



Transformers | Motors | Generators

| 19-21 May 2026

● A Hyve Event

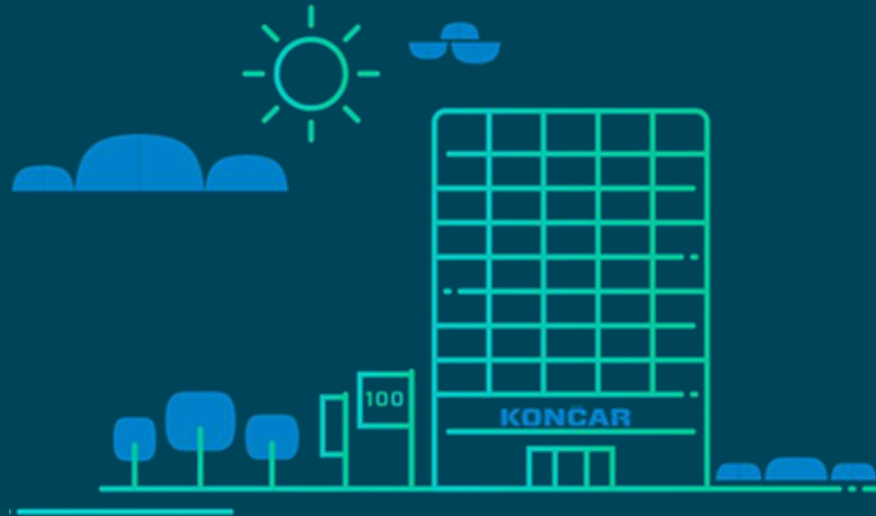
From Regulation to Implementation: EC Motor Technology Choices for EU Transformer Cooling

Bojan Jakovljević, mag.ing.el.

Project and Electrotechnology Manager

Topics

- Current regulations affecting the market
- Critical raw materials
- Motor technology for modern transformer cooling
- Are new technologies for transformer cooling a good investment?
- AC vs. EC transformer cooling fans



Efficiency

Motors with new technologies

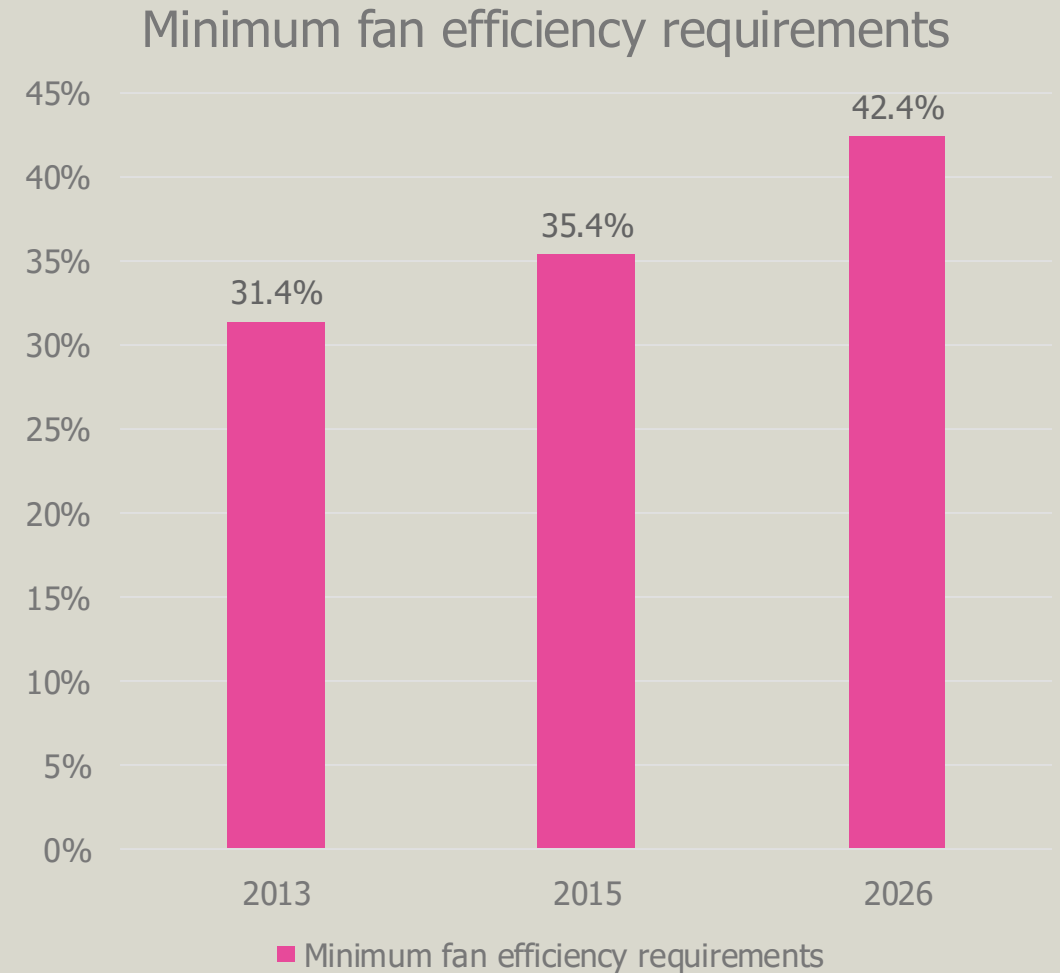
- (EU) 2024/1834
- Ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW
- A key regulation that initiated the development of more efficient motors and fans
- The efficiency standards, which were introduced in 2011, applied from 2013, and tightened in 2015, will be raised again on 24 July 2026
- A stronger push towards high-efficiency motors

