Energy savings in drive applications

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[Machines] NOW!

Schneider Electric

Questions

- How can we save energy in motor and drive applications?
- For which applications?
- How much energy (estimation in%) can be saved?

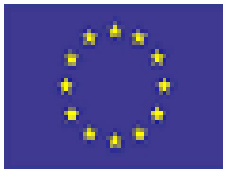
Energy efficiency

- Drive systems are involved in approximately 65% of industrial electricity consumption
  - > therefore here is the biggest potential for energy savings

- There are three approaches to saving energy
  - Energy saving motors
  - Energy saving drive systems
  - Optimization of the process

> The immediately accessible savings potential is about 1 / 5 on the motor side and about 4 / 5 by the use of electronic speed control due to flow applications

Efficiency standards and grade efficiency of 3 phase induction motors



- IEC 60034-2-1
  - Defines the procedure for determining the efficiency
- IEC 60034-30
  - Defines the new efficiency classes and unifies the previously different country regulations
- ErP-directive 2009/125/EG (**E**nergie **r**elated **P**roducts)
  - Determines which efficiency classes following IEC 60034-30 should be used in Europe (including Switzerland)

Grade efficiency following 60034-30

- Which motors are affected by this standard ?
  - 3-phase inductance motors with 50 and 60 Hz line frequency
  - 2-, 4- und 6-pole motors
  - Power range 0.75…375 kW
  - Line supply up to 1000V
  - Operation mode S1 (constant Load)

Grade efficiency test following IEC 60034-2-1

IEC 60034-2 (old)

- **Measurement at 100% Load**
- **Measurement at 75% Load**
- **Measurement at 50% Load**
- **Measurement at 25% Load**

Additional stray field approximate +0.5%

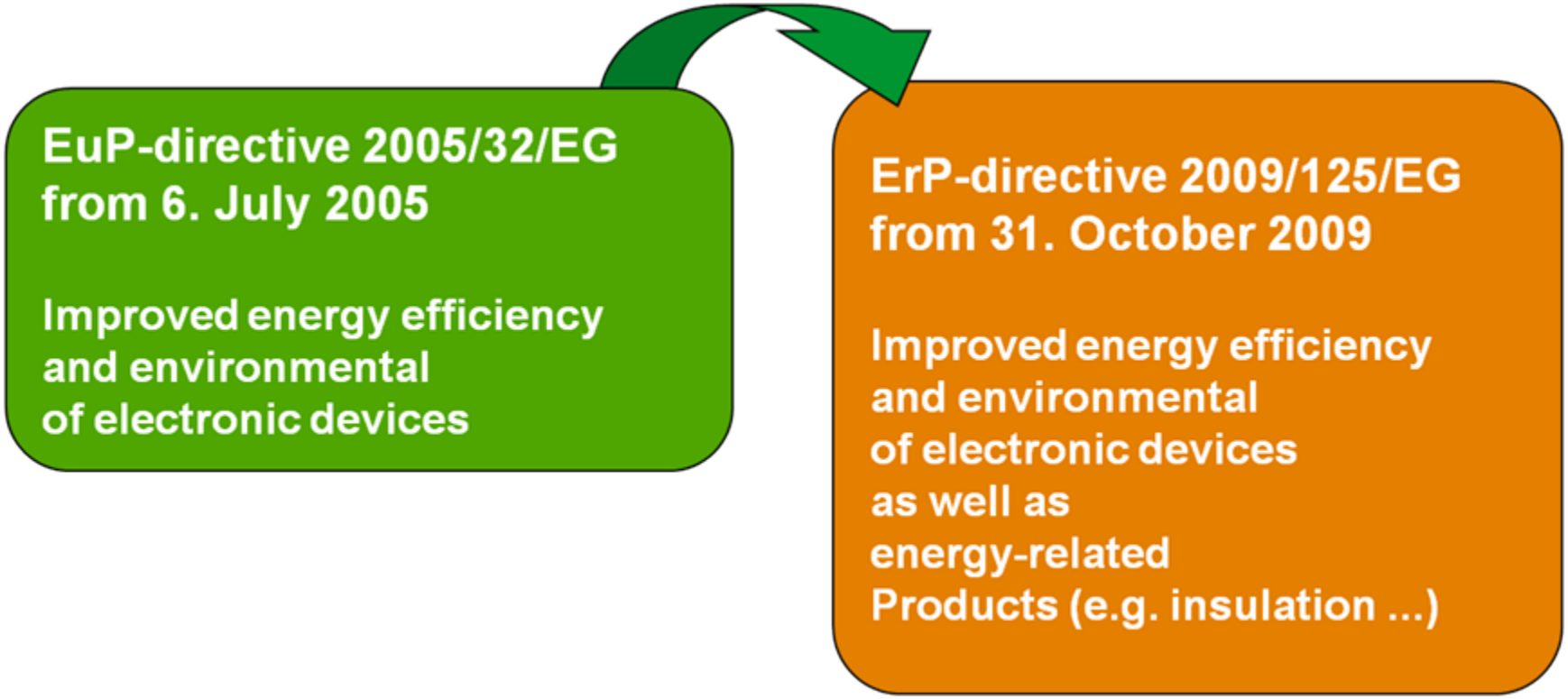
IEC 60034-2-1 (new)

- **Measurement at 100% Load**
- **Measurement at 75% Load**
- **Measurement at 50% Load**
- **Measurement at 25% Load**

