in promoting energy saving, left the company. The result was that energy consumption ceased to be monitored, and energy use went up again. This became the reality, as opposed to expected trend shown in the dotted line.

The conclusion drawn was that there was a need for a structural approach in saving energy based on the Plan-Do-Check-Act (PDCA) approach [10]. This approach, which we nowadays simply call energy management, was introduced as an obligation within the Voluntary Agreement programme at the beginning of this millennium.

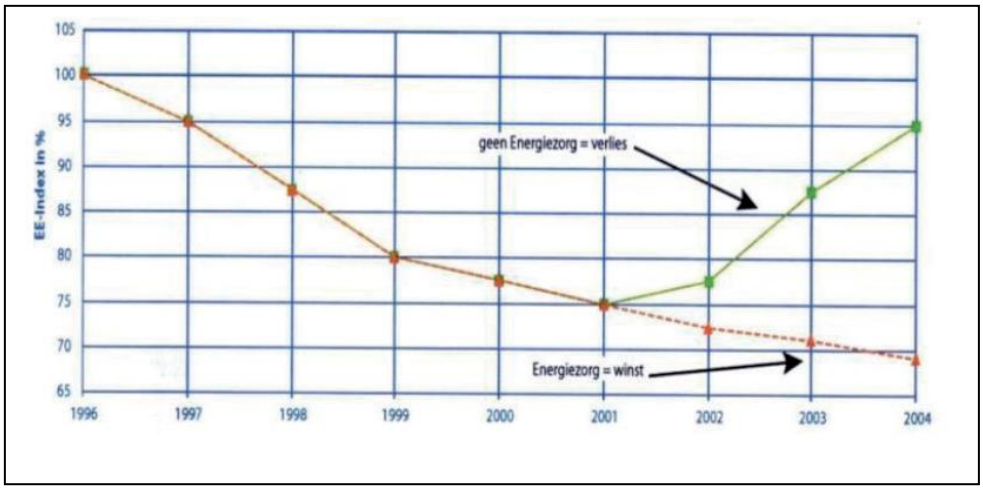

Figure 2 Energy Efficiency Index development for a specific enterprise: with and without active energy management [2]

Based upon the structure of ISO 14001, a new management system approach was designed for energy. This seemed very logical since energy could be addressed in the ISO 14001 framework, which sets out the criteria for an environmental management system, as soon as it is identified as a significant environmental aspect. This also guarantees alignment of the energy management system with the environmental management system. The other reason to do so is the familiarity of part of the Netherlands' enterprises with the ISO 14001 system structure. Currently up to almost 1900 organizations in the Netherlands hold an ISO 14001 certificate. Based on this structure the so called "Energy management specifications" were designed to be accompanied with a "Reference Guide" to facilitate implementation.

Monitoring quality of implementation of energy management systems

Currently approximately 900 organizations have implemented an energy management system. This is based on the "Energy management specification" mentioned above or is being integrated within the ISO 14001 environmental management system. Having implemented an energy management system

doesn't however always guarantee practical success in operation. To facilitate ongoing improvement yearly audits are being executed at a random selection of 50 organizations to assess how they meet the requirements of the "Energy management specifications". These audits are done on behalf of NL Agency. On top of that several organizations are already being certified for ISO 50001 or are preparing for certification.

Highlights of the audits (on the quality of implementation of energy management systems) of 2011 were that Technical management moves to Facility support, leading to a reduced guidance on technical buying within companies. And a reduction of the number of operational (technical) personnel, leading to reduced time for development (of energy efficient measures). Also although there is the introduction of more automated process control, but less attention (or capacity) for energy consumption analyses. Overall there is a development towards less single-head technical responsibility within the participating companies.

The audits in 2012 shows that a general weak point in the operation of the systems lays within a weak or non-existent management review, leading to low involvement of the management, and reduced chances engagement of personnel in implementing the appropriate responsibilities and energy saving measures. Secondly a general weak aspect of the audited systems is the 'checking-part of the system'. In short this means that the effectiveness of taken measures is not being monitored, nor is the mechanism of PDCA-cycle working correctly, since the 'C' of the checking part is missing.

The 3 main elements of the VA-program, i.e. 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, give government and industrial companies a solid basis to develop and implement energy efficiency activities. For the Dutch government the VA-program strengthens the national climate and energy efficiency goals of the Dutch government. However, as the following paragraph shows, more actions from policymakers and industry is needed to come to an more successful implementation of efficient electric motor systems.

2. Knowledge network on electric motor systems (KnEMS)

Analyses of market and barriers for efficient electric motor systems

Analysis of the market of electric motors supply and maintenance in the Netherlands and the practices of the Original Equipment Manufacturers (OEM's) and industrial end-users shows that for a successful acceptance of efficient electric motor systems all market parties have to get involved, see Figure 3. As a result of this and of the above mentioned market developments NL Agency broadened the focus of their activities on efficient electric motor systems from end-users alone towards addressing all market parties in a 'knowledge network for efficient electric motor systems'. This KnEMS also lays more responsibility on to the market itself, which became necessary with a government which aims to meet new efficiency goals and effective ways in supporting businesses in their pursuit for energy efficiency [3].