Source: <https://eur-lex.europa.eu/eli/reg/2024/1834/oj/eng>

Efficiency

A big step in minimum efficiency requirements

- Efficiency is calculated at the fan's best efficiency point
- BEP is defined by airflow, pressure, and motor electrical input power
- Fans for transformer cooling applications are optimised for airflow at 0 Pa static pressure
- **$q_v \approx 4.49 \text{ m}^3/\text{s}$**
- **$\Delta p_{\text{stat}} \approx 167 \text{ Pa}$**
- **$P_e \approx 1.879 \text{ kW} = 1879.4 \text{ W}$**
- **Integrated variable-speed drive**
- **Integrated protective grids**



Sustainability

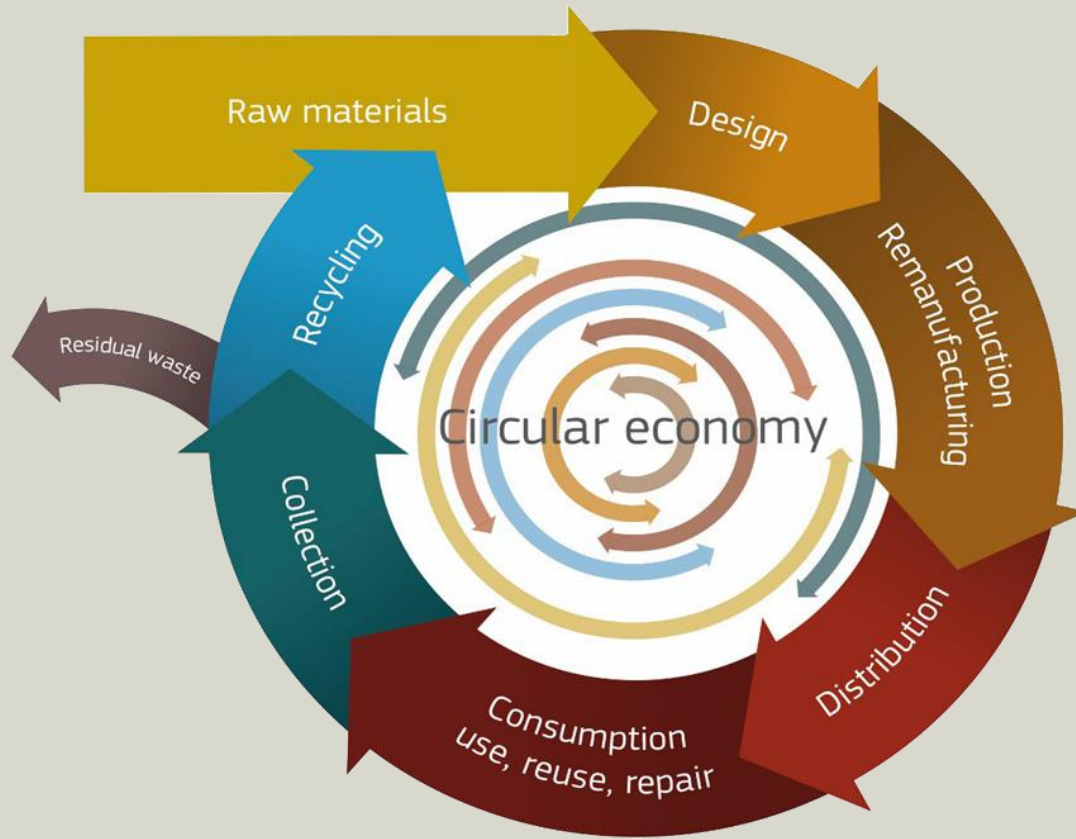
Only positive outcomes for the end customer

