

An energy efficient, system based approach to motor control

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CAPIEL 

european coordinating committee of manufacturers
of electrical switchgear and controlgear

About CAPIEL

- European Coordinating Committee of Manufacturers of Electrical Switchgear and Controlgear
 - Intended to control and to protect electrical equipment
 - mostly in the industrial environment
 - applied in the voltage range up to 1000V
- Promotes and supports the common interests of the European low voltage switchgear and controlgear industry
- Federation of national associations representing small, medium and large-sized companies that in total directly employ more than 100 000 people in Europe.
- www.capiel.eu

Members



Teknikföretagen



Motor control & Capiel

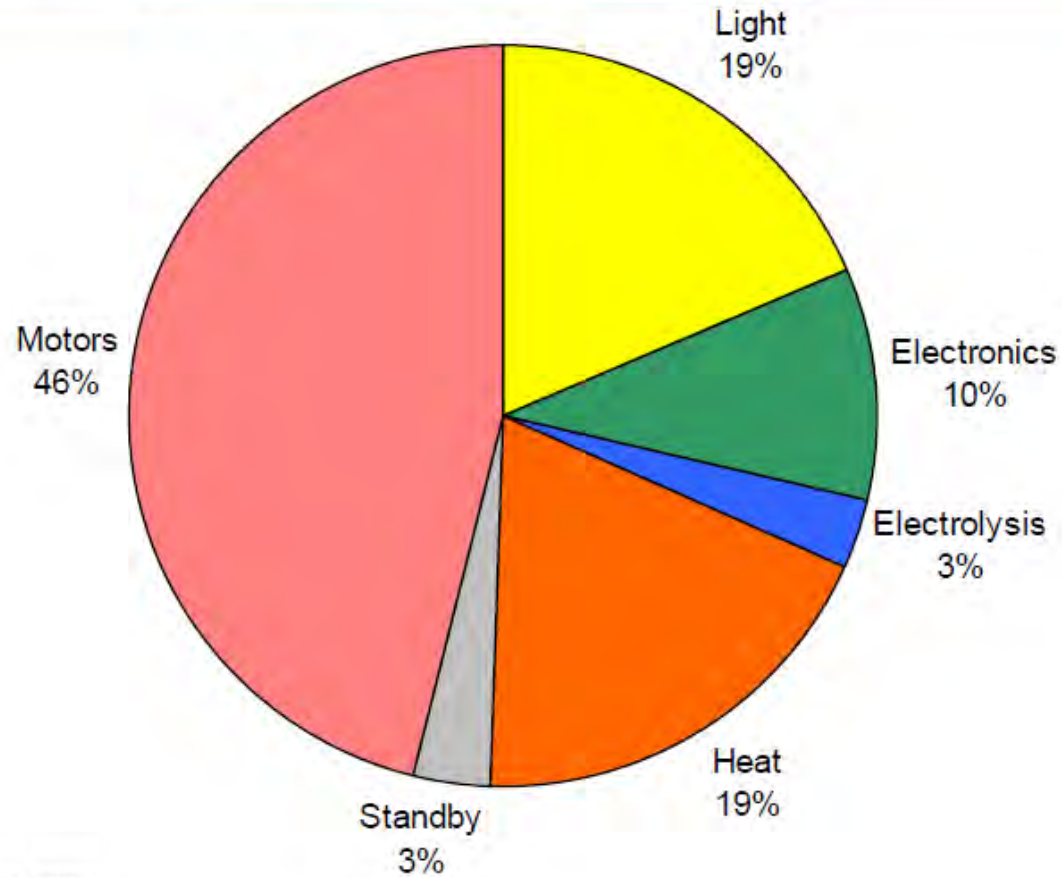
- Product portfolio
 - all kinds of relays, contactors, circuit breakers and **soft-starters**, but also switchgear assemblies, PLC's and control cabinets.
 - In conjunction with motors these products are also called **Motor starters**.
- Motor control
 - The main purpose is the control and the protection of electrical motors, from very small machines with some (hundreds) of Watts up to about 1000 kW.
 - The introduction of motors with efficiency levels IE2, IE3 or IE4 have had an impact.
 - Motor control with motor starters mean “**fixed speed**” applications, driven by induction motors.
 - 60 to 70% of all industrial motor applications are “**fixed speed**” applications in Europe and maybe more than 80% worldwide.