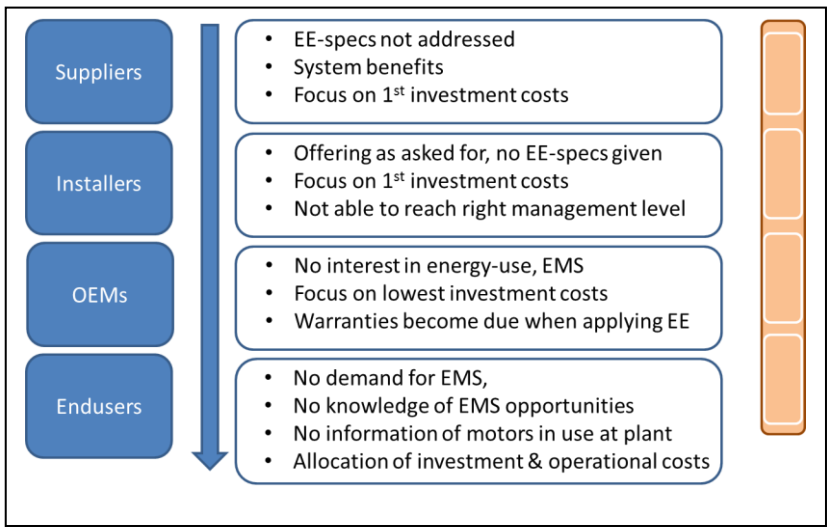

Figure 3 Obstacles in the marketplace for Efficient Motor Systems [3]

KnEMS (Knowledge network on electric motor systems)

In cooperation with NL Agency the motor systems industry has started a 'knowledge network' to support the implementation of Efficient Electric Motor Systems (EMS) and raise the awareness of its potential. Two Dutch sector associations, of suppliers (FEDA) and of installation engineers (Uneto-VNI), have joined the network and representatives of one OEM sector are also involved (the Dutch Pump Association (HPG)) [4].

A short film on efficient electric motor systems has been made to introduce the new EU regulation for efficient electric motors. Three managers of VA-participating companies show how they got involved in applying efficient electric motor systems in their businesses. The situations for two of them - end-users - are different, but the benefits and results are comparable as seen through large economic savings in HVAC, luggage handling and inside passenger transport systems, as well in industrial ventilation systems. The Original Equipment Manufacturer (OEM) applies the IE2 high efficiency motor as standard as part of its company policy in delivering high quality, modern equipment with low maintenance cost over its life cycle. An English version is available on www.motorsystems.org.

The network assists in organizing 3 workshops specific for VA-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 will also work 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. A specific tool that is promoted is the EMSA Motor Systems Tool, developed by Danish Technology Institute. This tool is unique in how it is applying a system approach. Not only is the motor performance calculated, but also the transmission, drive and load itself are calculated and optimized (see: www.motorsystems.org/motorsystemtool). Best practices and factsheets will be produced that are suitable to inform both a technical and non-technical public.

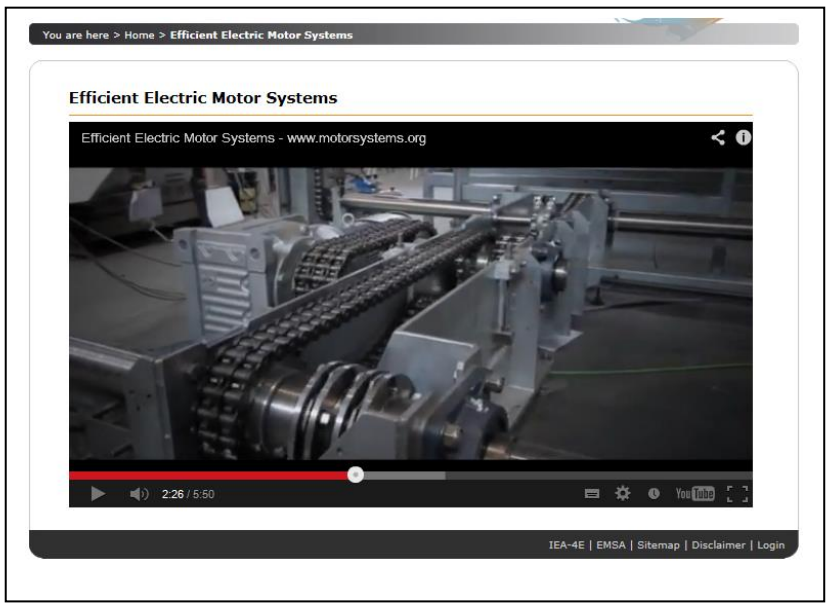

Figure 4 Screenshot of Short film on electric motor systems [4]

The KnEMS 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 (VSDs) 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.