- (EU) 2024/1781
- Framework for the setting of ecodesign requirements for sustainable products
- Improving product durability, reusability, upgradability and reparability
- Enhancing the possibility of product maintenance and refurbishment
- Making products more energy and resource-efficient
- Addressing the presence of substances that inhibit circularity
- Increasing recycled content
- Making products easier to remanufacture and recycle
- Setting rules on carbon and environmental footprints
- Limiting the generation of waste
- Improving the availability of information on product sustainability

Source: <https://eur-lex.europa.eu/eli/reg/2024/1781/oj>



Sustainability



Raw materials

Crucial for the choice of motor technology

- (EU) 2024/1252
- Framework for ensuring a secure and sustainable supply of critical raw materials
- The key is to establish stable supply chains
- Avoid “exotic” components and materials
- Become a reliable producer in any situation
- Increased demand for critical raw materials could lead to negative environmental and social impacts
- The list of critical raw materials
- The goal is to avoid the use of listed materials as much as possible

Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401252

52%

COPPER EXTRACTION

83%

COPPER PROCESSING

23%

IRON EXTRACTION

95%

IRON PROCESSING

11%

ALUMINIUM EXTRACTION

42%

ALUMINIUM PROCESSING

0%

NEODYMIUM EXTRACTION

0%

NEODYMIUM PROCESSING

0%

BORON EXTRACTION

30%

BORON PROCESSING

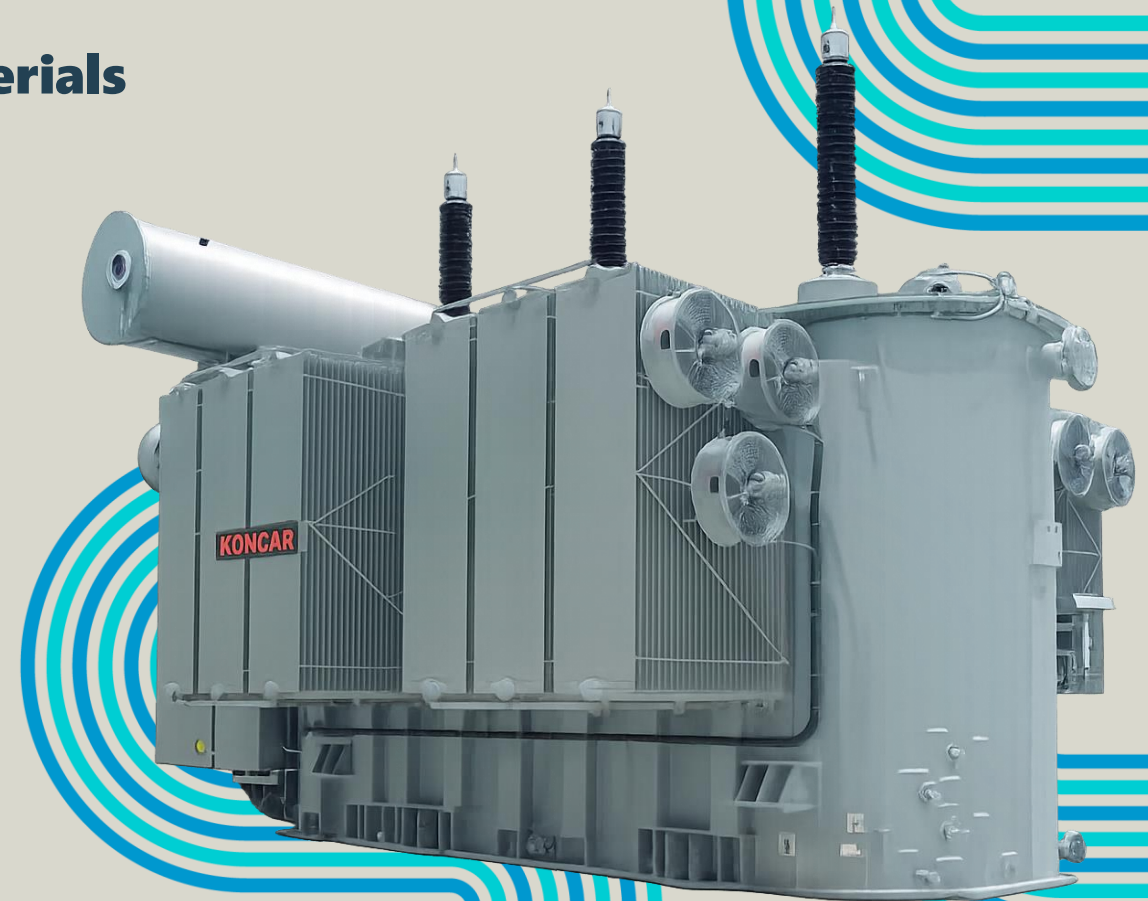
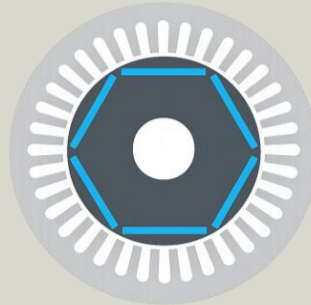
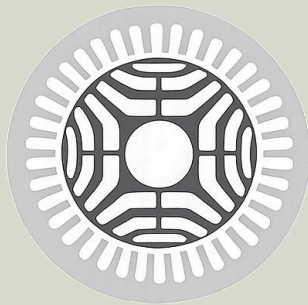
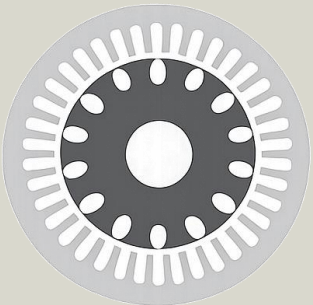
The type of material used for efficiency matters

