Digitizing Industrial Motor Systems for Energy Efficiency

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CUB
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SAARC ENERGY CENTRE
Energy for Peace & Prosperity

Efficient Electric Motor Systems

Overview of motor system energy efficiency improvement

SAARC Energy Center
(online)

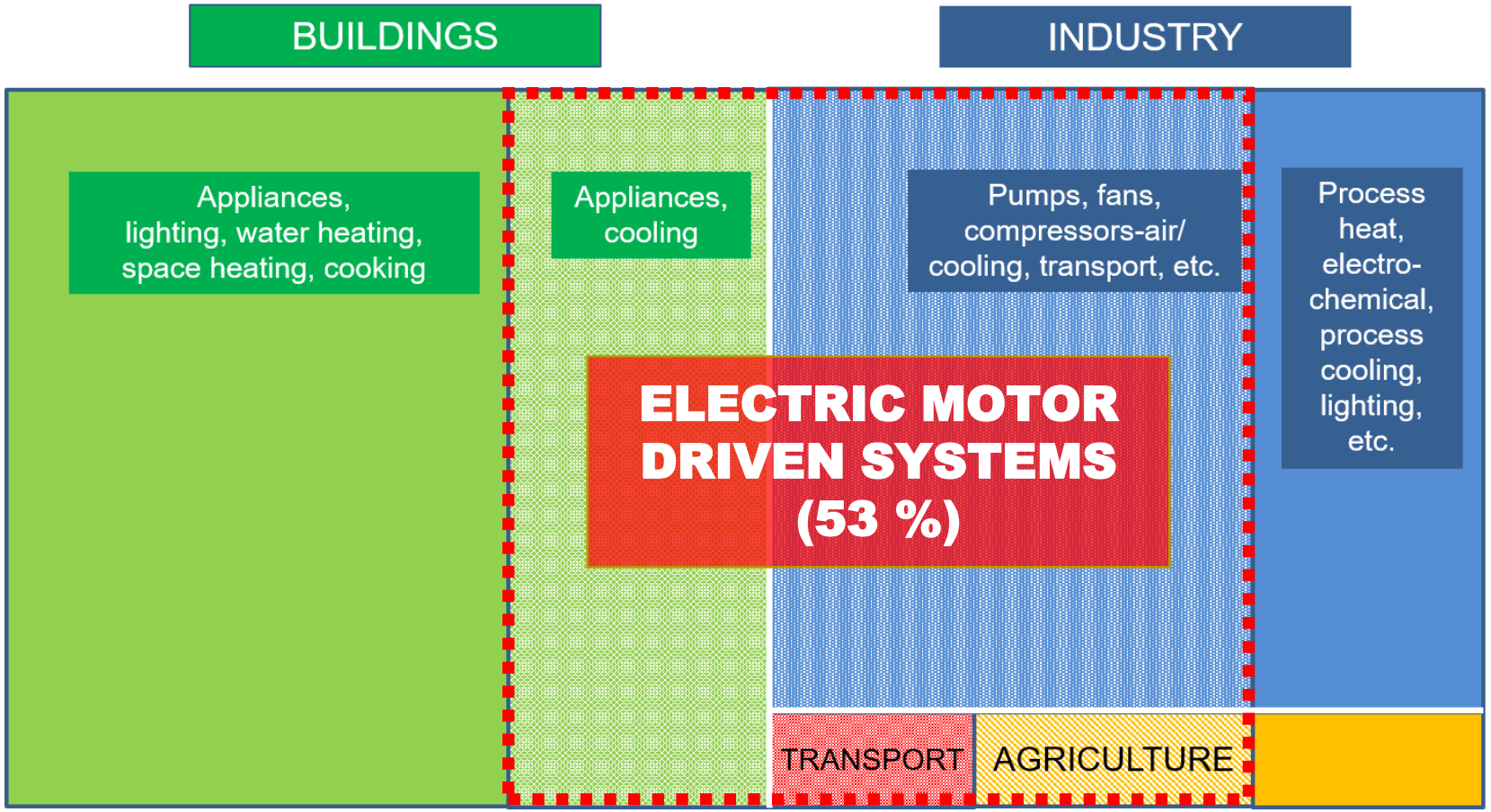
Conrad U. Brunner
Energy Efficiency Advisor
Zurich Switzerland