*In many ways, energy efficiency
can be seen as Europe's biggest
energy resource*

-European Commission
Energy Efficiency Plan 2011



Figure 9: Estimated share of global electricity demand by end-use (2006)

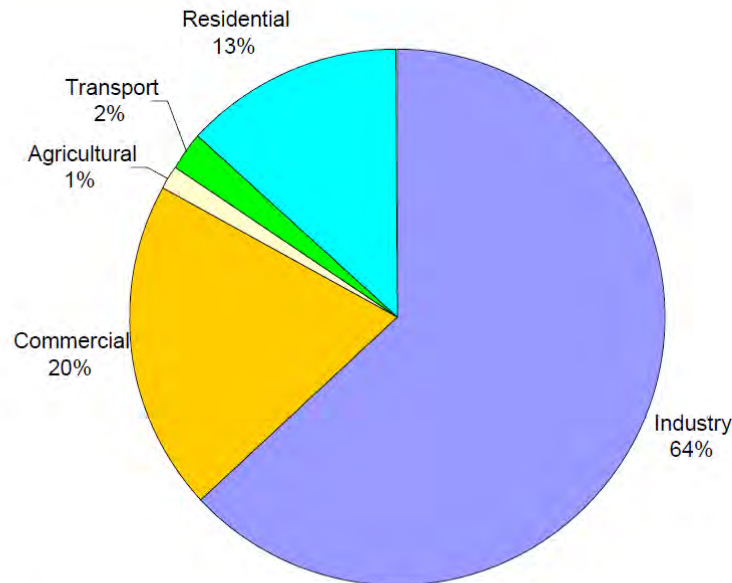


Source: A+B International, 2009.

The major applications for EMDS fall within the following sectors (figure 3):

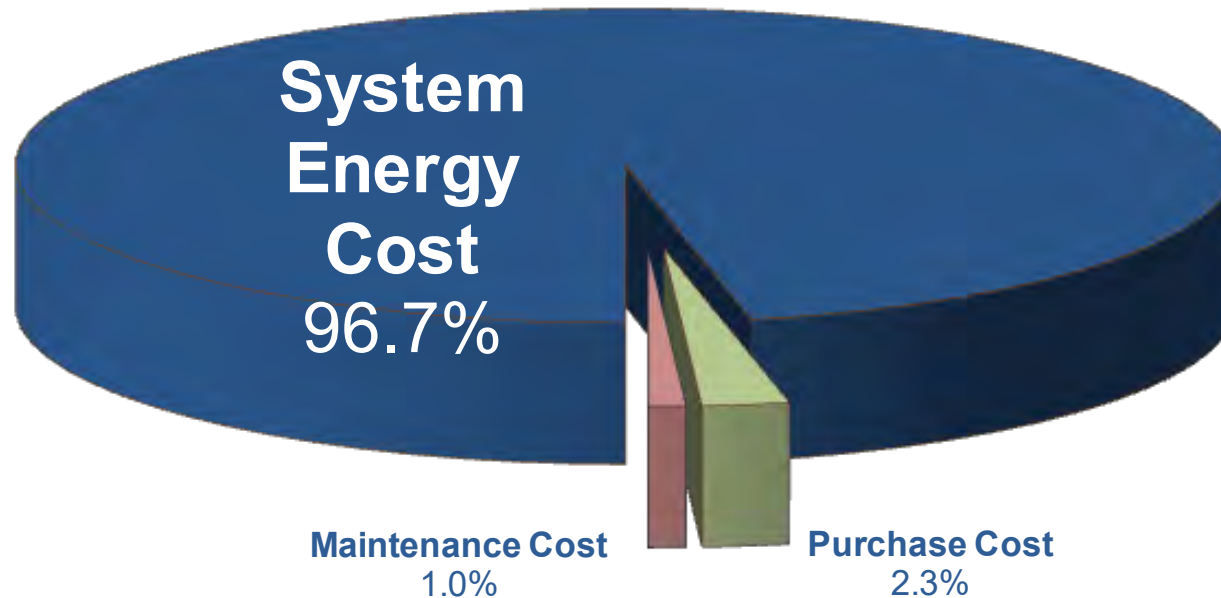
- **Industrial:** Pumps, fans, compressed air delivery, conveyors, motive power for other machinery, etc.
- **Commercial building:** pumps, fans, conveyors, lifts, compressors in HVAC systems, etc.
- **Residential:** Household appliances, air conditioners, IT fans/drives, cooking appliances, extractor fans, garden appliances, pool pumps, etc.