- CRMs are mostly sourced from outside the EU
- EU is aiming to diversify its supply
- Using magnets may become more burdensome, more expensive, and more strategically risky
- China provides 100% of the EU's supply of heavy rare earth elements
- Turkey provides 99% of the EU's supply of boron
- South Africa provides 71% of the EU's platinum requirements

Motor requirements

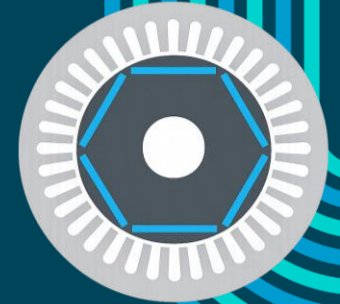
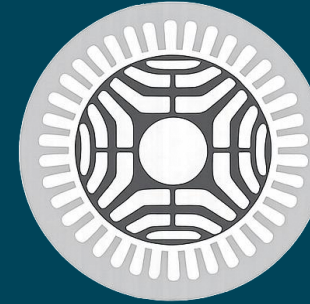
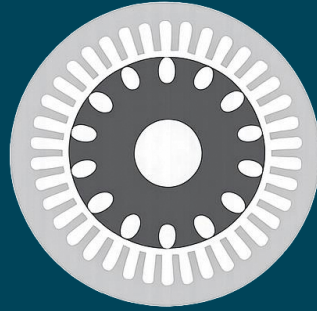
Efficient, sustainable & free of critical raw materials

- The main starting point is the motor's target power consumption based on fan design/load
- Motor for an 800 mm axial fan for transformer cooling applications
- IEC motor frame 100 or 112
- IP66
- $T_a = 55^\circ\text{C}$