Global electricity end-use



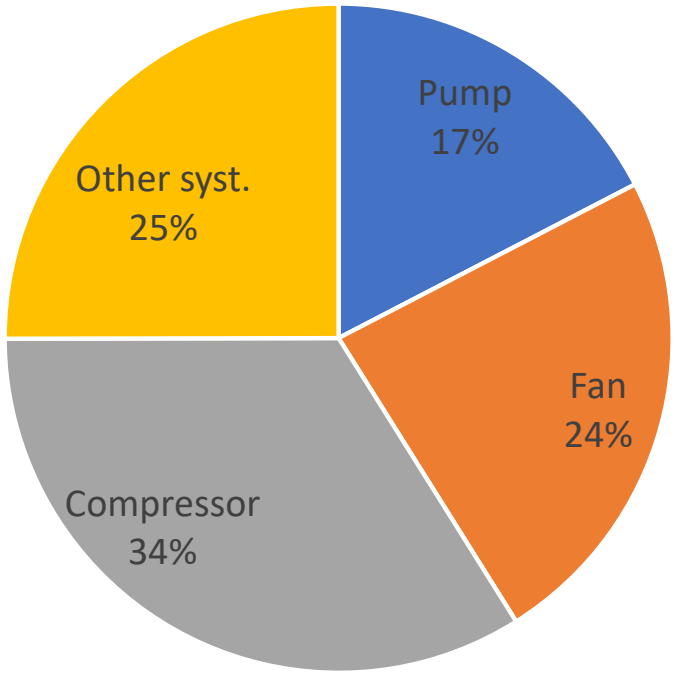
Global end-use electricity: IEA WEO 2016

Electric Motor Systems

Electric motors drive:

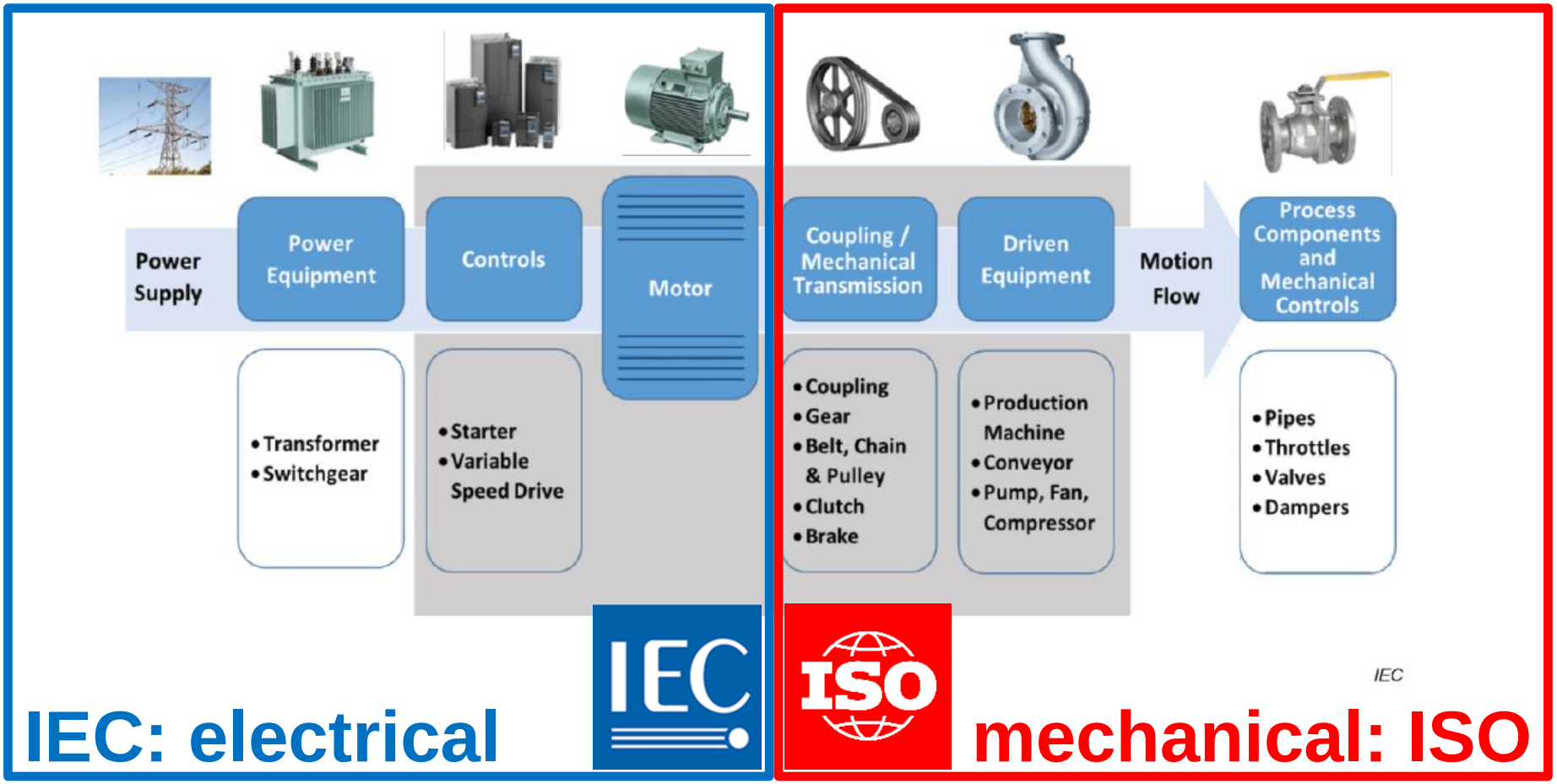
- pumps
- fans
- air- and cooling-compressors
- transport systems
- handling & process systems
- others