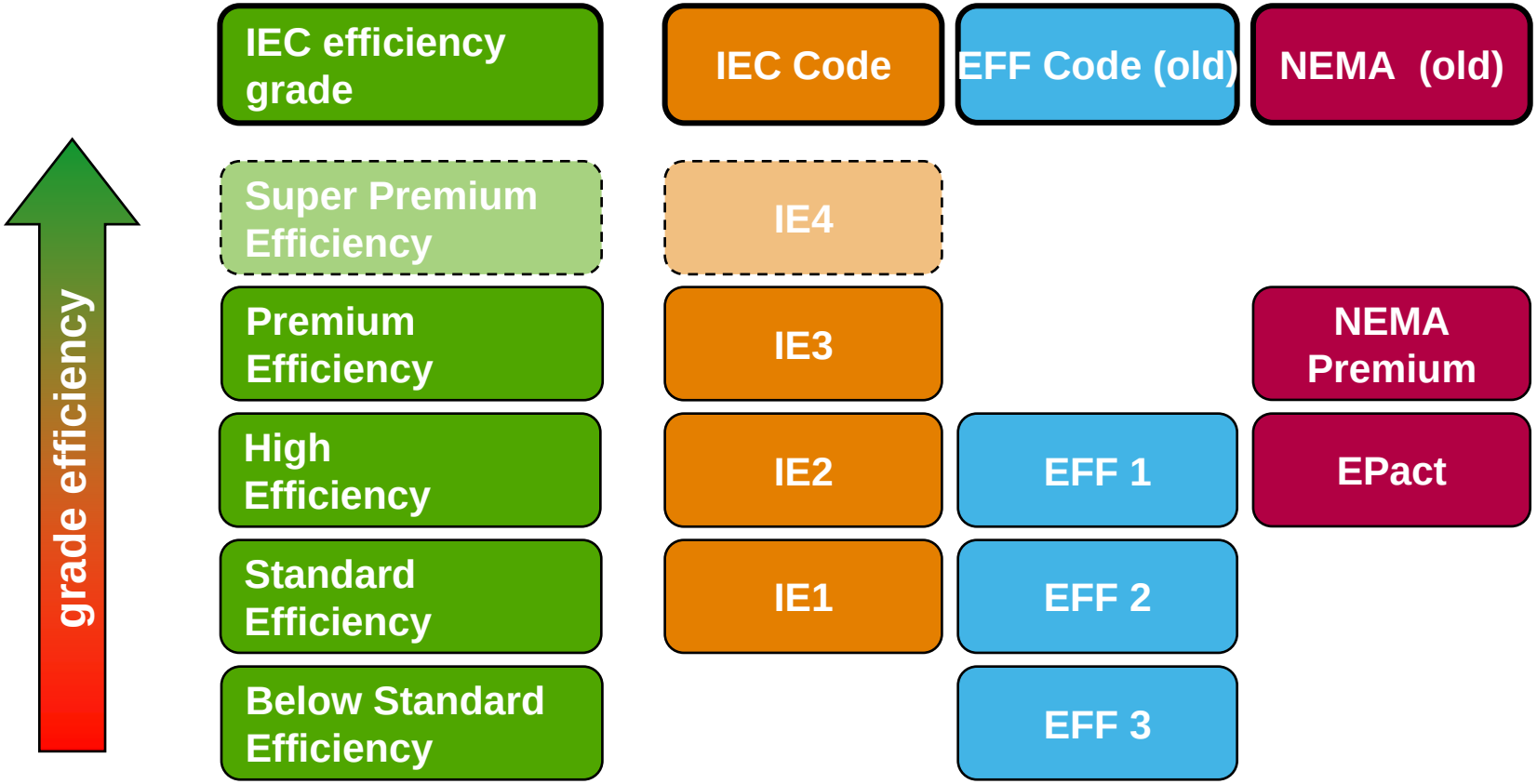
•Measurement of the additional stray field losses

Remark: Future catalog information must be reduced between 0.5% (high performance) and 1.8% (low power)