Motor technology

- Comparatively good
- Comparatively medium
- Comparatively poor

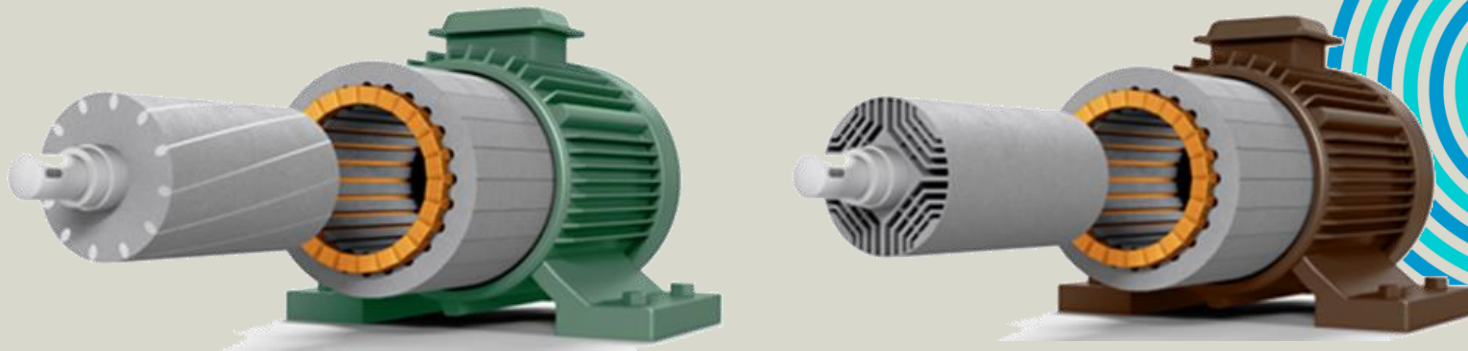


	Induction motor	Synchronous reluctance	Permanent magnet
Torque / power density	•	•	•
High speed operation	•	•	•
Resistance to high temp.	••	•	•
Raw materials & manufacturing	•	•	•
Partial load efficiency	•	•	•
Rated current	•	•	•
Major advantage	Easy control - VSD not required.	Efficient with low material cost.	Lighter for the same efficiency
Major disadvantage	For IE5 efficiency one or even two IEC sizes larger compared to IE3.	Requires advanced control algorithms. Higher rated current.	High cost of magnets, maintenance and recycling.