- 53% of global electricity use
- Industry: share 60-70%



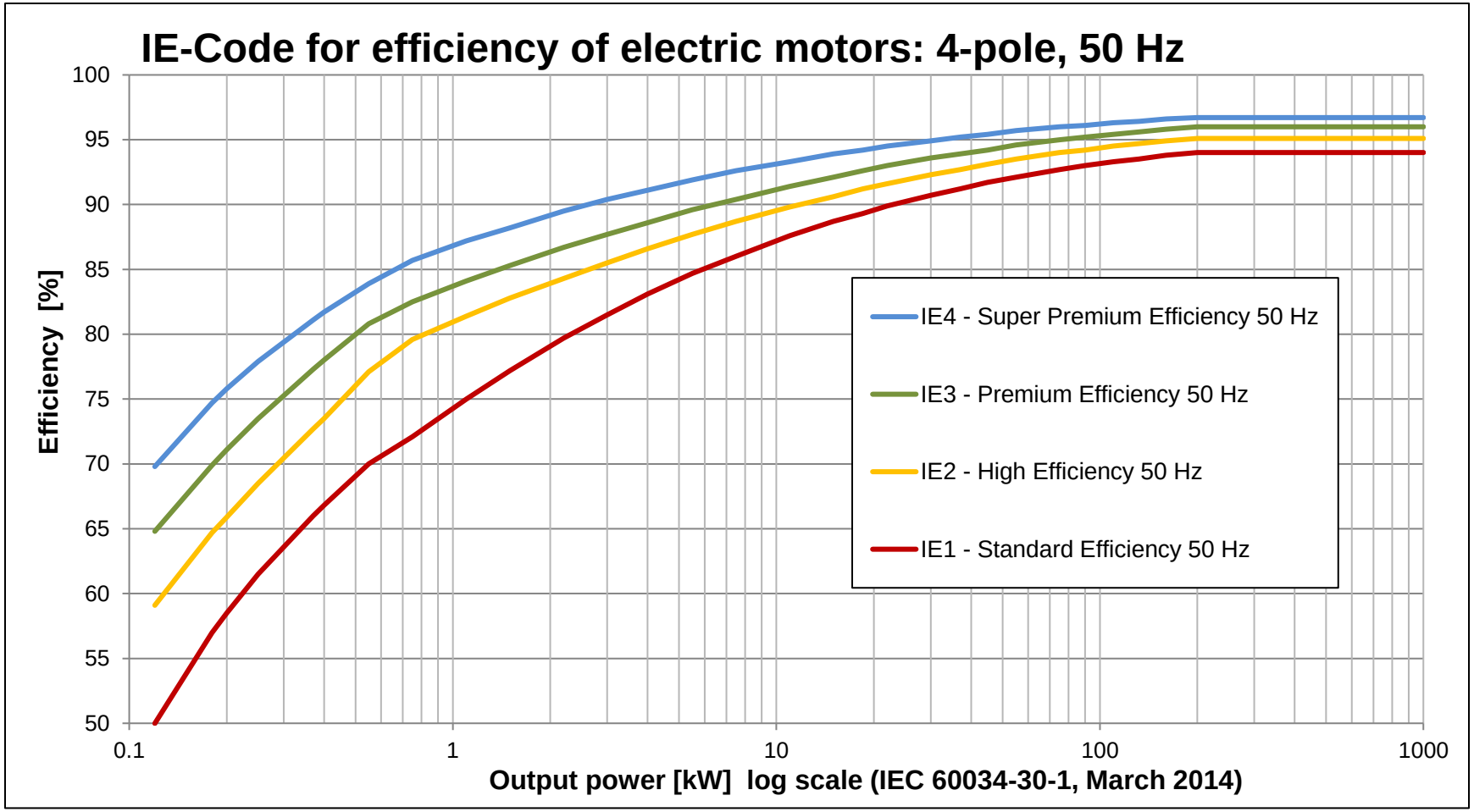
Source: IEA World Energy Outlook 2016
10’800 TWh/a (2016)