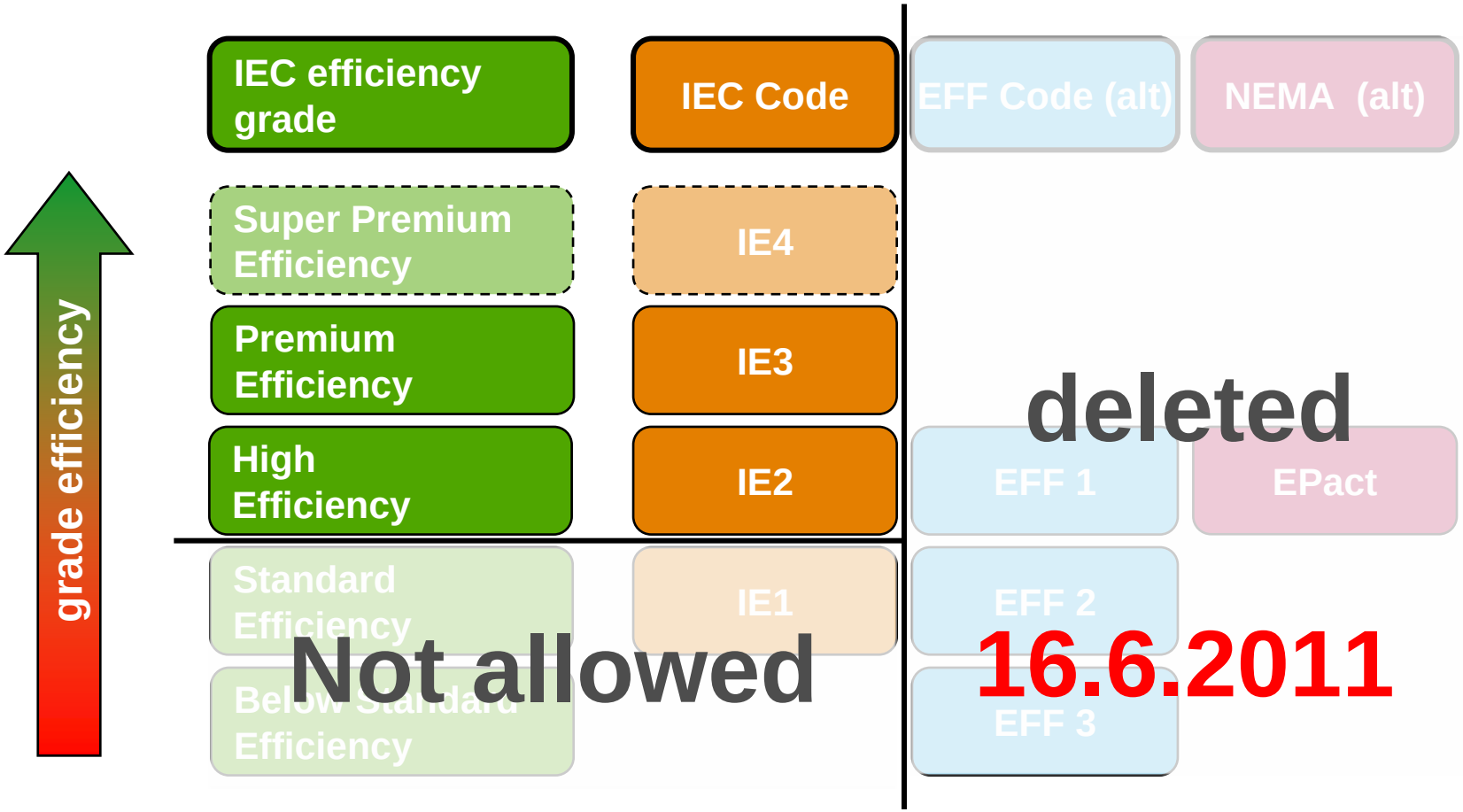
ErP-directive 2009/125/EG



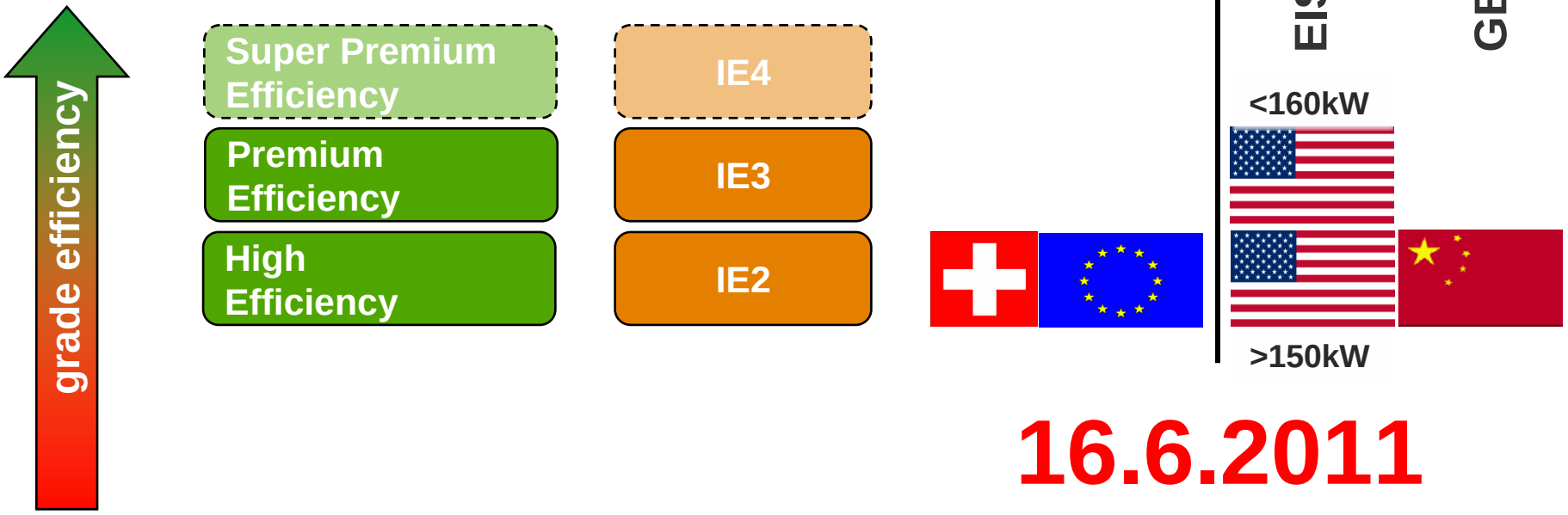
Grade efficiency following IEC 60034-30



ErP-directive 2009/125/EG

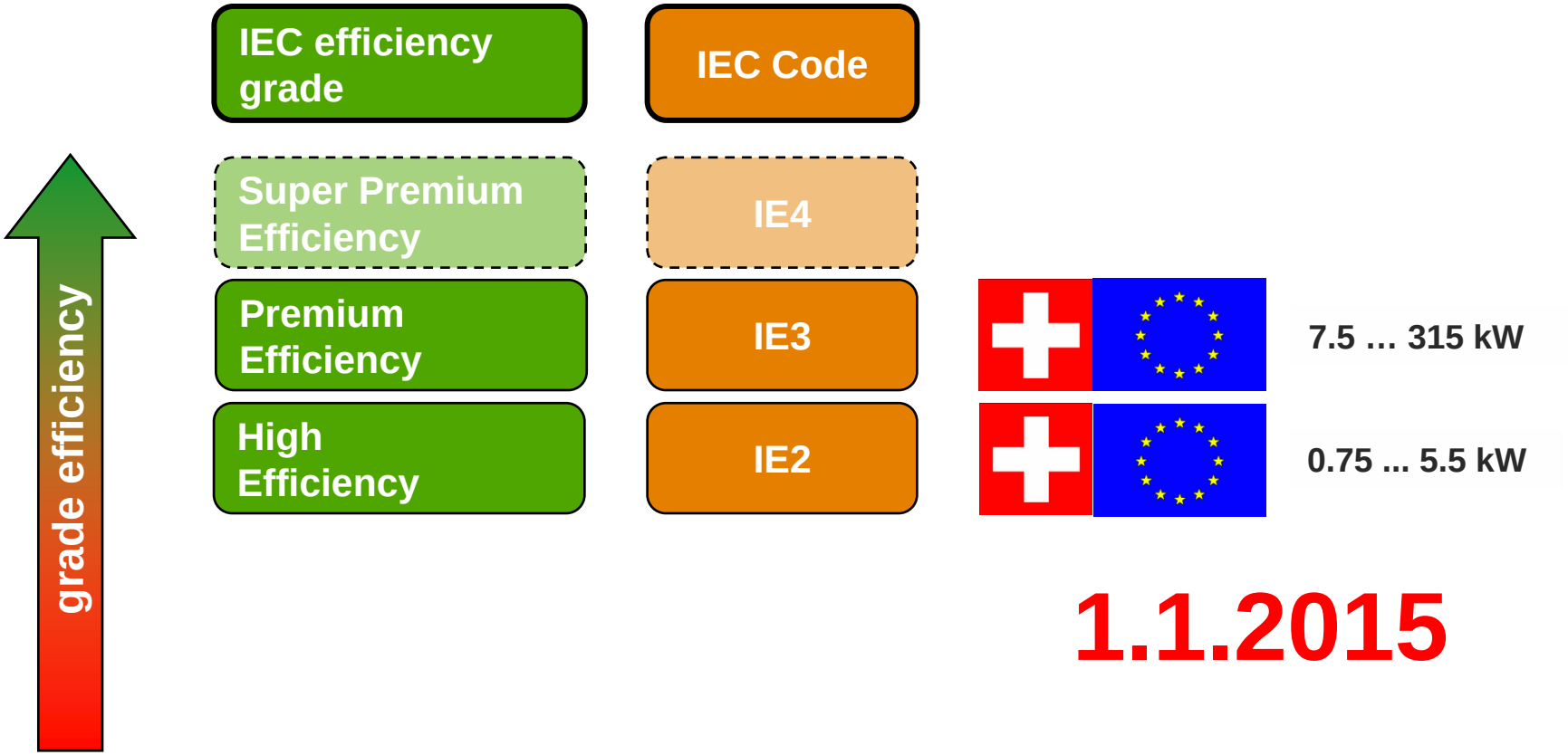


ErP-directive 2009/125/EG



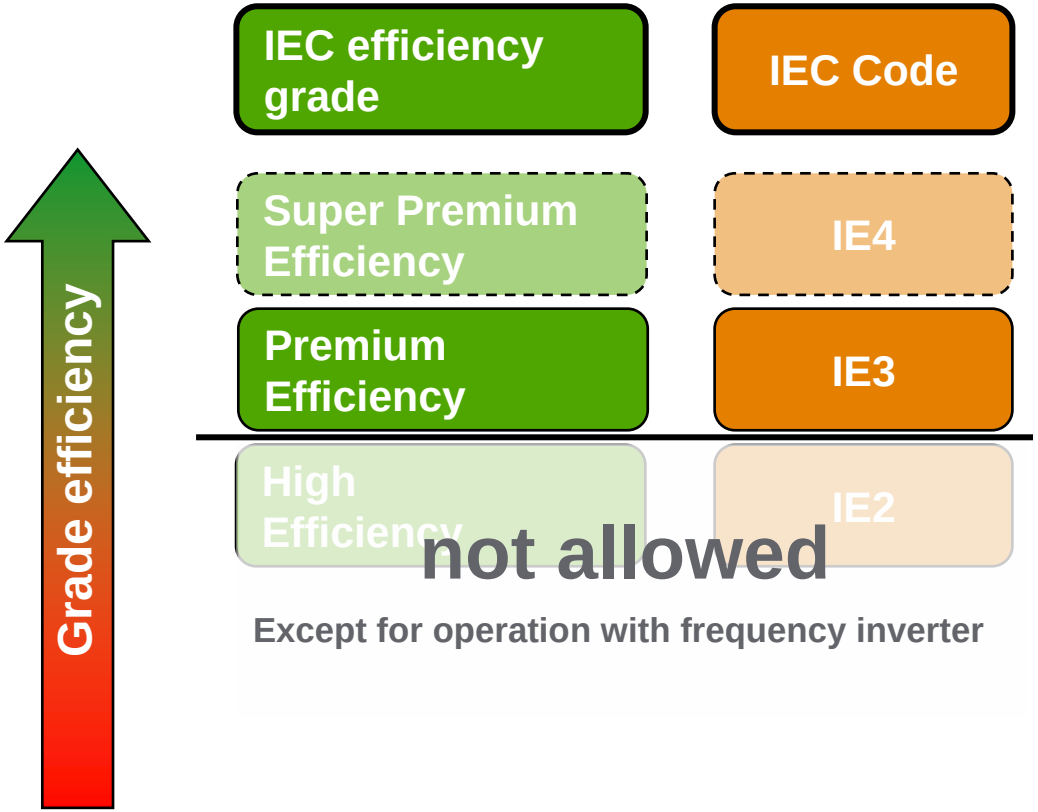
16.6.2011

ErP-directive 2009/125/EG



1.1.2015