Figure 3: EMDS energy use by sector



Source: IEA statistics, 2006; A+B International, 2009 (motors).

The lifetime cost of an electric motor is nearly all energy cost.

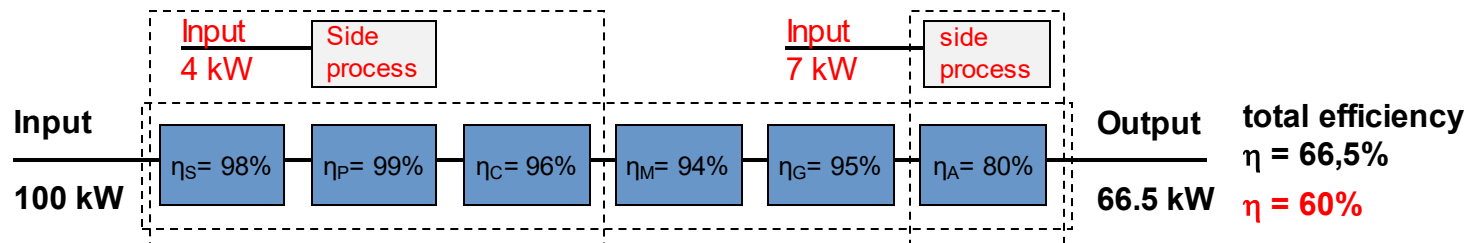
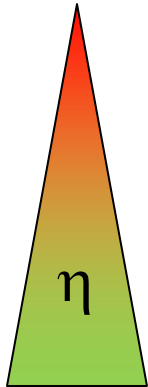


- 11kW IE3 Motor
- 4000 hours per year
- 15 year lifecycle

Motor control & Energy Efficiency

• Main Influences on Energy Efficiency

- Process requirements (e.g. steadily/intermitted; constant/variable ...) → load profile
- Processing machinery (e.g. pump) and necessary installation (e.g. tube system)
- Side processes (e.g. cooling / heating / stirring / handling ...)
- chosen motors, necessary transmission (e.g. clutches, gears, brakes)
- Motor control (speed / torque control, soft-start, YD-start, DOL-Start)
- Protection equipment and power supply (+ further equipment: e.g. filters, cooling ...)



• General

- The longer the chain the worse the efficiency (typically)
- Load profile & sizing of all components has the biggest impact
- **Motor control is just one aspect of EE**

Motor control & improved Energy Efficiency

- **Getting highest achievable EE for each individual application**
 - System-level analysis has to be carried out (e.g. Extended Product Approach in EN 50598 and IEC 61800-9), *but process requirements and processing machinery have to be challenged too*
 - Use components with best available efficiency
 - Share and level of part load situations should be as low as possible (load profile)
 - **Motor control can improve EE in case of different load levels only**
 - by speed control
 - by torque control
 - by ON an OFF control
 - by cascaded systems

Motor control should fit to the application and not to try to improve faulty / poor designs or sizing

