Transforming the market for super-efficient motors: the SEAD Global Efficiency Medal

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Abstract

The Global Efficiency Medal (GEM) competition, a cornerstone activity of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative, is an awards program that encourages the development, production and sale of super-efficient products. SEAD is a voluntary multinational government collaboration of the Clean Energy Ministerial. This winner-takes-all competition recognizes energy-efficient products, guides purchasers towards energy-efficient product choices, and demonstrates the levels of energy efficiency achievable by commercially available and emerging technologies.

The third Global Efficiency Medal competition recognized super-efficient electric induction motors in two size categories and four regions around the world. The SEAD Global Efficiency Medal complements existing labelling programs and advances comparable and transparent international test procedures that support MEPS efforts.

This paper focuses on the wide range of efficiencies among motors available worldwide. In 2013, the efficiency of motors sold in the European market trailed North American (most efficient) and Australian markets for motor sizes included in this competition. This correlates with the relative stringency of MEPS in each region, reflecting the impacts of different regulations in place. The SEAD award-winning motors are 1.5–6.4 % more efficient than the average motor sold in each corresponding regional market. For induction motors, this is a huge improvement that represents significant potential energy savings.

Motors nominated for a new technology category claimed full-load performance that was 1.2–6.4 % more efficient than requirements for the IE4 super-premium efficiency category. However, reliably assessing the efficiency of these motors, which require a variable frequency drive for operation, was not possible due to absence of an international test method. There is a clear need for transparent international test procedures that enable the energy performance of these products to be accurately measured so that these products can be included in future labelling and incentive policies.

Introduction

The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative of the Clean Energy Ministerial launched the third Global Efficiency Medal (GEM) competition, recognizing highly-efficient electric motors, on 3 June 2013[1]. As the only global mark of energy efficiency, SEAD's Global Efficiency Medal helps identify the world's most efficient products. It allows purchasers that care about energy-efficiency to differentiate the most efficient products on the market and spurs innovation among manufacturers. The competition also demonstrates support for more transparent and harmonized product efficiency testing around the world by using an internationally accepted test procedure to evaluate product nominations.

In the months following the competition's launch, interested manufacturers nominated motors from their product lines that they considered the most energy efficient. Presumptive winners were selected based on manufacturer claims for product energy

1. See http://superefficient.org/motorawards.

Figure 1. SEAD Global Efficiency Medal logo.

efficiency performance, and samples were selected at random to test and verify these claims. Verification testing, supported by sponsor governments, was conducted at a test laboratory procured through an open request for proposals process. On 7 October 2014, the regional winners were recognized at the fifth Motor Summit in Zurich, Switzerland. Announcements about the regional and global winners soon followed in Australia, Europe, India and North America, and the global winners will be recognized at an awards ceremony at the sixth Clean Energy Ministerial in Mexico in May 2015.

This paper focuses on the variety of efficiencies of motors available worldwide, and how the SEAD award-winning motors compare to the average motors sold in participating regions. It discusses challenges the competition faced due to the absence of an international test method for new technology motors which require a variable frequency drive for operation.

Background

The SEAD Initiative of the Clean Energy Ministerial is a voluntary international government collaboration that seeks to engage governments and the private sector to advance global market transformation for energy efficient equipment and appliances. To this end, SEAD is engaged in the following five activities: awards (SEAD GEM competition), procurement, incentives, standards and labelling, and technical analysis. The first three activities focus on mechanisms to increase demand for energy efficient products, the fourth facilitates exchange of technical information, and the last creates a strong analytical foundation for SEAD activities. Each activity is managed by a working group comprised of government representatives from participating countries. The SEAD GEM competition is developed by the SEAD Awards Working Group, which is comprised of government representatives from Australia, Canada, India, Japan, Sweden, the United Kingdom and the United States, and administered by CLASP.

The SEAD GEM competition is a global and regional awards program that encourages the development, production and sale of super-efficient products. Specifically, this competition aims to accelerate efficiency gains in existing technologies and to promote the introduction of new technologies into the market by recognizing both commercially available and emerging technologies. The SEAD Global Efficiency Medals complement existing national and regional efficiency labelling programs and the competition process actively engages the manufacturing industry in the design of the award categories and rules. It fosters international collaboration amongst government agencies responsible for promoting and regulating product energy efficiency by encouraging the development of transparent international test procedures. As SEAD's most publicly visible activity, the awards program is a cornerstone of SEAD's market transformation strategy.