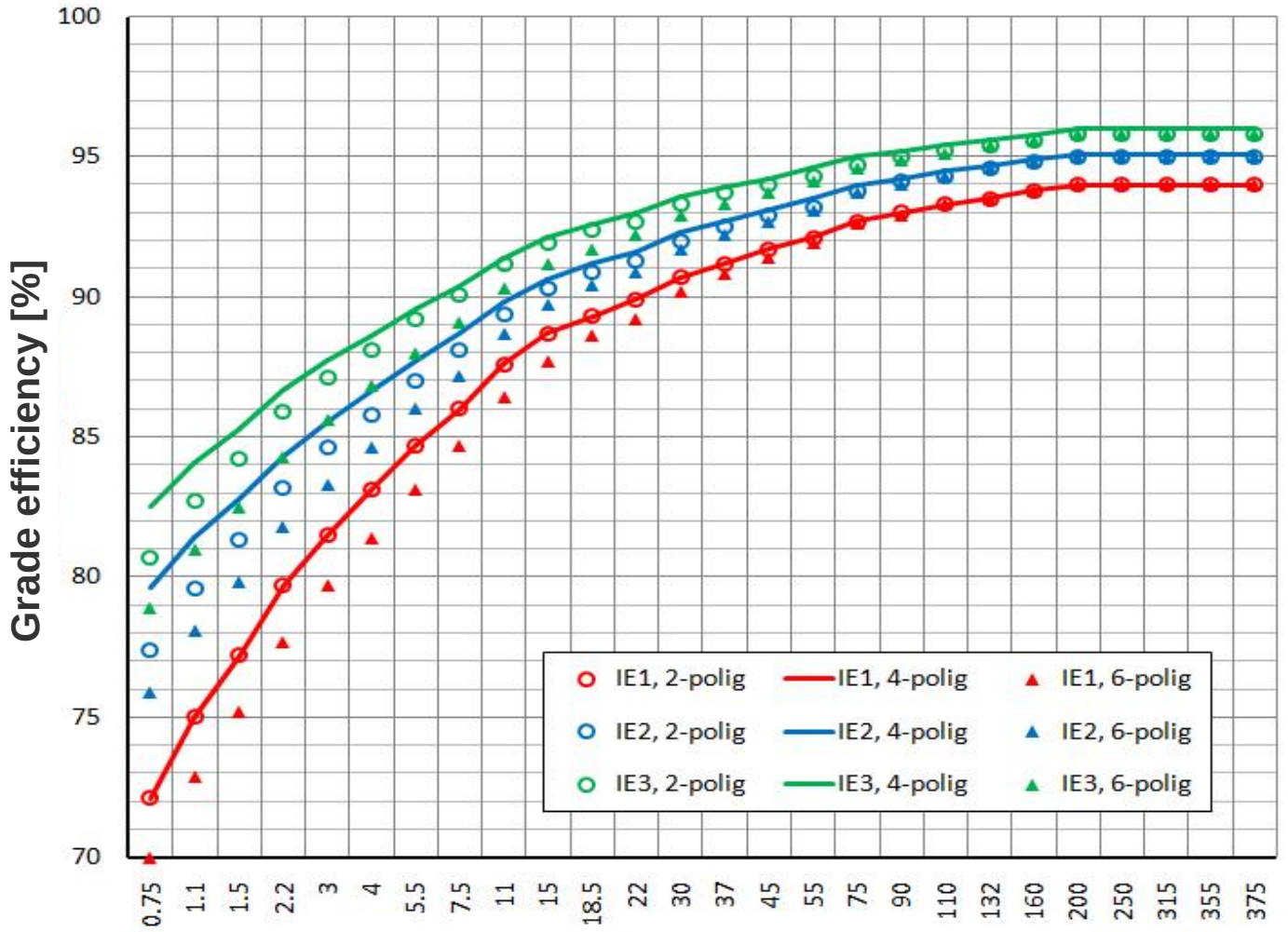
ErP-directive 2009/125/EG



0.75 … 315 kW

1.1.2017

Grade efficiency IEC 60034-30



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ErP-directive 2009/125/EG

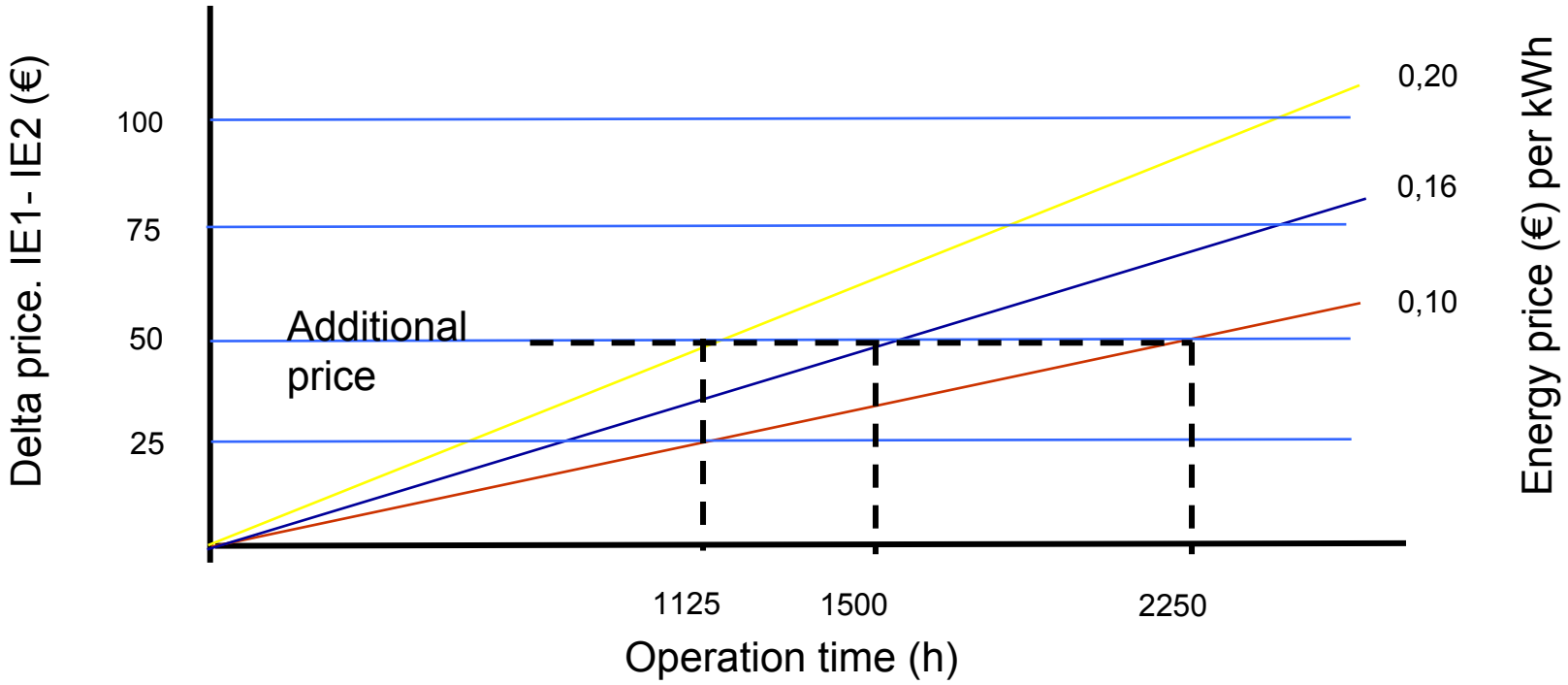
- From 16.6.2011
  - Motors which do not meet the efficiency standard IE2 may no longer be marketed
- From 1.1.2015
  - Motors with 7.5 kW or more must match the efficiency class IE3
- From 1.1.2017
  - Motors from 0.75 kW to 375 kW must match the efficiency class IE3
- Motors of efficiency class IE2 may also come into the trade after 2015
  - Variable motor control with frequency inverter (load dependent control of motor speed), always ensure the optimum efficiency operation point

