ISO and IEC work together to improve Energy Efficient Electric Motor Driven Systems (IEC & ISO JAG 22)

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Conrad U. Brunner, member of ISO/IEC JAG22
Maarten van Werkhoven, member of ISO/IEC JAG22

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2. Origin of IEC & ISO JAG 22
3. What are the current issues discussed in JAG 22
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Energy use and energy savings

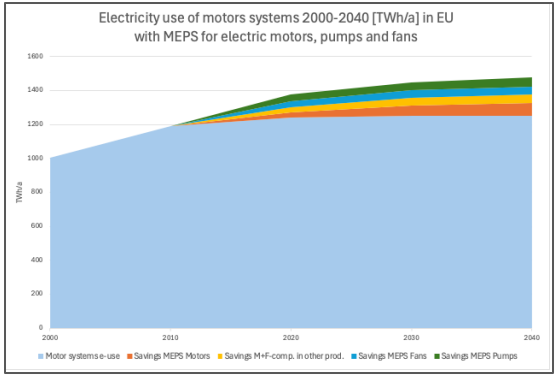
Challenge

- More than **50 per cent** of all electrical energy i.e. 12,400 TWh (2021) is used by electric motor systems globally
  - mostly in industry and buildings,
- Global electricity demand could **rise by 25% to 30% by 2030** (relative to 2021) due to
  - an increase in motor systems in industry and buildings
  - a shift to the use electric heat pumps, and
  - an increased use of electric vehicles
  - and hydrogen (production).

The main growth contribution i.e., 70% to 80%, will come from China, India and other emerging markets and developing economies.

Energy Efficiency works

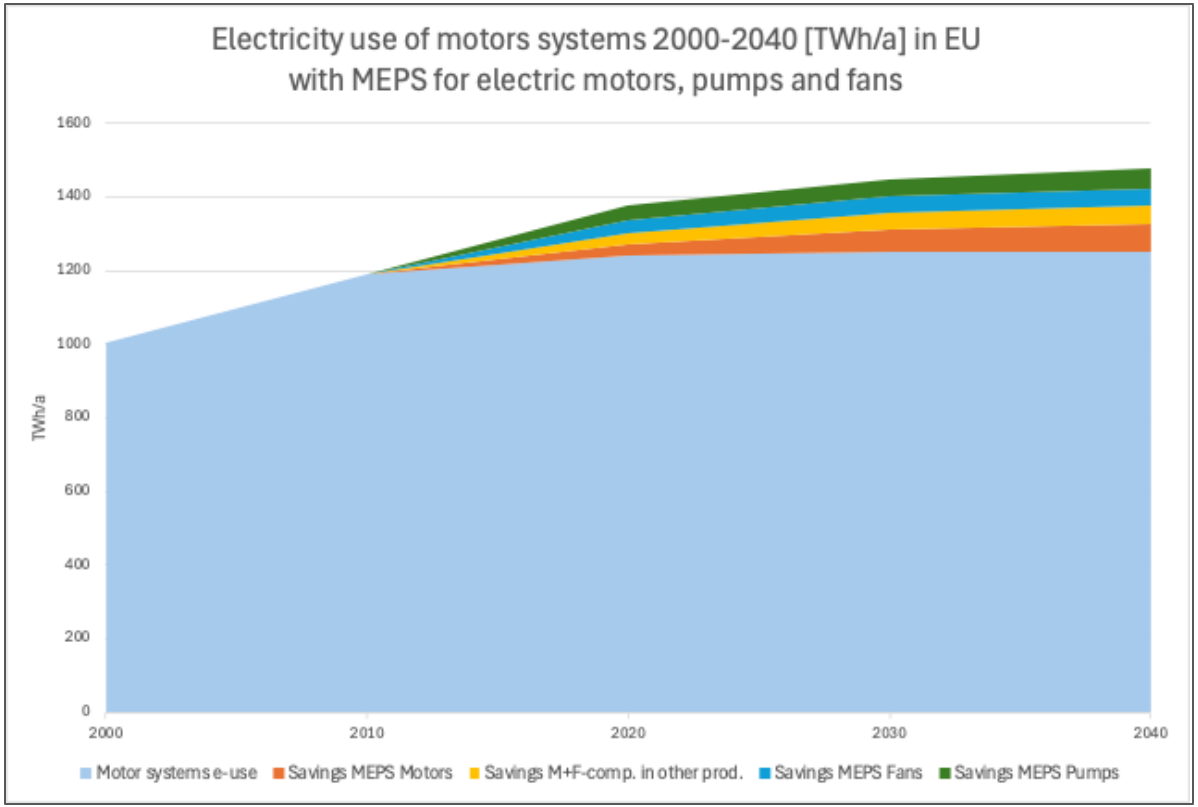
- Minimum Energy Performance Standards (MEPS) show effective savings for EMDS, e.g. EU Ecodesign Impact Accounting



- What's next, for 2030 and 2040; how to accelerate energy savings, to meet net zero goals?