While the first two SEAD GEM competitions focused on consumer electronics, successfully identifying the world's most efficient TVs in 2012 and displays in 2013, the third SEAD GEM competition focused on electric motors. Electric motor-driven systems (EMDS) account for 44 %–46 % of electricity end-use globally. The operating cost of medium and large size motors over the life of the motor can dwarf the initial purchase price. In North America alone, cost-effective efficiency technologies and practices can reduce the industrial motor-system electricity demand by 11 %–18 % (62 TWh to 104 TWh) and save US$3 billion to $5 billion a year.[2]

Competition Categories and Requirements

CATEGORIES

The competition planned to recognize the most energy-efficient IEC and NEMA induction motors in various size categories across four regions: Australia, Europe, India, and North America. Size categories were selected to maximize energy savings, which is the primary objective of the SEAD Global Efficiency Medal competition, and vary across the four regions to target motor sizes that present significant energy savings potential and a large market share. Because medium size motors between 0.75 kW (1 HP) and 375 kW (500 HP) account for 68 % of motor electricity consumption and will continue to dominate the market for price reasons, SEAD seeks to encourage the production of super-efficient motors and realize the efficiency gains in this particular size category.

Figure 2 shows the categories for the SEAD Global Efficiency Medal competition for electric motors. Frame sizes and frequency differ among the competition regions: North American markets tend to have 60 Hz motors following the NEMA frame standard, while Australia, Europe, and India use 50 Hz motors following the IEC frame standard. Because of variations in frame size and because the mains frequency affects induction motor efficiency, not all motors of similar size within the Regional Awards can be compared to each other for the International Awards.

Over the last few years, manufacturers have begun to offer new technology motors with efficiencies beyond those possible with AC induction motor technology. However, these new technologies still have a significant price premium and often require an electronic controller or variable frequency drive for their operation. SEAD sought to promote new technologies showing promise of being commercially available in the near future through a separate New Technology category in the competition. However, SEAD competitions rely on the use of international or regional test methods that have achieved consensus within the international community. Without such

2. Waide and Brunner 2011. *Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems*. IEA.

Regional Awards	IEC Induction Motor			NEMA Induction Motor	
	3.7 kW	4 kW	11 kW	5 HP	15 HP
Australia		•	•		
Europe		•	•		
India	•		•		
North America	•		•	•	•
International Awards		•	•		

Figure 2. Categories for the SEAD Global Efficiency Medal competition for Electric Motors – commercially available products.

Minimum Shipments (units)	IEC Induction Motor		NEMA Induction Motor	
	3.7 kW - 4 kW	11 kW	5 HP	15 HP
Australia	1400	500		
Europe	1400	500		
India	1400	500		
North America	420	150	980	350

Figure 3. Minimum projected annual shipment of motors.

a test method for new technology motors, SEAD was unable to include these products in the competition.

SHIPMENT REQUIREMENTS

In addition to selecting categories to maximize energy savings, the competition put in place shipment thresholds to ensure that winning products have sufficient market share to impact energy savings. Nominated products were required to have plans to ship a certain number of units within a one year period starting between 3 June 2013 and 1 September 2014. The shipment thresholds also ensure that nominated products are not custom-made products or prohibitively expensive. Shipment thresholds were determined through market analysis and consultation with technical experts and industry representatives.

Award-winning Products

Nominated products were expected to be fairly similar in terms of energy efficiency. Therefore, to eliminate any testing variations between test laboratories, SEAD tested all nominated IEC motors (eligible for the international awards) in a single laboratory to determine international award-winners and to verify manufacturers' energy performance claims.

While most categories had GEM winners, several categories had either no nominations or no eligible products nominated. These included the two categories in Europe as well as the two IEC categories in North America. (North America did have GEM winners in the NEMA categories.)

Winning products in the commercially available electric motors categories were between 1.5 to 6.4 percent more efficient than the average motor sold in each corresponding regional market. For induction motors, this is a huge improvement that represents significant potential energy savings. The winning products for each region of the SEAD Global Efficiency Medal for electric motors are:

Australia:

- 4 kW: YZTE4-112M – Nanyang Explosion Protection Group Company Limited.
- 11 kW: YZTE4-160M – Nanyang Explosion Protection Group Company Limited.

Europe:

- 4 kW: No winner.
- 11 kW: No winner.

India:

- 3.7 kW: 1LA21134NA80 – Siemens Limited (India).
- 11 kW: 1LA21634NA80 – Siemens Limited (India).

North America:

- 5 hp: NSPE184T – Nanyang Explosion Protection Group Company Limited.

Table 1. Comparison of average motor efficiencies and SEAD Global Efficiency Medal winner efficiencies.