ErP-directive 2009/125/EG

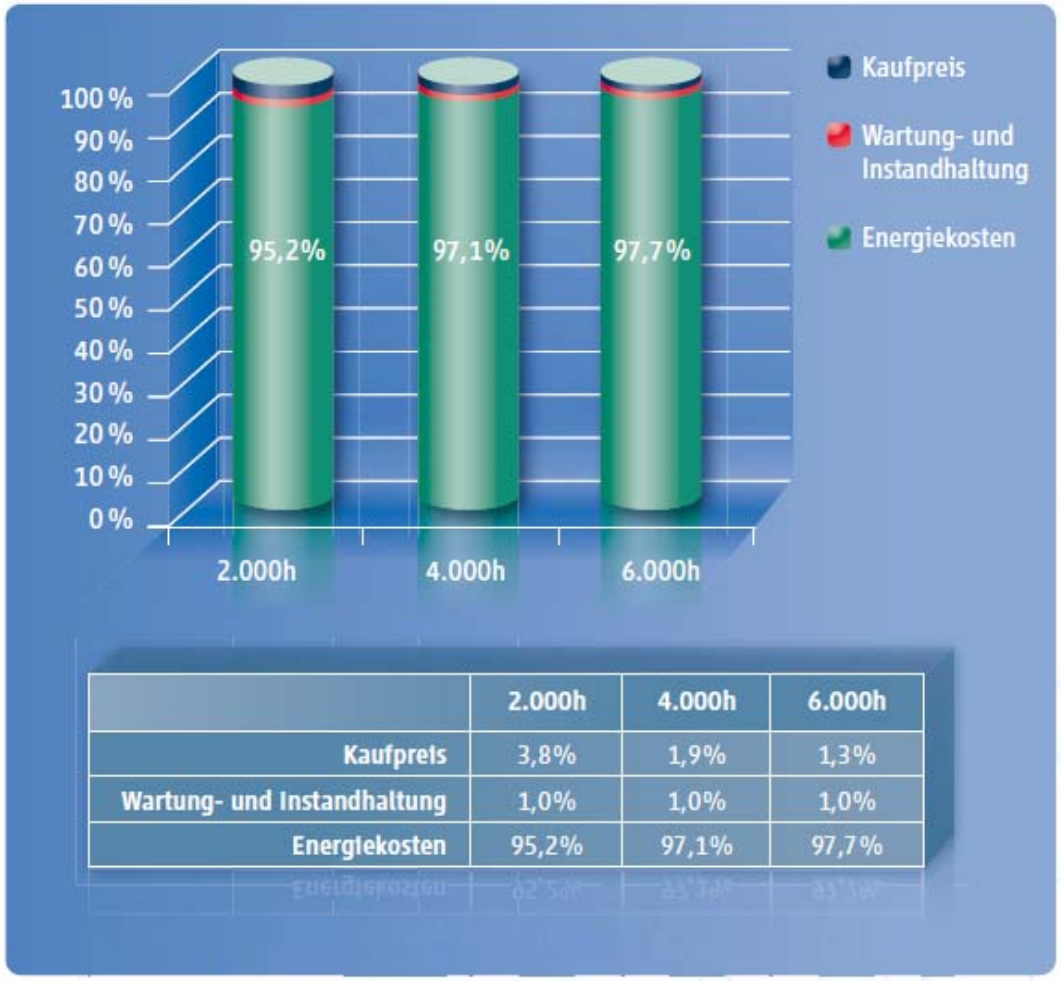
- Excluded from the ErP directive are the following motors:
  - SD-time not S1 or S6
  - Inverter stamped motors
  - IE2-motors with frequency inverter (marked with „VSD use only“)
    - from 2015: 7.5…375 kW
    - from 2017: 0.75…375 kW
  - All motors following RL 94/9/EG (ATEX-directive)
  - Brake motors (also S1 and S6)
  - Specially designed motors for ambient temperatures below-r 15 ° C or about 40Â ° C
  - Installation altitude above 1000m (specified on the nameplate)
  - Smoke extraction motors

Argumentation: Consideration of operating costs (life cycle costs)

- Amortization example of an energy saving motor 5.5KW (4 pole) at different hours of operation and electricity prices



Life cycle costs für 11kW Motor ASM

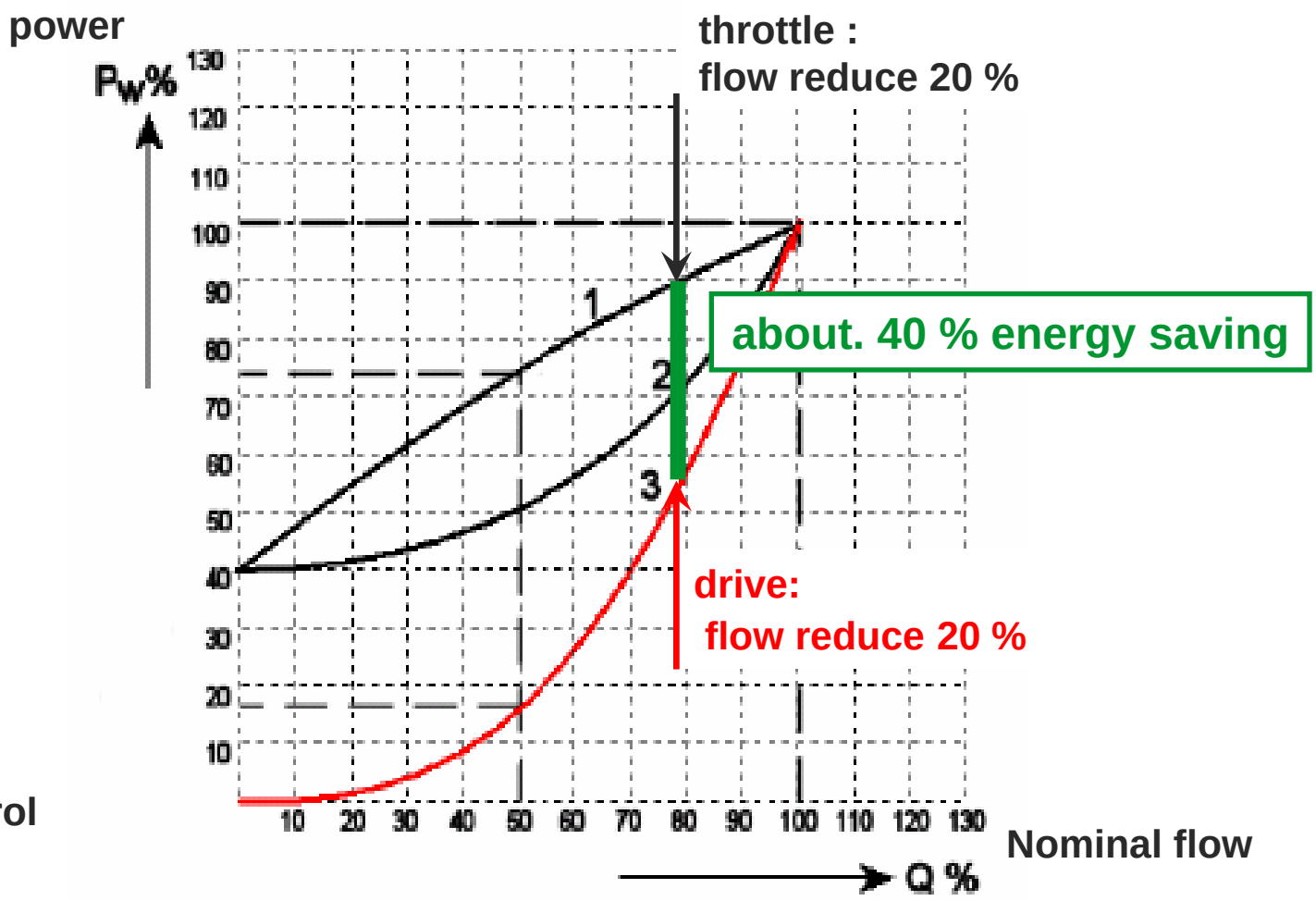


	2.000h	4.000h	6.000h
Kaufpreis	3,8%	1,9%	1,3%
Wartung- und Instandhaltung	1,0%	1,0%	1,0%
Energiekosten	95,2%	97,1%	97,7%