1 IEA World Energy Outlook 2022, plus IEA World Energy Outlook 2016
2 EC Ecodesign Impact Accounting Overview Report 2023, VHK

Energy Efficiency works



19% savings 2040

(source: EC Ecodesign Impact Accounting, Overview Report 2023)

Energy use and efficiency – product level

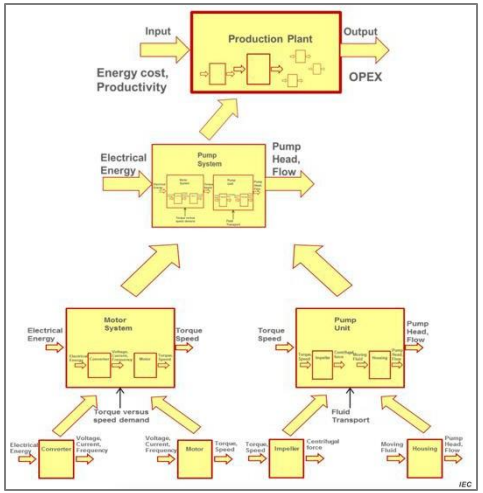
- IEC and ISO, global standard makers

Motor control		Motor	Mechanical equipment		Driven equipment			
IEC TC 121	IEC TC 22 SC 22G	IEC TC 2	ISO TC 41	ISO TC 60	ISO TC115	ISO TC 117	ISO TC 86	ISO TC 118
Switchgear & controlgear	Adjustable speed drive	Rotating machinery	Pulleys & belts	Gears	Pumps	Fans	Cooling-Com-pressors	Air-Com-pressors
1927	1934	1911	1947	1947	1964	1964	1957	1965

- Energy efficiency standards
  - definition of scope
  - testing standards
  - efficiency classification

- On product level

- Components -> make systems -> make factories



Energy use and efficiency – product level

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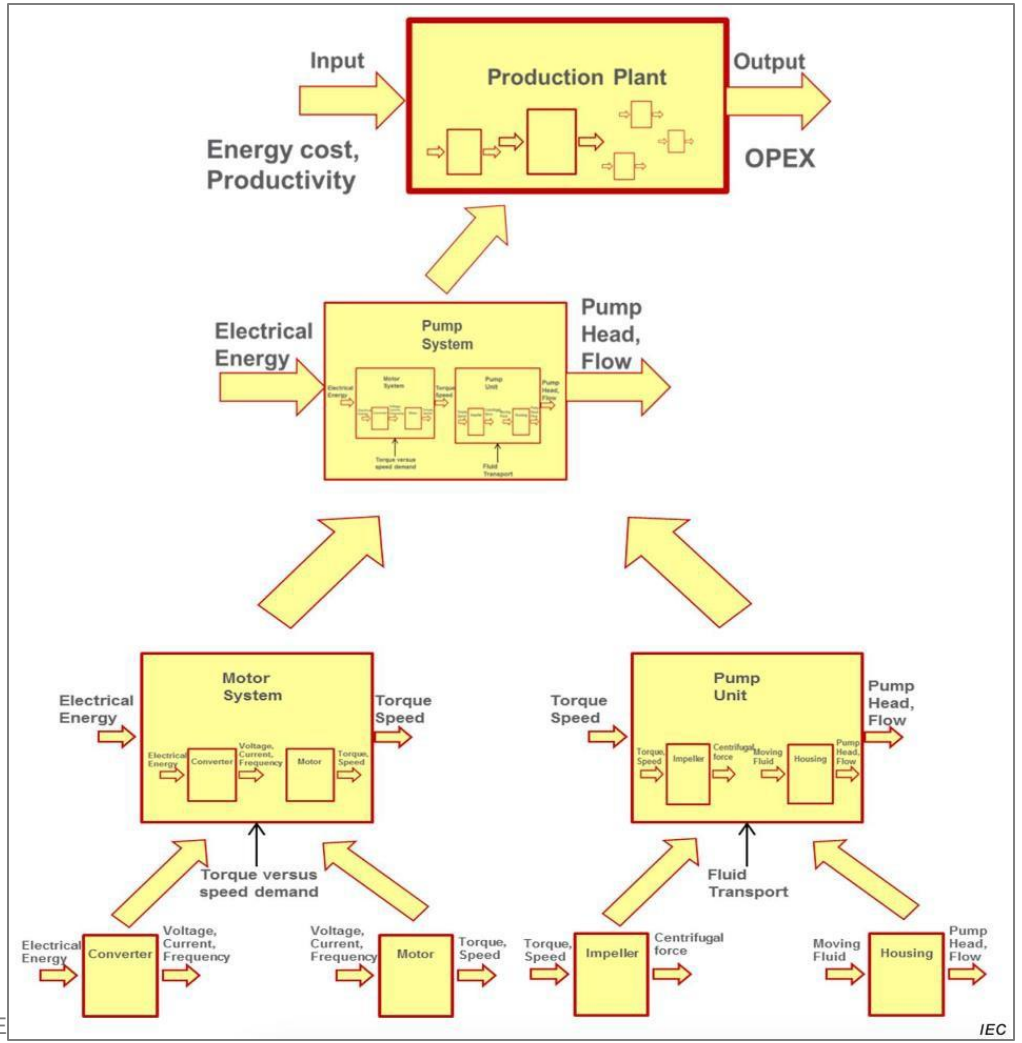