SynREL & Induction motor construction

Efficient, sustainable & free of critical raw materials

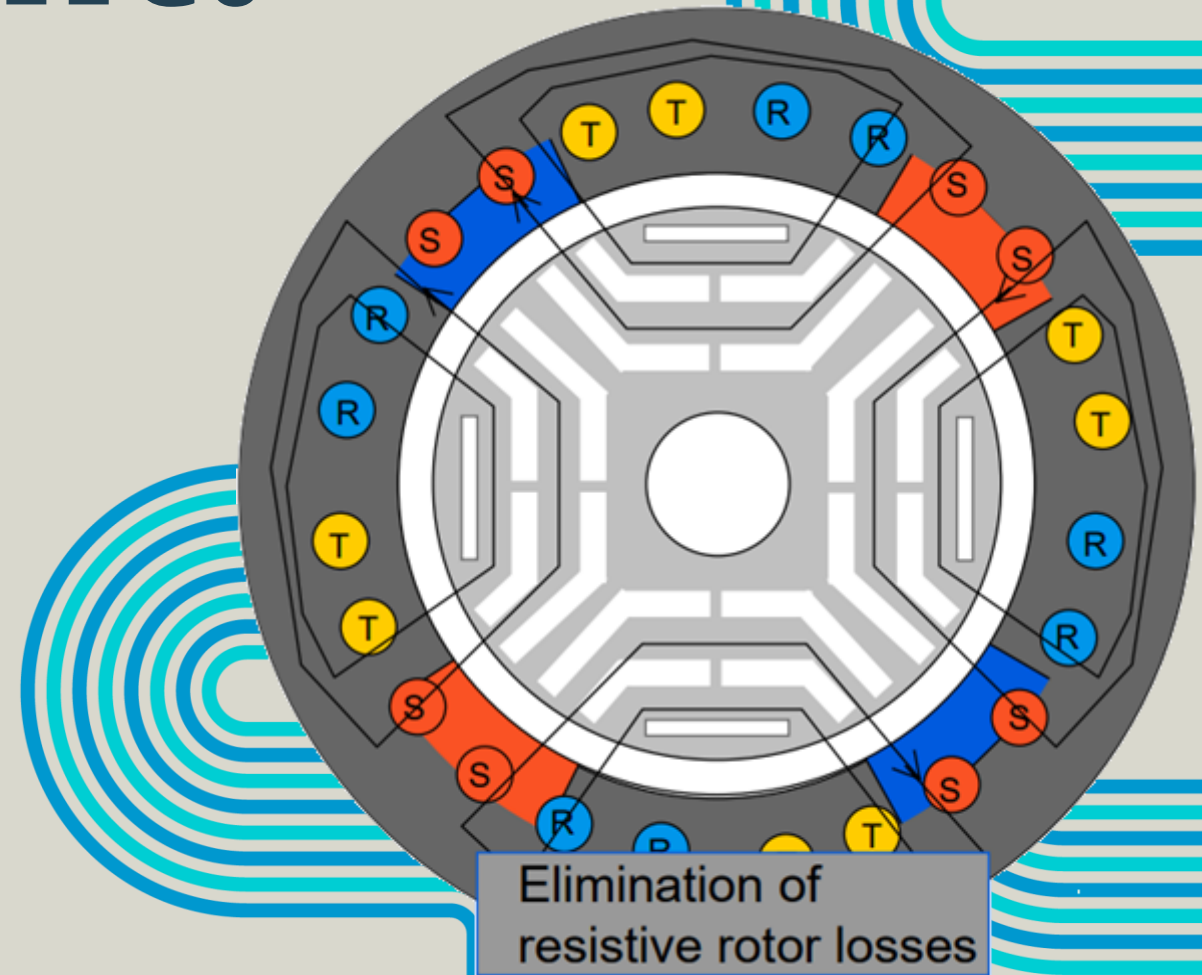
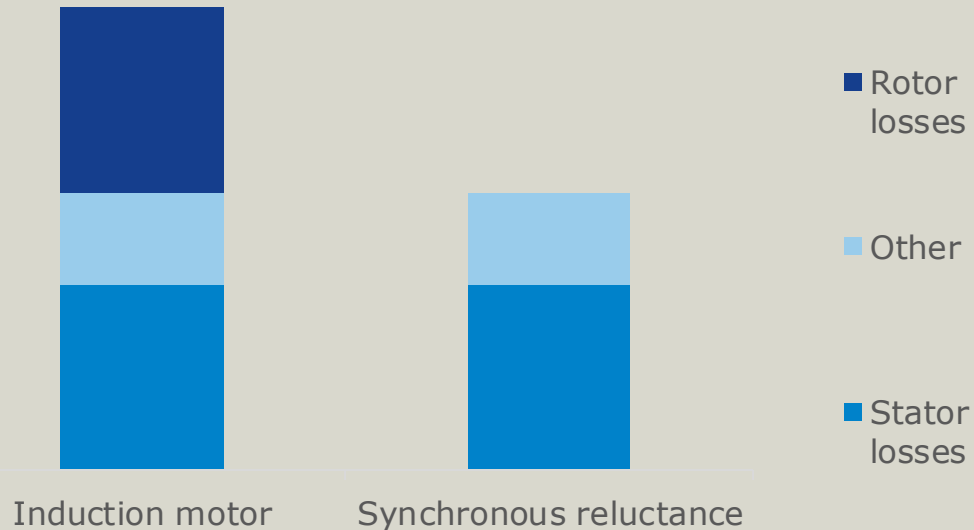
- Same type of stator winding
- Same housing, terminal box and shaft.
- Same production procedures and tools
- Same level of reparability, with the same maintenance and recycling procedures
- The main and only difference is in the design of the active part of the rotor
- Without casted aluminum in the rotor



Graphic source: Danfoss drives

Why is the SynREL motor efficient?

- No rotor bars through which current passes
- Rotor speed is equal to synchronous rotating magnetic field of the stator.
- Rotor losses are eliminated.



Speed control

One fan for all applications / airflows

- EC = electronically commutated
- A synchronous reluctance motor requires a variable-speed drive for operation
- A frequency converter is a major advantage
- The fan can be operated at any airflow operating point
- Instead of using motors with different pole counts: 6, 8, 10, 12, 16, etc. it is possible to use only one motor and fan
- An integrated frequency inverter saves space
- A BIG STANDARDISATION OPPORTUNITY