Bild 5: LCC-Betrachtung, 11kW Motoren Lebensdauer 15 Jahre, IE2
(Quelle: Preparatory Studies, EUP- Lot 11 Motors)

ASM:
life time: 15 J.
P = 11kW
IE2

Pump - flow as a function of power in HVAC and machine applications



curves:

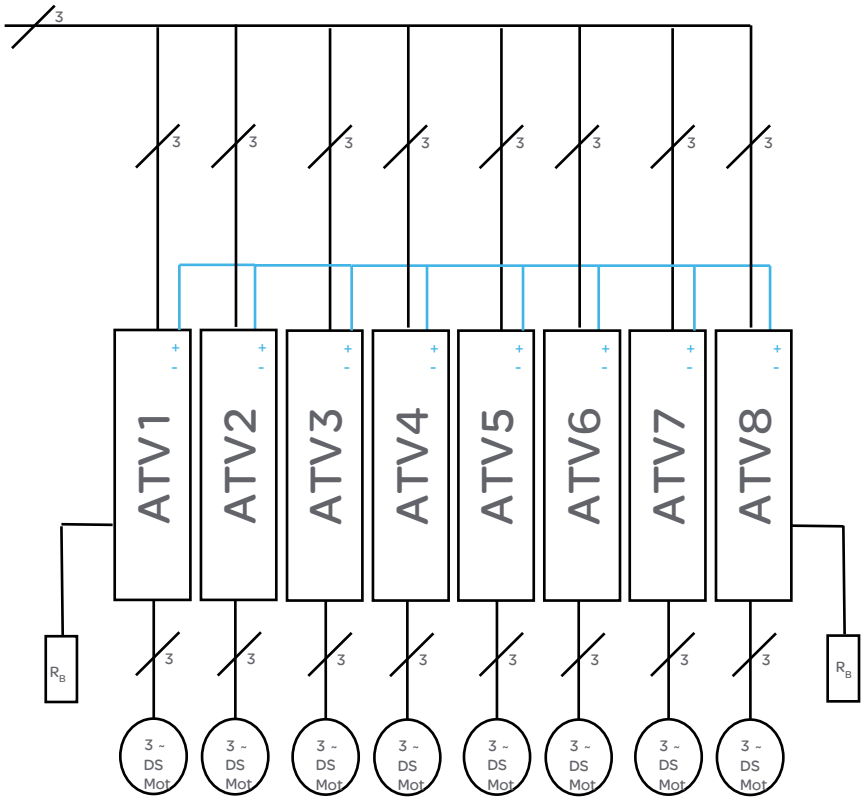
1 throttle
2 vane control
3 drive

Application – DC Link

- Knoll Umkirch / Ski polisher
  - http://www.knoll-feinmechanik.de
  - Up to 11x ATV32 in one machine via EtherCat
  - Safety and field bus communication at the same time
  - compact design
  - DC link

cabinet

Application – DC link



Old 2 brake resistors each 3KW

New 1 brake resistor 2KW

➔during the brake phase, about 20s/min reduce of the line power consumption in average 3-4KW

Application – DC link

- Typical applications for the use of regenerative energy
  - Downhill conveyor
  - Rotating masses with large inertia loads in cyclic operation
  - saw mills…
  - Hoisting applications
  - Braking translational movements
    - roller conveyors, conveyor belts …

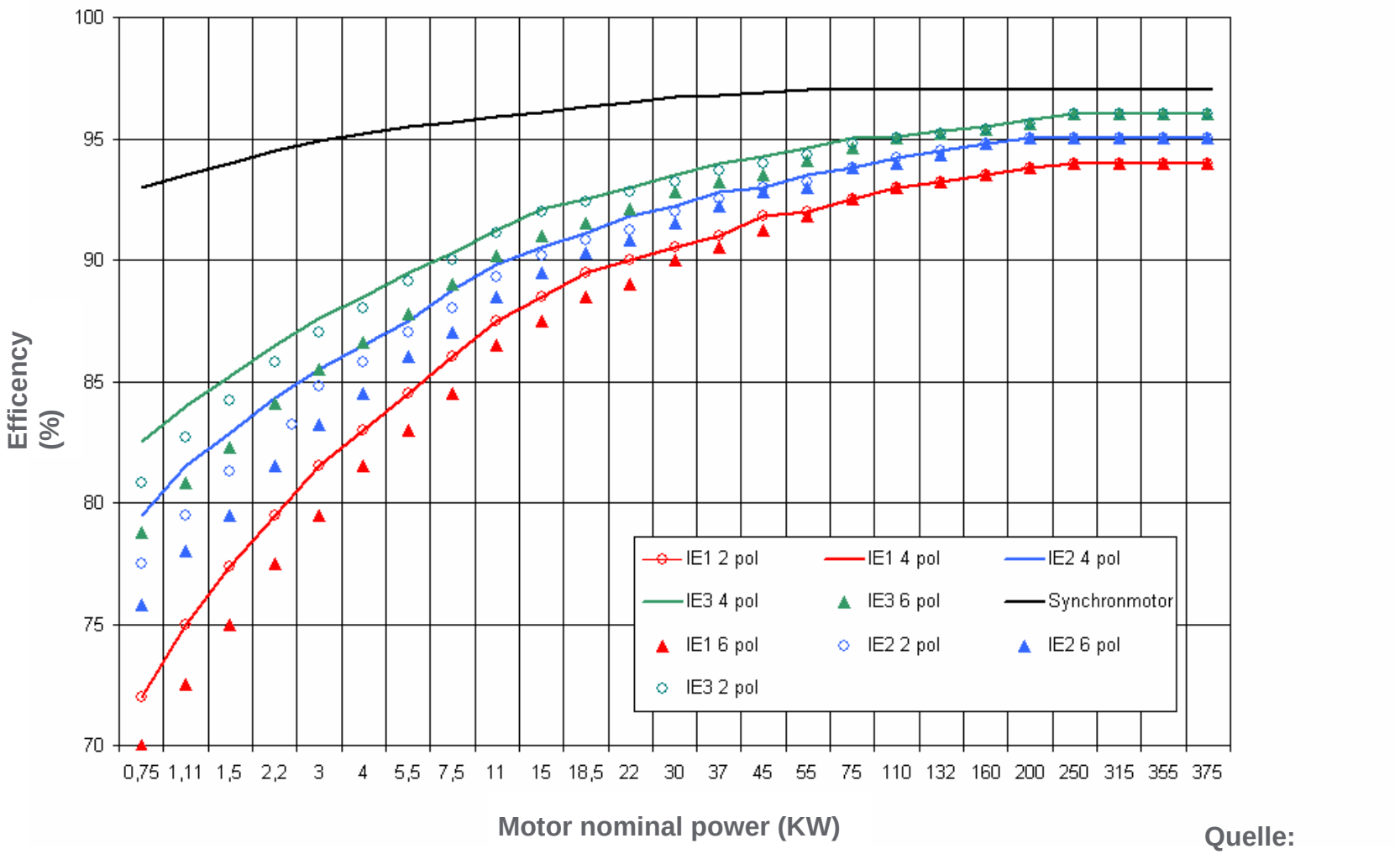
Application
Polishing machine with synchronous motor