Source: IEC Guide 118, 2024 E

IEC Guide 118 > Energy efficiency aspect categories

The use cases for energy efficiency

Table 1 – Energy efficiency aspect categories and examples

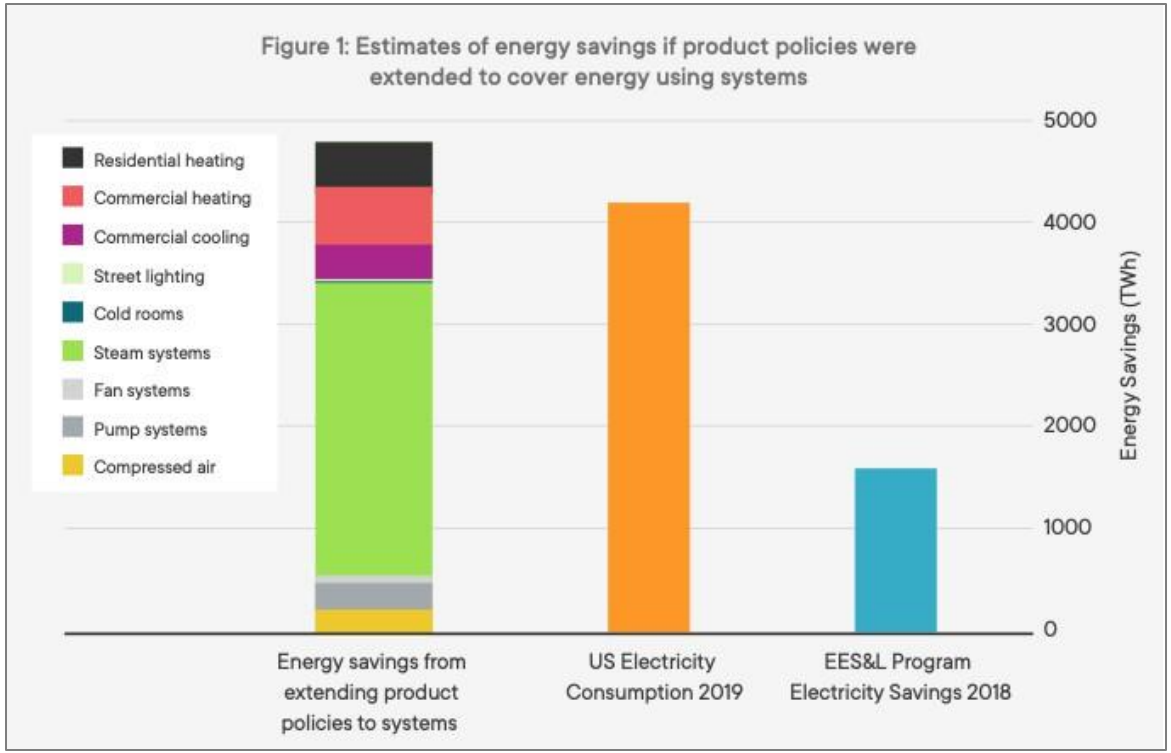
Energy efficiency aspect categories	Energy efficiency aspect
Define energy efficiency	terminology
	system boundaries (including the scope for energy efficiency)
	EE KPI's (energy efficiency key performance indicators)
	energy baseline
	driving parameters (adjustment factors, static factors)
	reference applications
	reference load profiles
	reference control strategies
Determine energy efficiency	test methods
	measurement methods
	measurement plans
	calculation methods
	classes
Assess energy efficiency	Energy audits
	Benchmarking methods
	Energy efficiency investment evaluation
Improve energy efficiency	Energy management system
	Design criteria guidelines
	Application guidelines
	Best practices
	Loss reduction
	(Standby losses)
Enable energy efficiency	Interoperability
	Communication
	Standardized data format
	Qualification of energy efficiency services
	Measurement infrastructure