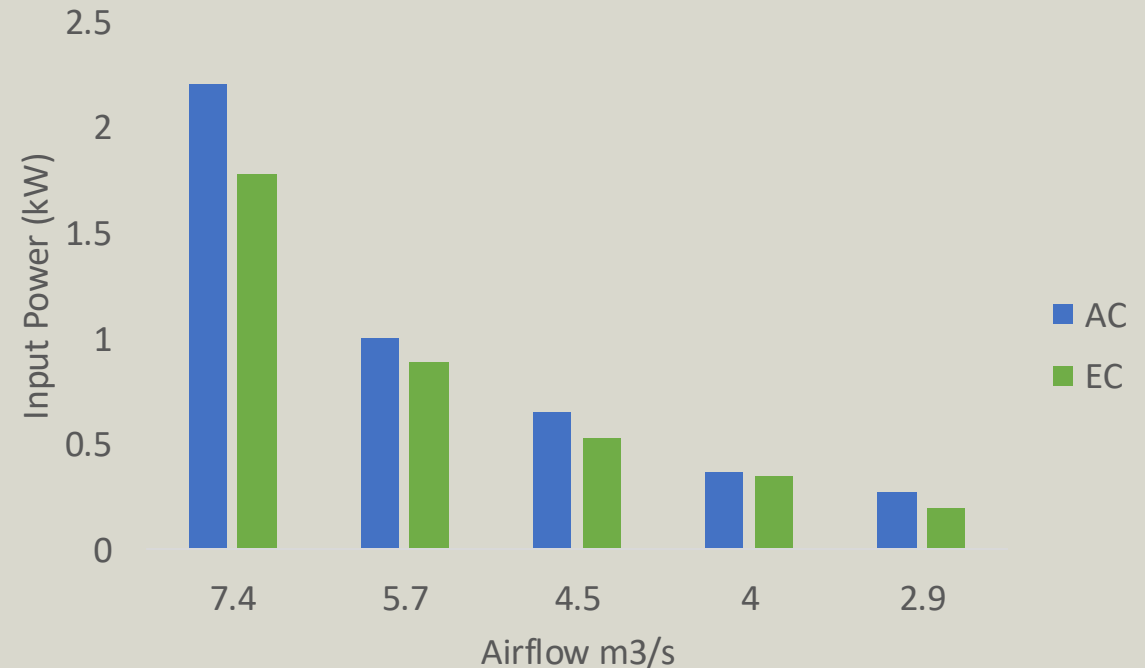
Energy savings

Adjust speed based on actual transformer temperature

- Static power savings are significant
- Input currents are also significantly lower
- If demand is low, it is not necessary to run the fans at maximum power
- Airflow can be continuously adjusted
- Half the airflow does not mean half the power, it means exponentially lower power consumption
- This is where the greatest power savings can be achieved