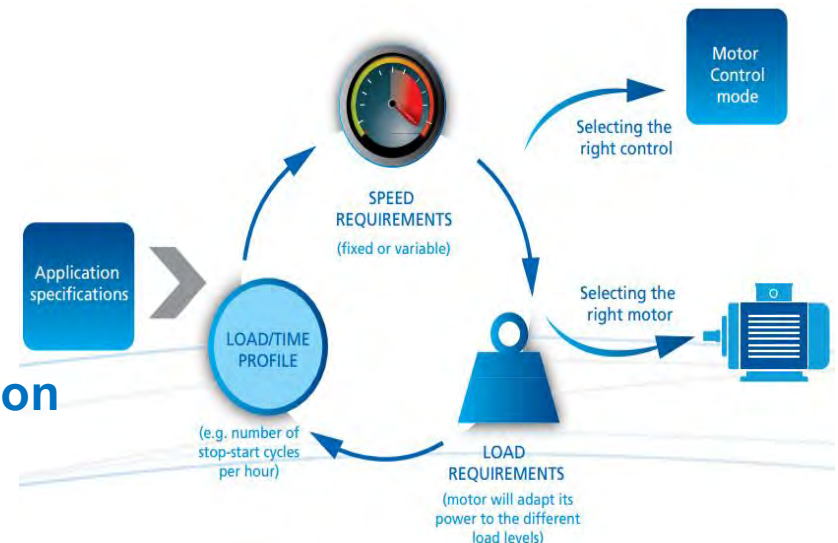
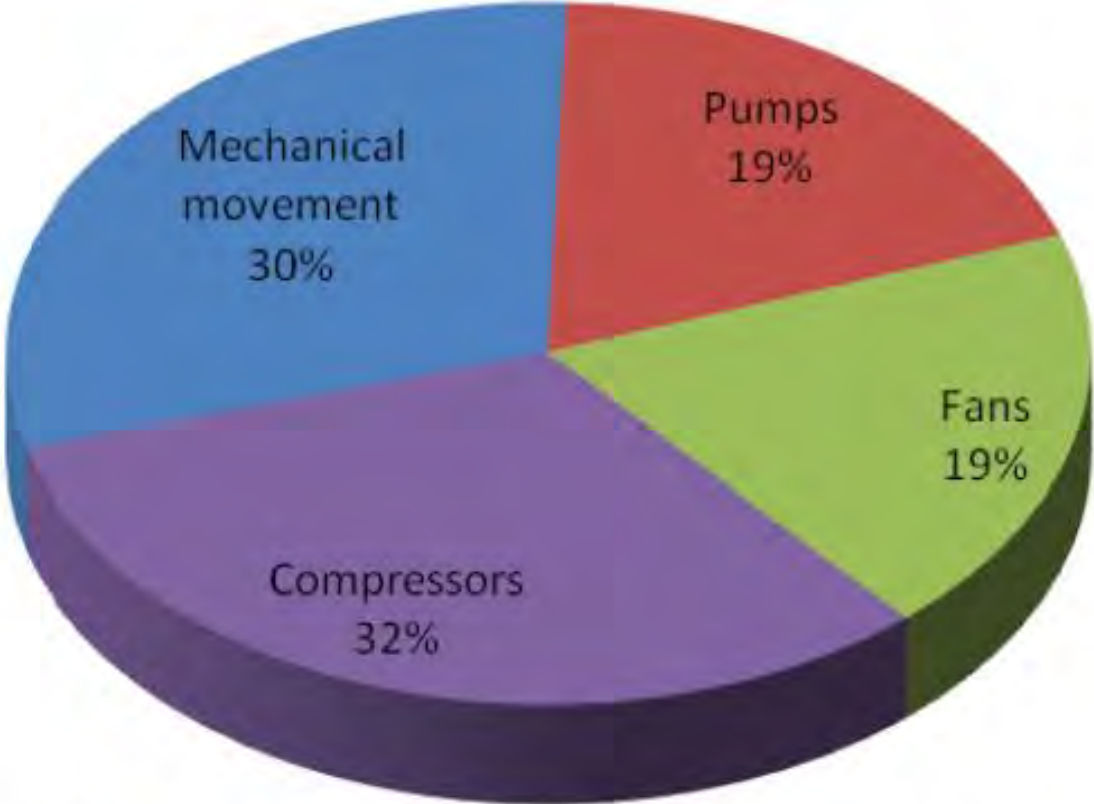