3. EMSA (electric motors systems annex)

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 [5]. 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 was renewed in 2012 and will run for three years. The Netherlands participate 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.

Implementing ISO 50001 and opportunities for efficient electric motor systems

The quality of the energy management systems implemented by the VA participants is monitored every year and opportunities are identified to improve the system and its effectiveness. The systems are based on (elements of) the standard ISO14001 and some participants have already started a transition towards ISO50001 [6], [7].

During the 2012 monitoring period of the energy management systems special attention was given towards the opportunities for efficient electric motor systems. The areas which offer the best opportunities are shown below – the 'starting position' in the energy management systems (EnMS) is show in Figure 5:

- Energy Planning: give specific attention to drives in relation to the electricity use in the energy review. Are the important groups of motor systems identified? ISO 50001 characterizes significant users also as users with a significant efficiency potential.
- Implementation, operation and monitoring: is 'motor management' identified and described as an activity? Is there adequate knowledge and capacity to implement this activity? Which part of the organization holds this domain?
- Maintenance and repair of electric motor systems. How are these technical issues organized? What procedures are in place for rewinding or replacement, for redesign or adjustment of drives and for preventive replacement versus replacement by failure? Is Total Cost of Ownership (TCO) a standard element in the business cases?
- Procurement and Design. Are minimum efficiency requirements for motors in place? Are they differentiated according to the motor system, e.g. processing equipment or pumps? How are the responsibilities allocated between engineering, energy and procurement? Are personnel trained in the use of TCO principles?

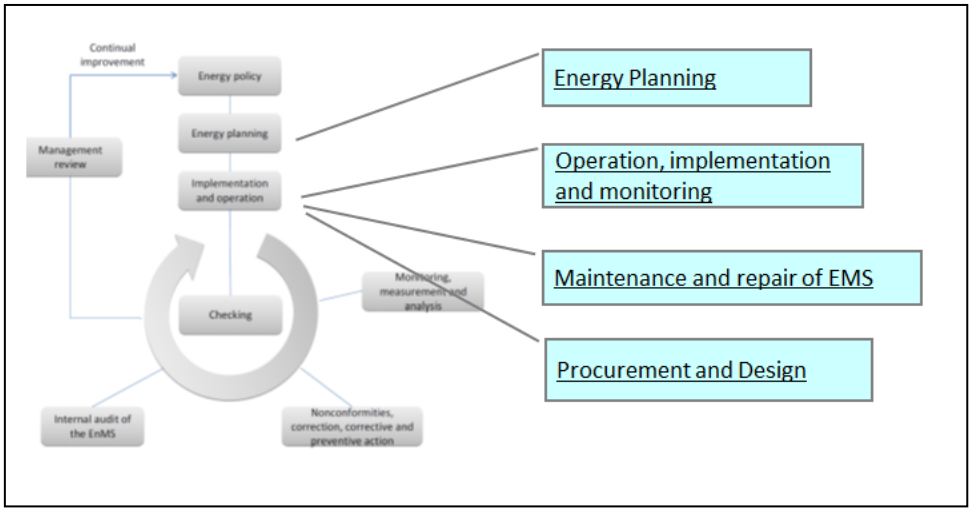

Figure 5 Opportunities for electric motor systems in energy management system ISO50001 [7]

The implementation of these specific aspects of and opportunities for electric motor systems in ISO 50001 will enhance the implementation of efficient electric motor systems within industry, and will help industry, Original Equipment Manufacturers, suppliers and maintenance parties to work more efficiently and increase their competitiveness.

EMSA provides a forum for the direct and in-depth exchange between members on their experience with motor systems efficiency policy, as well as a vehicle for collaborative projects. EMSA's research results are publicly available.

4. Conclusions

The three lines of activity of the Dutch government and the Dutch motor systems industry - VA-programmes, technology networks and EMSA - are complementary to each other and bring more focus and attention towards the implementation 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.

The VA-programme provides a framework for the participating companies to integrate energy efficiency activities into their daily operation, and to integrate energy management into their organization. Due to the specific characteristics of electric motor systems the VA programme alone is not enough for a successful uptake by industry.

Where the VA programme makes the companies accessible and engaged with energy efficiency activities, the KnEMS activities supply the companies with the information and knowledge on electric motor systems. The network forms a platform for the sector (suppliers, maintenance, services) to deliver objective and consistent information on electric motor systems for end-users and works actively on knowledge transfer via best practices, workshops and factsheets, for example.

The third line of activity, EMSA, brings in up-to-date knowledge on international practices on electric motor systems, on capacity building and the development of new standards. New tools and practices can be introduced and absorbed quickly by the members of the KnEMS and be brought to their own members and to end-users.

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Figure [source]