Source: IEC Guide 118, 2024

From product to systems – regulatory needs

Energy efficiency **regulations for systems** need at least

- The scope which identifies those products or systems that are included and excluded
- The addressees of the regulation
- The energy efficiency metric(s) and requirements
- The performance assessment methods including testing or alternatives.



Source: IEA 4E Progressing Energy Efficiency Policies for Systems, 2022

Origin of ISO & IEC JAG 22 (Joint Advisory Group 22)

- Precedes informal cooperation and information exchange between IEC and ISO
- Preparatory project during 2020-2021 led to the launch of ISO/IEC JAG 22:

  Optimized Energy and Power Consumption of Electric Driven Machine Units

Purpose

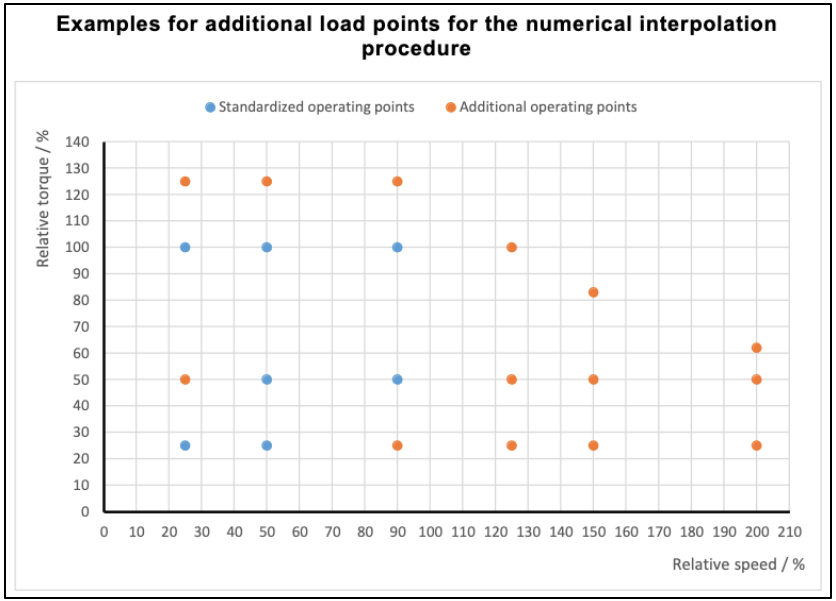
- To facilitate the exchange and coordination between ISO and IEC in the field of all types of Electric Driven Machine Units (EDMU).
- To identify the relevant coordination issues and proposed solutions and describe these considerations or results of such exchange and coordination discussions for guidance, reference.

ISO & IEC JAG 22

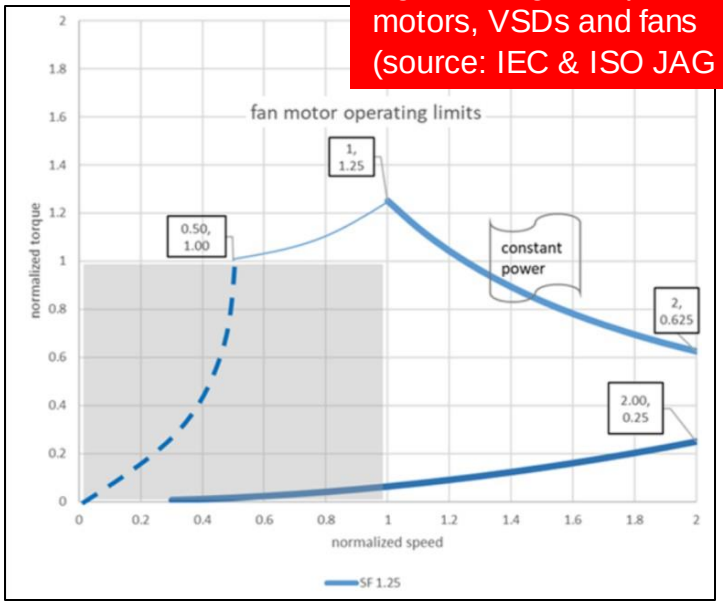
The list of items worked on/detailed in 2023:

- Mutual access to committee confidential draft standard documents by each other group (IEC & ISO TC or WG)
- Possibility of inclusion of formal comments on each other's standard projects
- Operating range of motor systems for over-speed and over-torque
- Aligning operating points for tests
- Round Robin for losses of Variably Frequency Converters (report 1 and 2)
- Interpolation and extrapolation programs for efficiency calculation for motors, converters and their combination
- The mutual citation rules from IEC and ISO standards were clarified (example in ISO 12759-6)

Interpolation and extrapolation programs: operating range



Agreed range of operation for motors, VSDs and fans (source: IEC & ISO JAG 22)



IEC TS 60034-31 edition 2 (published in 2021) specifies an interpolation method for efficiency (including an official excel tool) for 50 Hz motors, converters and their combination from 0 % to 100 % speed and 0 % to 100 % torque based on measurements of 7 operating points

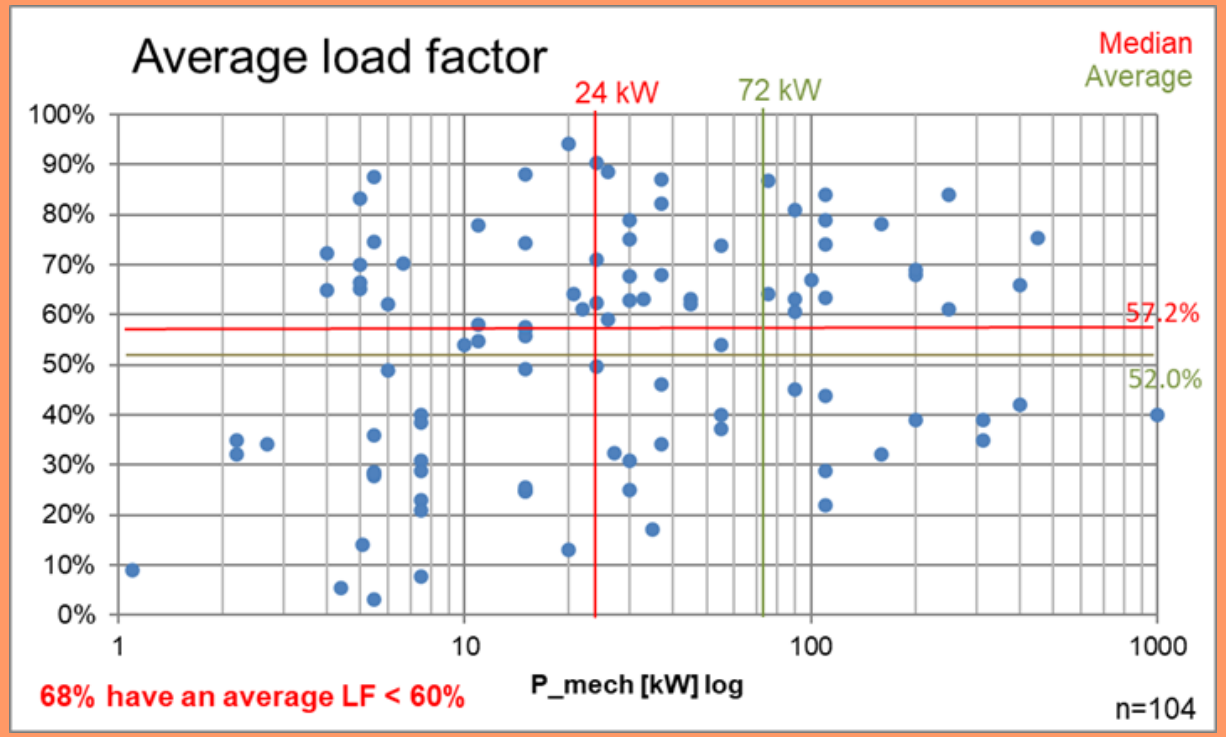
(Source: IEC 60034-2-3, Ed.2)