System standards - energy efficiency



Source: IEC 60034-31

Motor Efficiency



available at www.iec.ch

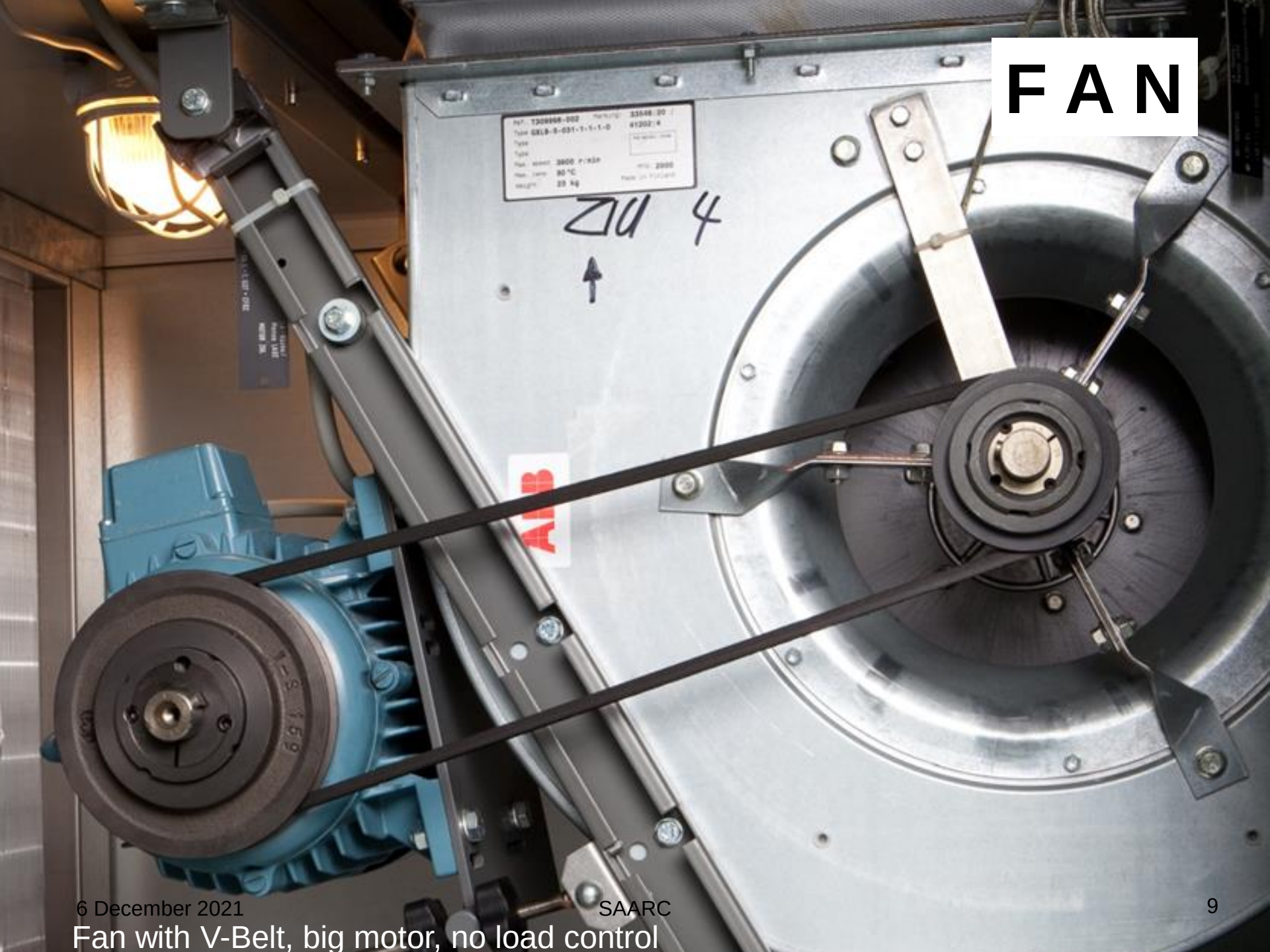
Minimum Requirements for Motors

Efficiency Levels 3-phase induction motors (Low Voltage < 1000 V)	Efficiency Classes IEC 60034-30-1, 2014 Global classes IE-Code [I]	Testing Standard IEC 60034-2-1, 2014 incl. stray load losses	Performance Standard Mandatory MEPS [III] National Policy Requirement	
Super Premium Efficiency	IE4	Preferred Method [II]	EU 27 d), UK	75 - 200 kW
Premium Efficiency	IE3		Canada	0.75 - 375 kW
			Mexico	0.75 - 375 kW
			USA	0.75 - 375 kW
			USA, Canada a)	0.18 - 2.2 kW
			South Korea	0.75 - 375 kW
			EU 27 d), UK	0.75 - 1.000 kW
			Switzerland **	0.75 - 375 kW
			Japan	0.75 - 375 kW
			China c)	0.12 - 1.000 kW
			Israel	7.5 - 375 kW
			Singapore	0.75 - 375 kW
			Taiwan	0.75 - 375 kW
			Brazil	0.12 - 370 kW
			Ukraine b)	0.75 - 375 kW
			Egypt f)	0.75 - 375 kW
		Summation of losses with load test:	Turkey	0.75 - 375 kW
			Saudi Arabia	0.75 - 375 kW
High Efficiency	IE2	Additional losses P_{LL} determined from residual loss	Australia	0.73 - 185 kW
			EU 27 d), UK	0.12 - 0.75 kW
			Chile	0.75 - 7.5 kW
			China c)	0.75 - 375 kW
			Peru	0.75 - 375 kW
			Colombia e)	7.5 - 375 kW
			New Zealand	0.73 - 185 kW
			Israel	0.75 - 5.5 kW
			EAEU g)	0.75 - 375 kW
			India	0.12 - 1000 kW
			Ecuador	0.746 to 373 kW
Standard Efficiency	IE1		Peru	*0.75 - 375 kW*
			Kenya	
			Argentina	0.75 - 30 kW

Source: 4E EMSA 2021

Efficiency for industrial motor systems:

1. Design for necessary demand: pressure and flow, capacity, temperature, etc.
2. Downsize all components to actual demand.
3. Use motor only when necessary.
4. Load control is imperative for changing load applications.
5. Go to direct-drive wherever possible.
6. Use digital monitoring and remote control.