	Average efficiency		Efficiency of winners	
North America	5 HP	15 HP	Nanyang 5 HP	Nanyang 15 HP
	89.3 %	92.2 %	91.1 %	93.6 %
Improvement over average			**2.0 %**	**1.5 %**
Australia	4 kW	11 kW	Nanyang 4 kW	Nanyang 11 kW
	88.2 %	90.8 %	91.2 %	93.5 %
Improvement over average			**3.4 %**	**3.0 %**
India	3.7 kW	11 kW	Siemens 3.7 kW	Siemens 11 kW
	83.1 %	87.6 %	88.4 %	91.5 %
Improvement over average			**6.4 %**	**4.4 %**
EU	4 kW	11 kW		
	85.5 %	89.1 %		
Note: Average efficiency data is based on 2013 sales as determined by IHS Technology (NYSE: IHS) through market analysis.				

Table 2. Test methods indicated in the Official Rules for various categories of the SEAD Global Efficiency Medal competition for electric motors.

Award Category	Test Method
IEC Induction Motor	IEC 60034-2-1:2007, Summation of Losses Method
NEMA Induction Motor	U.S. Department of Energy test procedure for Electric Motors and Small Electric Motors, as specified in 10 CFR part 431
New Technology Motor (< 75 kW)	IEC 60034-2-1:2007, Direct Test Method: Out/Input
New Technology Motor (< 100 HP)	IEEE Standard 112, Test Procedure for Polyphase Induction Motors and Generators, Efficiency Test Method A, Input-Output

- 15 hp: NSPE254T – Nanyang Explosion Protection Group Company Limited.
- 3.7 kW: No winner.
- 11 kW: No winner.

The two products that won regional awards in Australia also won the international awards.

WINNING PRODUCT EFFICIENCY

All of the winning products are significantly more efficient than the average motor sold in each corresponding regional market. Table 1 shows the average efficiencies of motors in each regional market[3], the efficiencies of the winning products, and the efficiency improvements that these winners have achieved over the average.

3. The average motor efficiencies in each regional market in 2013 were analyzed through market analysis by IHS Technologies.

Table 1 also shows the average efficiency of motors in the market of each competition region. This table clearly shows that the average efficiency of 4 kW and 11 kW motors in the EU falls well below those in North America and Australia. It is likely that this stems from the less stringent minimum energy performance standards in Europe (IE2 levels) as compared with Australia (slightly above IE2 levels) and North America (IE3 levels).

New Technology Motors

A number of manufacturers nominated motors for a proposed new technology category, but each of these required an electronic controller or variable frequency drive. The SEAD Global Efficiency Medal competition uses test methods that have international consensus. Table 2 shows the test methods that were indicated for this competition.

For products that require an electronic controller, the test methods indicated for the new technology motors could only determine the efficiency of the system (electronic controller or variable frequency drive plus motor); they cannot determine the efficiency of the motor alone. Therefore, in the absence of an internationally-accepted test method that could determine the efficiency of the motor within the system, these products were ultimately deemed ineligible for the competition. However, based on manufacturer claims, these products were 1.2 to 6.4 percent more efficient than requirements for the IE4 super-premium efficiency category.

With new technology motors using electronic controllers or variable frequency drives being the most efficient and the direction the market is trending, there is a clear need for a test procedure to compare controller and motor combinations across different regions.

Conclusions

The SEAD Global Efficiency Medal competition for electric motors planned to recognize the most energy-efficient IEC and NEMA induction motors in various size categories across four regions: Australia, Europe, India, and North America. Size

categories were selected to maximize energy savings, which is the primary objective of the SEAD Global Efficiency Medal competition, and vary across the four regions to target motor sizes that present significant energy savings potential and a large market share.

The SEAD award-winning motors are 1.5–6.4 % more efficient than the average motor sold in each corresponding regional market. For induction motors, this is a huge improvement that represents significant potential energy savings. Although no products were submitted in the Europe region, market analysis showed that the average efficiency of 4 kW and 11 kW motors in the EU falls well below those in North America and Australia. It is likely that this stems from the less stringent minimum energy performance standards in Europe (IE2 levels) as compared with Australia (slightly above IE2 levels) and North America (IE3 levels).

To encourage higher participation and even better results in the future, SEAD will consider several improvements based on lessons learned from this competition. Longer lead times for the competition may be important for garnering more manufacturer participation. In addition, given the large differences in supply chains for different products, more detailed consideration will be given in the future as to product-specific avenues to best encourage manufacturer participation and impact market transformation for selected GEM competition products.

New technology motors, requiring an electronic controller, were ultimately deemed ineligible for the competition due to the absence of an internationally-accepted test procedure that could measure the efficiency of the motor within an extended system. However, with new technology motors using electronic controllers or variable frequency drives being the most efficient and the direction the market is trending, there is a clear need for a test procedure to compare controller and motor combinations across different regions. Once fully accepted international efficiency testing standards are developed for these new technology products, the SEAD Global Efficiency Medal competition could use them to expand the scope of competitions in future years.