(source: IEC & ISO JAG 22)

New Projects JAG 22:
Avoiding oversizing electric motor systems

- Oversized electric motor systems are everywhere
- In all applications
- Many explanations …
- But no good excuses

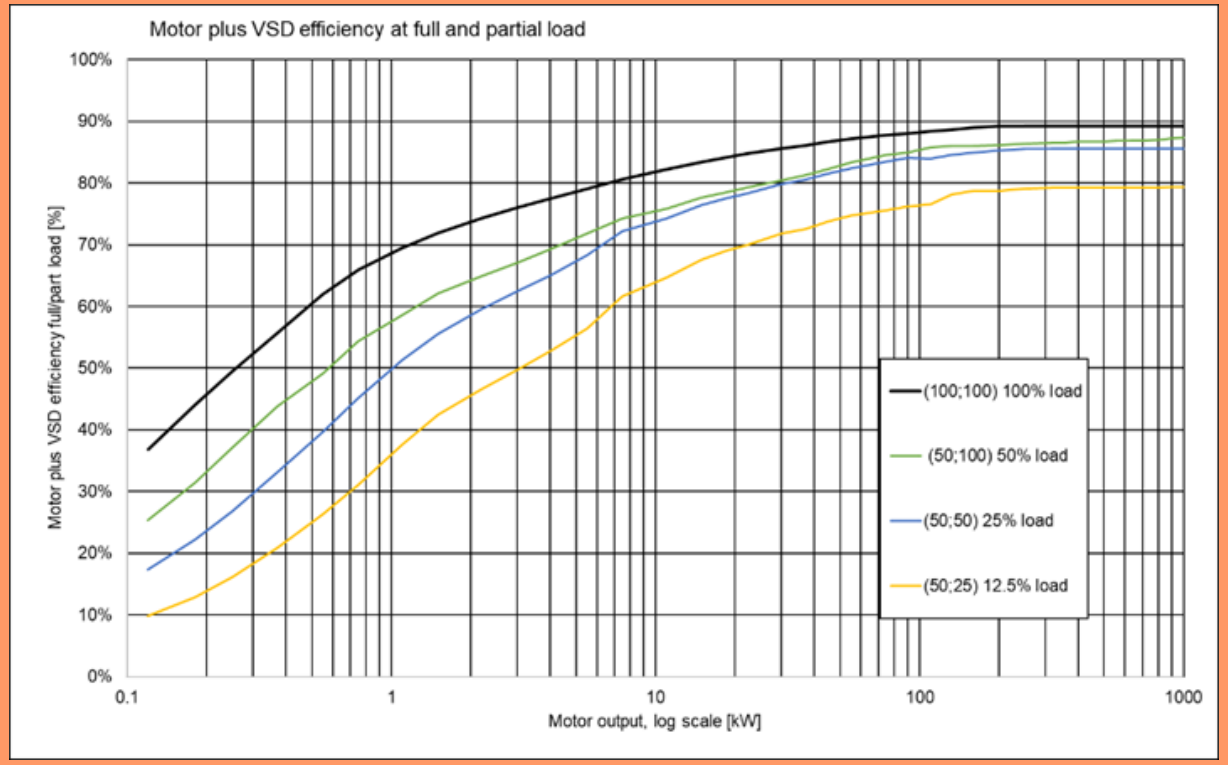
New Projects JAG 22:
Avoiding oversizing electric motor systems



Average load factor (x-axis: 0-100%) of 104 measured motor systems
(source: Easy Impact-Energy, 2015 [12])