- Axel Wirth Maschinen
  - http://www.axel-wirth-maschinen.de
  - Up to 4x ATV32 in one machine
  - Start the engine after mechanical rotation
  - High speed range
  - High speed stability
  - Safety
  - Replacement of inductance motors

Application
Polishing machine with synchronous motor

- Permanent magnet synchronous motor
  - Higher efficiency
    - Motor from about. 77% up to 93%
    - Fewer losses in the drive
  - No feedback system necessary
  - smaller
  - lighter
  - No fan
    - Less noise
  - High speeds
    - Good polishing results with certain materials
  - No gearbox
    - Higher efficiency

Grade efficiency IEC 60034-30 vs. synchronous motor



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Application – synchronous motor

- Typical applications with synchronous motors
  - Conveyor belts
  - applications under partial load
  - Bottler
  - Application with high speed stability
  - Sizes relevant applications
  - Weight-related applications
  - Application with 24h/365d/y
    - Pumps, fans, air conditioners…
  - Wide range of speed control without feedback
  - applications operating at low speeds
  - …

Application – synchronous motor

- Strong points
  - Higher efficiency
    - In average with 5,5KW about 10% compare to IE2 inductance motor
    - Energy and cost savings
    - No reactive power
  - Dimensions
  - Weight
  - Speed range
  - Less noise
  - Less maintenance

Energy efficiency ATV32 + synchronous motor

- Synchronous motor
  - Permanent magnet Motor
  - Gearless
  - Grade efficiency >>0,90
  - No load: 15 Watt
  - Nominal load: 100 Watt

- Load
  - torque: 3,1 Nm
  - speed 180 U/min
  - Nominal load: 64 Watt

- Inductance motor
  - Gearbox: i = 17
  - Grade efficiency 0,40
  - No load: 110 Watt
  - Nominal load: 180 Watt

Energy efficiency ATV32 + synchronous motor

- Synchronous motor

+
- High efficiency
- gearless
- No oil
- compact
- quietly
- less maintenance
- Less noise
- Smaller size

−
- Often no norm motor
- Expensive
- Only possible with drive

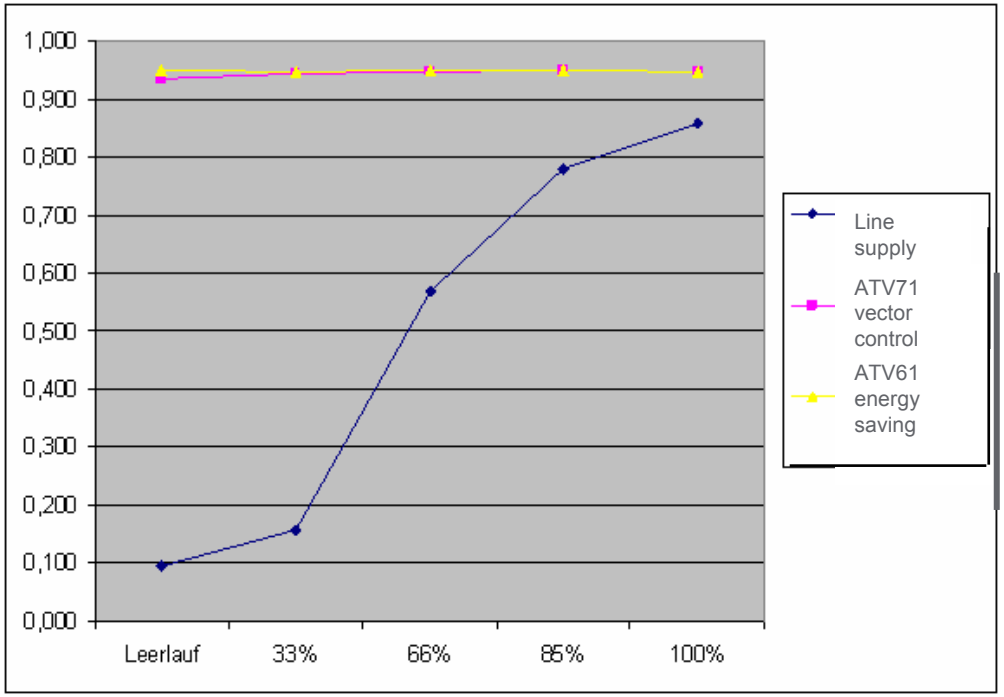
- Inductance motor with gearbox

−
- Low efficiency
- Gearbox
- Oil
- Hugh
- Loud
- Fan

+
- Cheap
- Standard – motor
- Direct line supply possible

Compared motor line supply vs inverter cos φ

Measuring cosφ



- Result
  - cosφ changed massively as a function of load
  - cosφ is thus a function of load!
  - Data on the nameplate is only for the nominal operating point

Summary of energy savings in drive applications

- Motors
  - Use of energy efficient motors IE2 IE4
  - Use of synchronous motors

- Application
  - Optimization of pressure or flow applications through using a frequency inverter
  - Optimization of the process
    - Reduction of weigh and size through synchronous motors
    - DC bus coupling for optimum utilization of regenerative energy
    - Change of gear types spur gears instead of worm gear
  - Power factor optimisation through frequency inverter
  - Elimination/ reduction of compensation systems

NOW !

You know !