IMPACT ENERGY

Global Overview

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Status quo

While motor technology develops rapidly beyond asynchronous induction motors, the national motor requirements follow suit only slowly. When IEC 60034-30-2 was updated in 2014 to include also 0.12 kW up to 1000 kW output size, expectations were high for the US, Europe and China to adopt this into national law quickly. It did not happen yet and the future is still dim (Figure 1). Also, China has retracted from its plan to update his minimum requirement of IE2 to IE3 in late 2016. Still, the good news is 11 countries have MEPS for motors: these countries account for 76% of the global electricity consumption of motor systems, and for 78% of the global Gross Domestic Product [1].

Efficiency Levels 3-phase induction motors (Low Voltage < 1000 V)	**Efficiency Classes** **IEC 60034-30-1, 2014** **Global classes IE-Code ***	**Testing Standard** **IEC 60034-2-1, 2014** **incl. stray load losses**	**Performance Standard** **Mandatory MEPS ***** **National Policy Requirement**
Super Premium Efficiency	**IE4**	**Preferred Method ****	
Premium Efficiency	**IE3**	**Summation of losses with load test:**	**Canada (0.75 - 150 kW)** **Israel (7.5 - 375 kW)** **Mexico (0.75 - 375 kW)** **USA (0.75 - 375 kW)** **South Korea (37 - 375 kW)** **Switzerland (7.5 - 375)****** **Turkey (7.5 - 375 kW)****** **Japan (Toprunner)** **EU 28 (7.5 - 375 kW)******
High Efficiency	**IE2**	**Additional losses P_{LL} determined from residual loss**	**Australia (0.75 - 185 kW)******* **Brazil (0.75 - 185 kW)** **Canada (151 - 375 kW)** **China (0.75 - 375)** **Israel (0.75 - 5.5 kW)** **Saudi Arabia (0.75 - 375 kW)** **South Korea (0.75 - 30 kW)** **New Zealand (0.75 - 185 kW)** **Taiwan (0.75 - 200 kW)** **Turkey (0.75 - 7.5 kW)**
Standard Efficiency	**IE1**		**Costa Rica** **Chile (0.75 - 7.5 kW)**

"italic" means in effect in 2016

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*) Output power: 0.12 kW - 1000 kW, 50 and 60 Hz, line operated 2-, 4-, 6- and 8-poles

**) for 3-phase machines direct online, < 1 kV, rated output power < 1000 kW

***) Minimum Energy Performance Standard

****) European Union, Turkey, Switzerland: IE3 or IE2 + VFD; 2017 above 0.75 kW

*****) Australia adoption of IE Standards pending

Figure 1, Motor MEPS around the globe (Source: Impact Energy, 2016)

Better Motors

Economic analysis by Ecodesign Lot 30 [2] has shown the energy efficiency benefits of IE4 motors with more than 2'000 operating hours per year. European market data from 2015 show only 22% IE3 and less than 3% IE4 sold. Prospects for a new and stronger market development of Permanent Magnet and Synchronous Reluctance motors seem (according to [3] and IHS, Figure 2) promising for the next decade. We will see annual growth rates in efficient motor sales of IE3 from 3% to 10% from 2017 to 2020. IE4 shows - starting from a very low level today - an annual growth rate during this peri-

od of 7% to 15%. Still, more disturbing is that on a global scale, IE2 still have annual growth rates around 5%. This is because for instance large developing economies like India do not have MEPS for motors. Only the lowest effciency class, IE1 definitively seems to be on the way out for good.

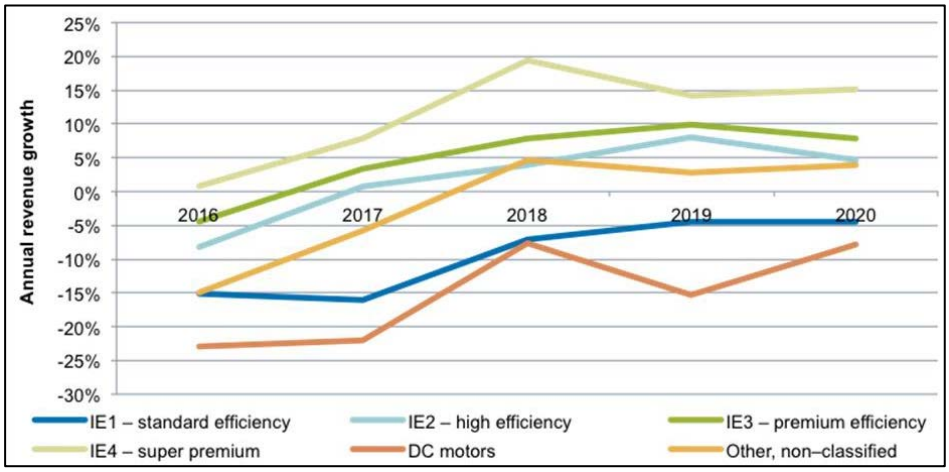

Figure 2, Future of Low Voltage motor market: Annual growth rate (Source: © IHS, 2016)

Roadmap for Motor Driven Units

VFDs are only used today in some 10% to 20% of all industrial motor applications in the running stock [4]. The development starts now with the goal to reach eventually 40% to 60% market share of new industrial motor systems installed. The performance of VFDs can only lately be measured according to a common testing method in IEC 60034-2-3 (under revision 2016) and given a clear efficiency class in IEC 61800-9-2 (FDIS 2016).

The use of a VFD in a specific configuration with variable load needs careful consideration:

- The efficiency gains in partial load (considerable savings in square torque applications like fans and closed loop pumps)
- The VFD loss at full load (defined as 90% speed and 100% torque in IEC 61800-9-2)
- The lower efficiency of VFDs in partial load (depending on proper sizing: no oversizing!)
- The extra losses inflicted to the motor from the non-sinoidal feeding

Due to the added complexity of combinations of motor, application and VFD ("Motor Driven Unit" MDU) it is still an engineering challenge with only few tools supporting its choice and configuration [5]. Few national MEPS for entire MDUs are supporting this development. A new 4E EMSA study (see [1]) shows today the large disarray in scope, metrics and methodology of standards and regulations for MDUs with motors, VFDs, pumps, fans and compressors.

Reference:

[1] Maarten van Werkhoven, Rita Werle, et al.: Policy Guidelines for Motor Driven Units, Part 1: Analysis of standards and regulations for pumps, fans and compressors, IEA 4E EMSA, Zurich, Switzerland, 2016

[2] Anibal de Almeida, et al.: Ecodesign Lot 30, Coimbra Portugal, 2014

[3] Maarten van Werkhoven, Rita Werle, et al.: Energy efficiency roadmap for electric motors and motor systems, IEA 4E, 2015 (www.motorsystems.org)

[4] Rita Werle, Conrad U. Brunner, Rolf Tieben: Swiss motor efficiency program EASY: results 2010 - 2014 of 4'142 motor systems in Switzerland, in: ACEEE Industrial Summer Study, Buffalo NY USA, 6 August 2015

[5] Sandie B. Nielsen: Motor-Systems-Tool, available for free download in: www.motorsystems.org.