two thirds oversized

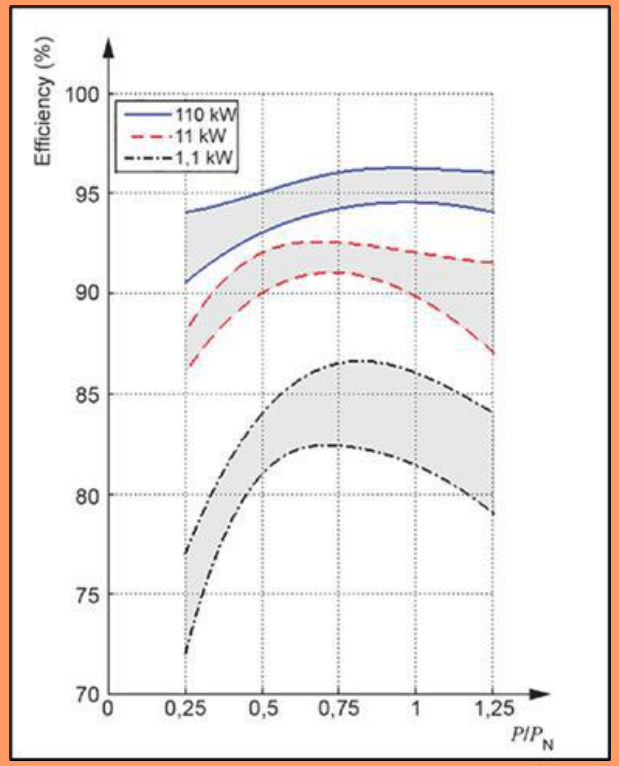
New Projects JAG 22:
Avoiding oversizing electric motor systems



Efficiency for electric motor plus VSD from 0.1 to 1000 kW in full and partial load (source of data: IEC 60034-31 and IEC 61800-9-2)

below 50% load efficiency suffers

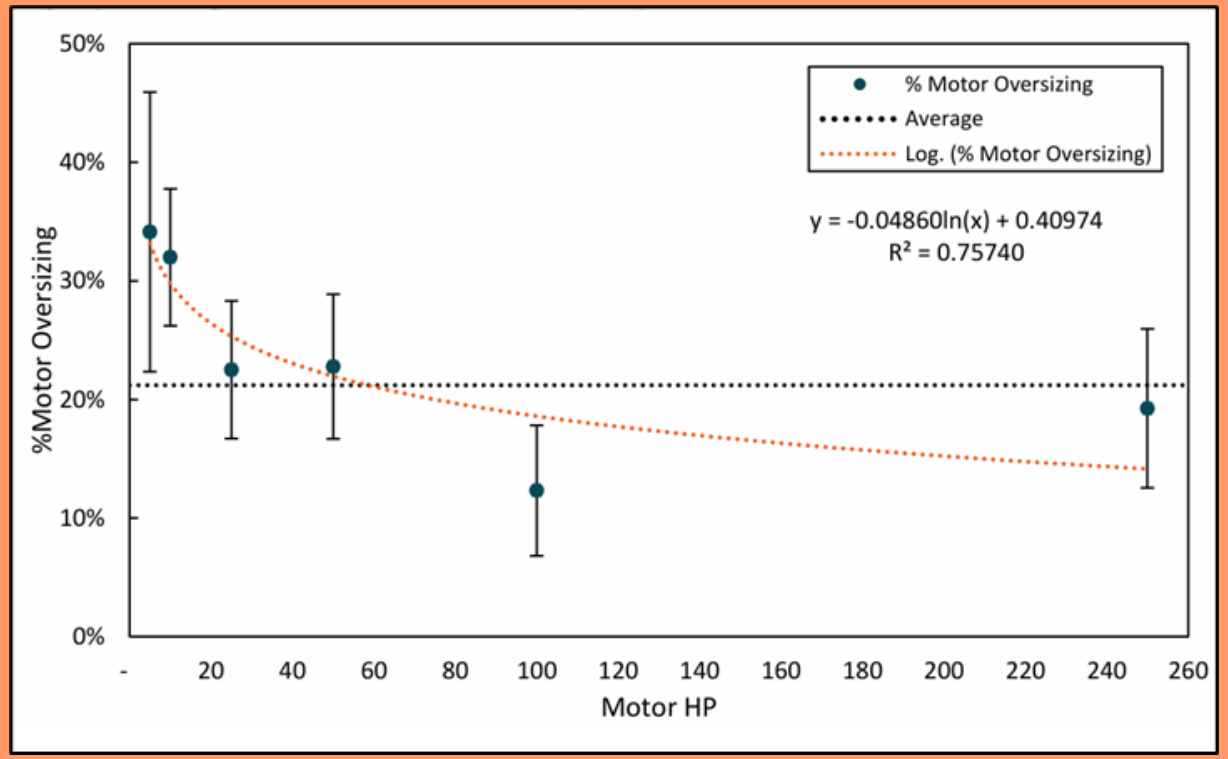
New Projects JAG 22:
Avoiding oversizing electric motor systems