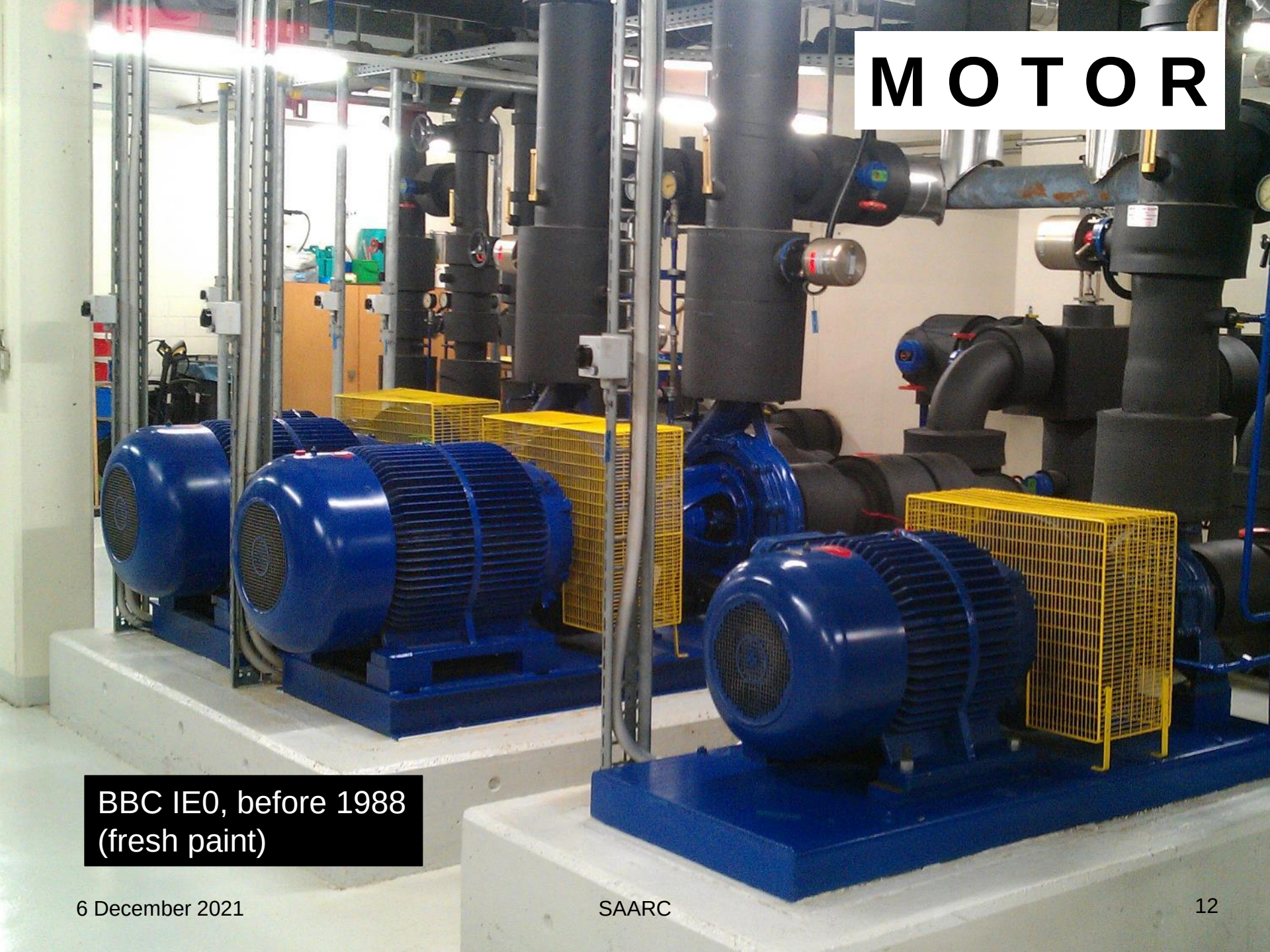


Fan with V-Belt, big motor, no load control

https://www.engineerlive.com/content/industrial-pump-survival-guide-beginners

AIR-COMPRESSOR

Zhengzhou Kaishan
JN Series Energy-Saving Two-Stage Screw Air Compressor

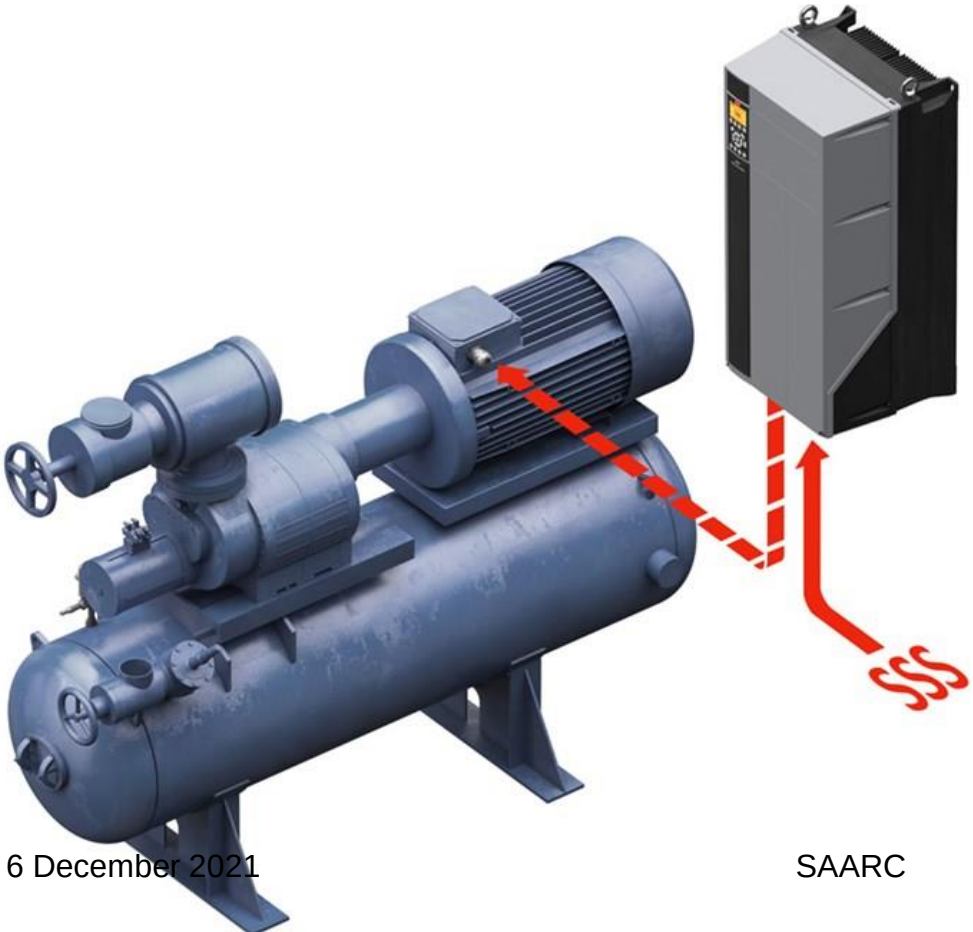


BBC IE0, before 1988
(fresh paint)

MOTOR

ABB IE5 SynRM

V A R I A B L E F R E Q U E N C Y C O N V E R T E R



Danfoss VFC with screw compressor

Digital motor systems

- Condition monitoring
- Remote control (www)
- Load control
- Digital Twin

system failure
performance check
energy savings
system optimisation

Digital sensors for motor monitoring

Sensors record temperature, vibrations, operating time, maybe also speed, torque

WEG	ABB	Siemens

THE #1 CASE
the outset

- any 0.1….1000 kW nominal output machine
- could be a pump, a fan, a compressor, anything that rotates

- the machine at the outset:
  oversized, with fixed speed, with gear and V-belt, current market components
- the system improved:
  downsized, with adjustable speed, direct drive, efficient components, remote control

The efficient motor systems means:

1. Supply mets demand: no more oversizing
2. Time of use: run only when needed (night, weekend)
3. No standby losses