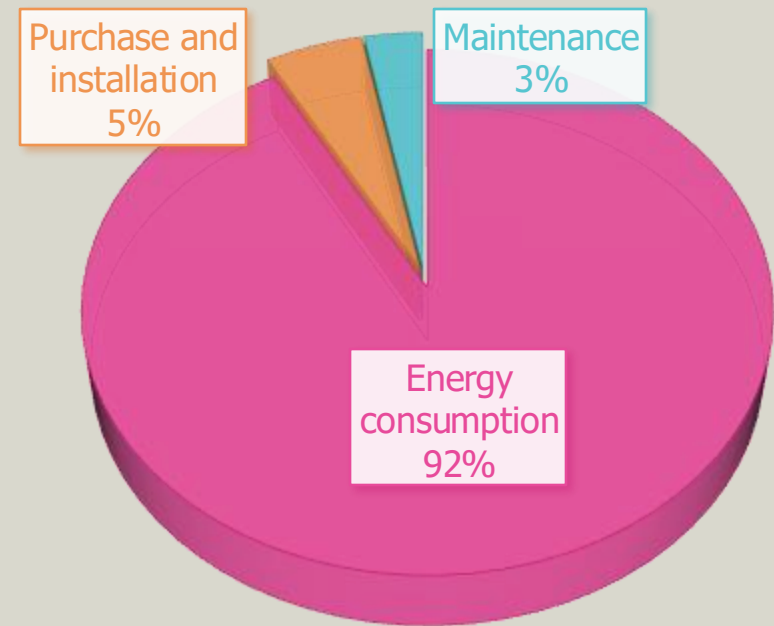
800mm AC vs EC fan power consumption



Energy is the main cost of ownership

Initial cost is almost irrelevant

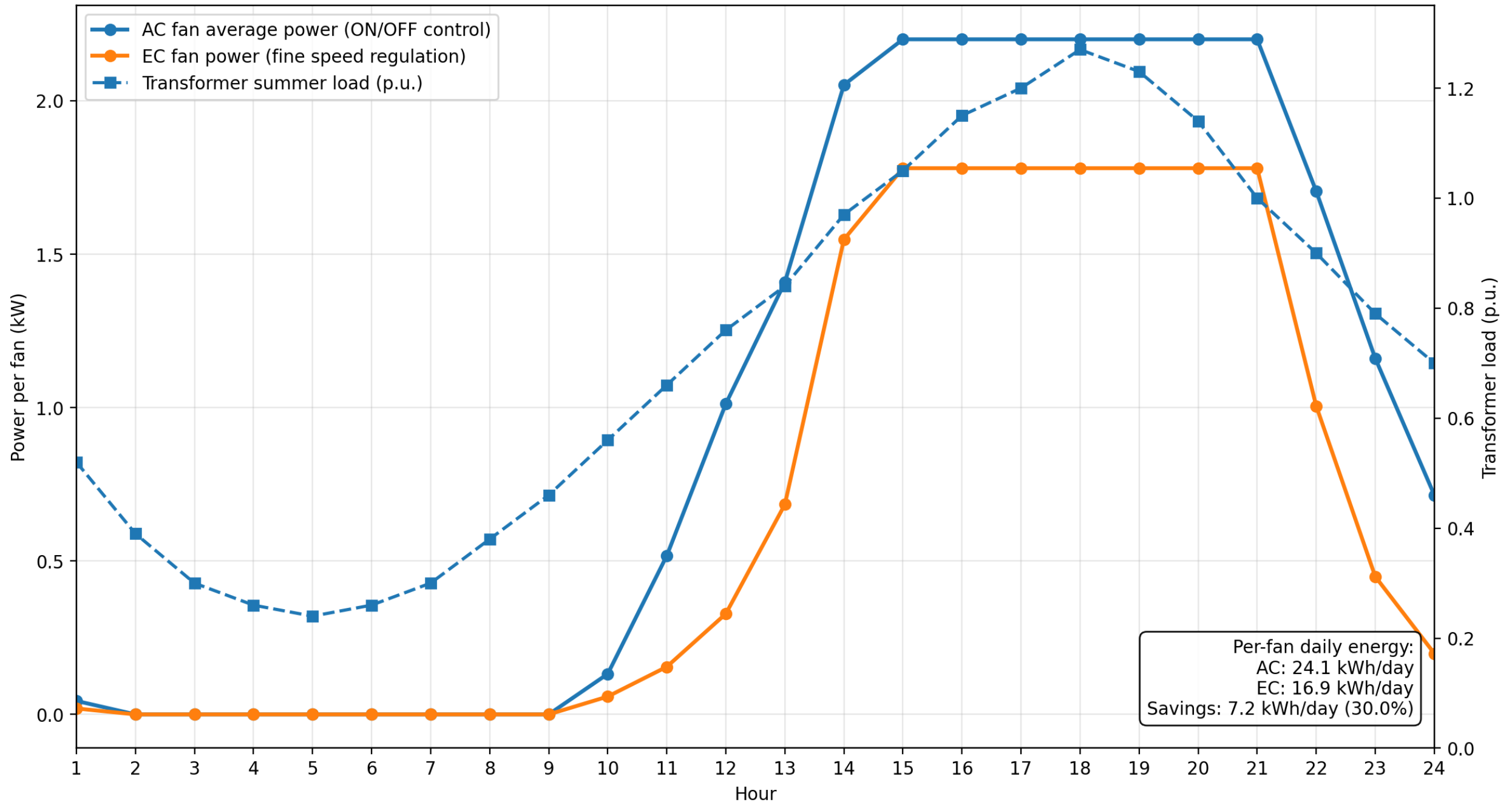
- The lifespan of electric motors is very long
- Transformer lifetime is also very long
- The main component of total fan ownership cost is energy
- It makes sense to invest more upfront



Typical life cycle costs of a motor installation over 25 years.

[Source link.](#)

800 mm fan - summer weekday hourly power consumption
EC with fine speed regulation vs AC with ON/OFF control



Conclusion

EC fans based on synchronous reluctance technology are aligned with all modern regulations

Regulations are driving the market towards more efficient solutions

Premium efficiency continuously saves money

Synchronous reluctance motors require no critical raw materials

Good repairability and ease of installation reduce waste and prolong the useful lifetime of the equipment

At the end all parts can be easily recycled and returned to the economy through standard procedures already in place

These regulations position EU products as premium products in the market, with top performance and usability

Thank You!

Questions?

Bojan Jakovljević, mag.ing.el.
Project and electrotechnology manager

Bojan.jakovljevic@koncar.hr

KONČAR
Inspired by challenge