Typical efficiency versus load curve bands, performance characteristics of 4-pole, three phase, cage induction motors of different power ratings, (source: IEC TS 60034-31, edition 2, 2021)

below 50% load efficiency suffers

New Projects JAG 22:
Avoiding oversizing electric motor systems



Motor oversizing (%) vs. motor output power (kW), based on analysis of 342 clean water pumps (source of figure: [13] NEEA 2019)

small motors are more oversized

New Projects JAG 22:
Avoiding oversizing electric motor systems

	Average load		Extra investment cost		Additional energy use	
	Range		Range		Range	
Oversizing	low	high	low	high	low	high
Heavy	20%	40%	30%	40%	20%	30%
Medium	40%	60%	20%	30%	10%	20%
Low	60%	80%	10%	20%	5%	10%
Optimum	80%	100%	0%	10%	0%	5%

Degree of oversizing versus extra investment cost and additional energy use (source: CUB 2024)

higher costs
more energy

New Projects JAG 22
Avoiding oversizing electric motor systems

C O N C L U S I O N S

1. Carefully determine max. operational load
2. Make motor output and application input equal
3. Make converter output and motor input equal
4. Use 20-Step-Checklist ➲ ➲ ➲
5. Save investment cost
6. Save energy

Component	Step	Activity	
FAN	1	Define field of operation for fan (pump, compressor, etc.) in terms of pressure (Pa) and flow (m3/s or kg/s) under project specific conditions (ambient tempeature, air quality, barometric pressure, etc).	
	2	Define duration of operation (h/d and h/a) in range of specific operation conditions.	
	3	Define max. power point (kW), pressure (Pa) and air flow (m3/s or kg/s), including specific starting situation	
	4	Select diameter of fan (mm) at max mechanical output power (W)	
	5	Select rotating speed (rpm) at max power	
	6	Select fan type best suited for specific application and max power	
	7	Compare fan performance data from catalogues of several fan manufacturers and **select size.**	
	8	Decide on specific fan product for required performance to deliver necessary air flow and pressure with given inlet and outlet with optimum efficiency and cost: type, diameter, rpm, etc.	
	9	Define internal fan losses and efficiency at max output power (shaft friction, etc.)	
	10	Define **max necessary mechanical power input (W) to fan shaft.** Calculate fan efficiency in operation field and at max. power point.	I
Trans-missio n	11	Decide if necessary on transmission system (belt, gear) and their losses	
	12	Define **max mechanical input power (W)** to pulley or gear and its respective rpm and calculate necessary torque (Nm)	
MOTOR	13	Define required max electric motor shaft mechanical output power (W), torque (Nm) and rotational speed (rpm)	
	14	Select motor type, number of poles, rpm, efficiency class (and thermal and protection class, etc).	I
	15	Compare performance data from catalogues of several motor manufacturers and **select next larger standard size.**	
	16	Decide on specific motor product for required frequency (50 or 60 Hz) with necessary max input power (W), voltage (V), nominal and inrush current (A), power factor (cos phi) and service factor (over-torque and over-speed). Define motor efficiency in entire operation field including max power situation.	
	17	Decide on operation in starting and max. power conditions, define necessary max. input current.	
VSD	18	Decide if necessary for Variable Speed Drive: select VSD with respective grid frequency, voltage and required max. input current.	I
	19	Compare performance data from catalogues of several VFD manufacturers. **Select next larger (standard) VSD size.** Define VSD efficiency in operation field including max power situation.	I
	20	**Calculate fan system efficiency at weighted operating points**	U

Outlook, mid-term goal
ISO and IEC talk together

- Newby IEC/ISO JAG 22 has shown
  - potential benefits of cooperation and
  - necessary intensity of exchange
- Policy makers: challenge to find effective tools to accelerate reduction of energy use and emissions
- Going from products to systems adds complexity
  - energy efficiency aspects and
  - related aspects like e.g. power reduction, material use, safety and more.
- Technology development + the related global technical standards are key enablers

- Further coordination and alignment on these matters is even more necessary
  - in between ISO and IEC TCs, and
  - between policy makers and stakeholders
- JAG 22, looking ahead
  - continues to work on EE rotating systems
  - can serve as a cooperation model for other related subjects, other entities
  - will contribute to the challenge of verifying systems performance new AND installed in industry and buildings
  - Experts are invited: see ‘JAG22’ on IEC.ch

Thank you

Maarten van Werkhoven
TPA Advisors
Amsterdam, Netherlands
mvanwerkhoven@tpabv.nl

Conrad U. Brunner
CUB Zurich Switzerland
cub@cub.ch