4. Motor connects to pump/fan directly:

   no gear and belt necessary ► direct drive
5. Load control is necessary: variable frequency drive
6. Use high efficient components:
   - motors: IE4
   - VFD: IE2 or IE3 (variable frequency drive)
   - BAT for pumps and fans (best available technology)
7. Remote control is next

Repaired vs. New Motor

Repaired motor (after 50'000 h)

- motor dismantling, rewind, assembly: takes days or weeks
- efficiency decreased with rewind
- repair cost below 10 kW is higher
- same size,
- same type motor: fixed speed
- runs hot
- more greasing
- more maintenance
- risk of failure

► A repaired motor is never a new motor

New motor (after 10 years)

- plan ahead for delivery of new motor: installation takes days
- efficiency increased with IE3 / IE4
- cost of new motor above 10 kW is cheaper
- resizing/downsizing is possible,
- better motor type possible: poles, heat
- runs cooler
- less greasing necessary
- less maintenance, no failure
- use of variable frequency possible

► Recycling of old motor is easy

Thank you, questions?

Conrad U. Brunner

Member IEC ACEE, IEC & ISO JAG 22;
ISO TC 115 Pumps and ISO 117 Fans
cub@cub.ch
8032 Zurich Switzerland

4E EMSA: Electric Motor Systems Annex
www.motorsystems.org
www.topmotors.ch