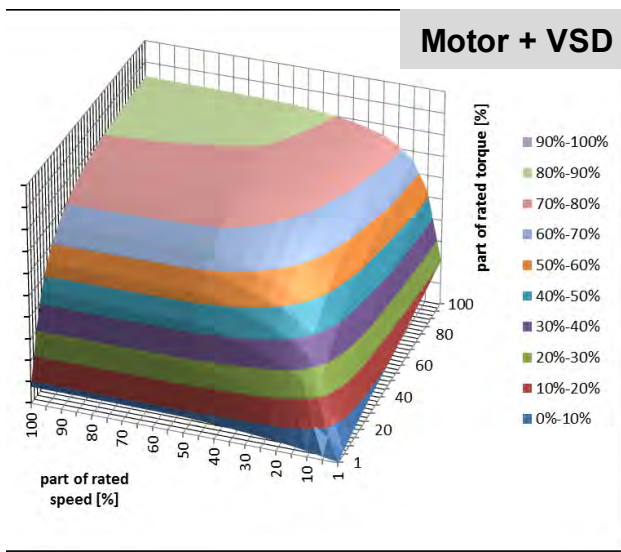
Figure 4: Estimated share of global EMDS electricity demand by end-use application



Source: De Almeida *et al.* 2008; A+B International, 2009.

Motor system (Speed control vs. fixed speed)

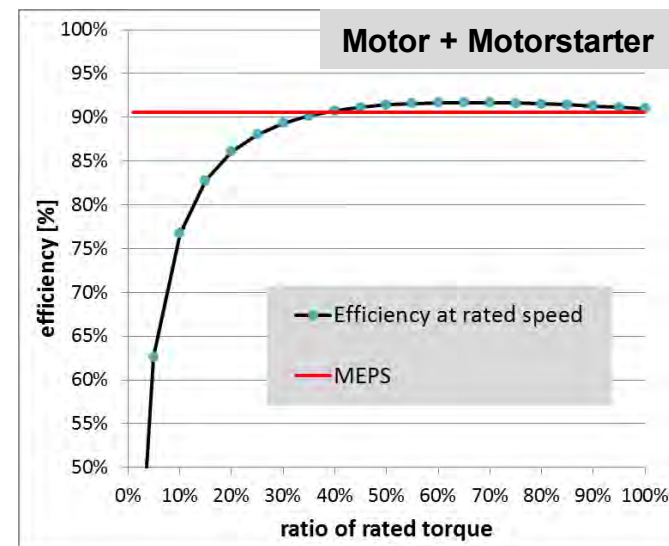
- Comparison for different load levels (= part load in application)



Source: EN 50598-2

% of rated Speed; Torque	% of rated Power	Motor + VSD	Motor + Motor starter
100; 100	100%	83,3%	90,5%
100; 50	50%	82,0%	91,3%
50; 100	50%	77,7%	n.a.
100; 25	25%	77,2%	87,9%
25; 100	25%	65,6%	n.a.
50; 50	25%	76,4%	n.a.
100; 10	10%	65,6%	76,7%
10; 100	10%	44,7%	n.a.

Example: 15 kW, IE2 Motor; IE1 VSD (PDS)



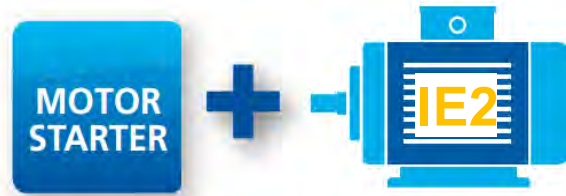
Source: IEC 60034-30-1 /-31

- **Efficiency of VSD + Motor is always worse than Motor Starter + Motor**
(about 10% in each load case in this example)
- **Gain in efficiency must be earned from application in case of speed control**
- **Use speed control in appropriate applications only**
- **In the case of fixed speed, load changes are automatically balanced by the self-adjusting characteristic of the induction motor**

Taking current EU regulation without care

Consumption of motors

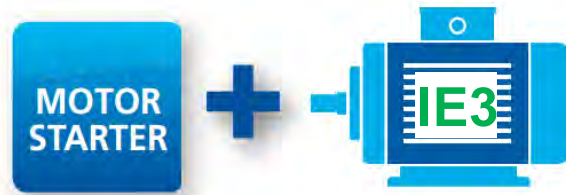
Fixed-speed applications
(assumption 80% share)



850 TW.h/year

680 TW.h/year

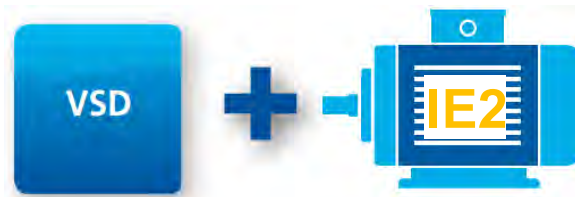
Component approach
IE2→IE3 and IE2+VSD
EE gain ~2.5%, fixed-speed



-17 TW.h/year
(-2.5%)



Improper fitting of VSD
IE2 + VSD,
wrong application



+34 TW.h/year
(+5%)

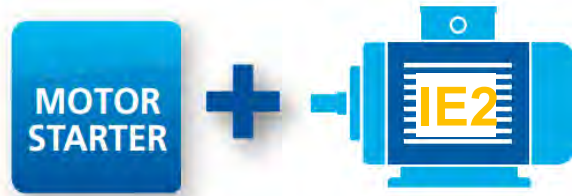


Lack of system-level analysis can ruin global efforts and transform savings into losses!

Real savings will come from *System* approaches

Consumption of motors

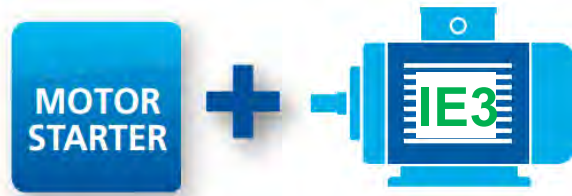
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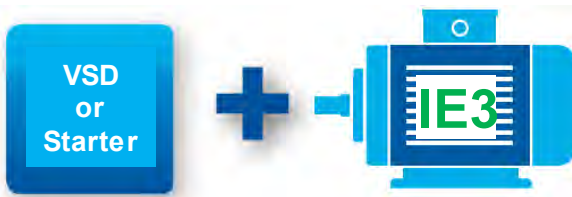
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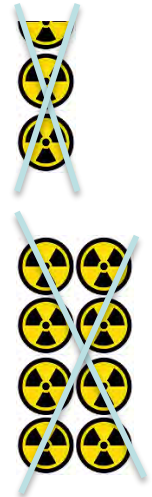


-17 TW.h/year
(-2.5%)

Extended Product App.
IE3 motors everywhere
Proper motor control fitting
additional 10% of application use VSDs*
efficiency gain +10% each*



-55 TW.h/year
(-6,4%)



Using the right motor control strategy for the right application is win-win & leads to greater savings.

Actions:

1. Ask people to take a complete system efficiency approach.
2. Distinguish between fixed speed and variable speed applications.
3. Go to: <http://www.capiel.eu/en/publications/leaflet/>

Thank you for your attention!

Questions?

www.capiel.eu

Kind of motor control – a question of the application

Fixed speed	Changing loads depending on application requirements	Variable speed
<ul style="list-style-type: none"> • pumps in water storage or booster pumps • stirring units in waste water treatment • constant speed conveyors • ventilation 	<ul style="list-style-type: none"> • HVAC of buildings • transportation of goods • water supply 	<ul style="list-style-type: none"> • hoisting • positioner in machine tools • closed-loop control: circular pumping or ventilation (without throttle)
<p>Typical control approach:</p>	<p>Typical control approach:</p>	<p>Typical control approach:</p>
<ul style="list-style-type: none"> • switching devices such as contactors or softstarters 	<ul style="list-style-type: none"> • switching devices and/or VSD with an appropriate control strategy 	<ul style="list-style-type: none"> • variable speed drive • complex control electronics

Using the right motor control strategy for the right application is win-win & leads to greater savings.