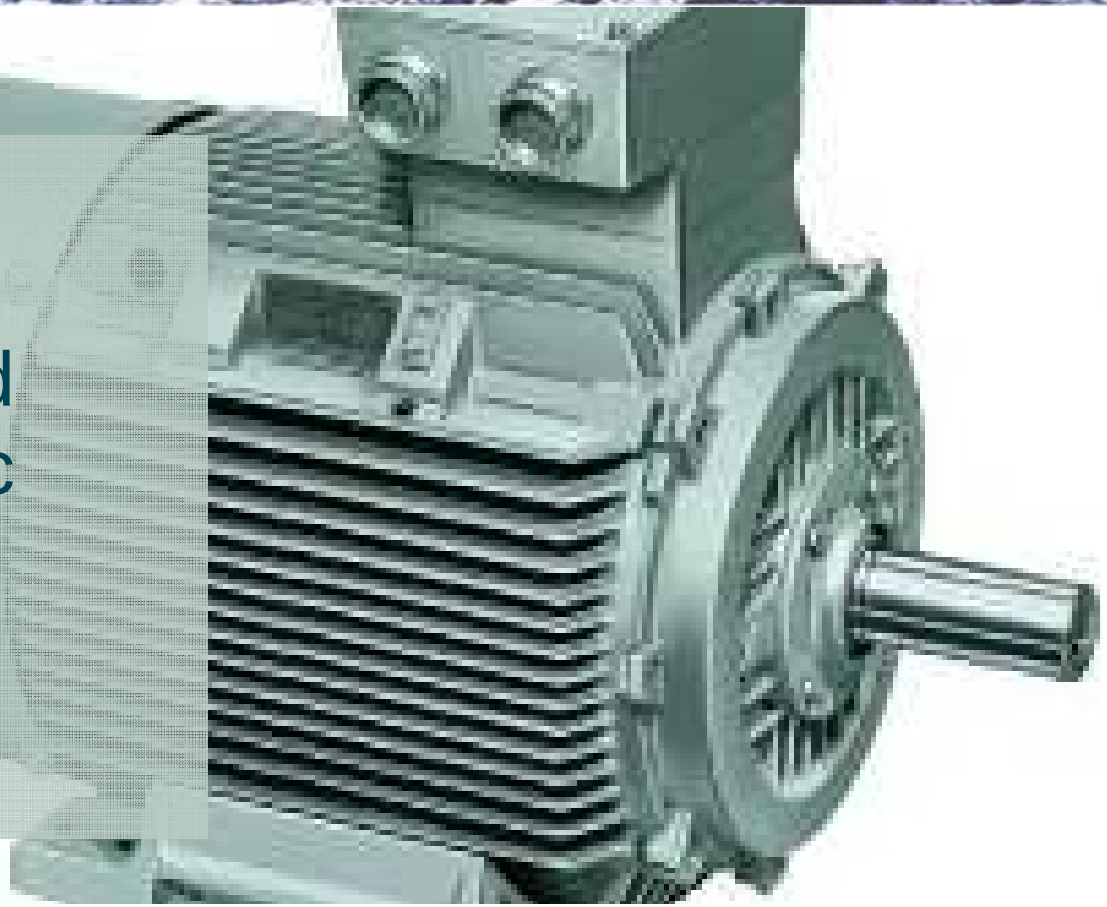
European Copper Institute
Copper Alliance

Promoting the accelerated replacement of old electric motors in the EU

JULY 2022



AGENDA

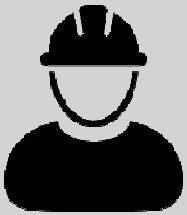
1. The European Copper Institute
2. The relevance of motors in electricity consumption
3. Motors stay for longer than expected
4. Reasons why
5. Benefits of accelerated replacement

1

Copper in the EU

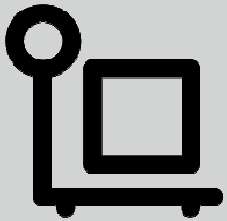
The EU copper sector

50,000 people

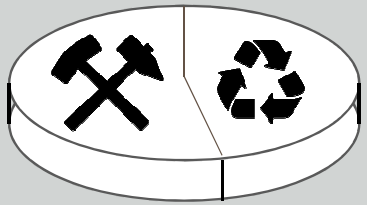


€45 billion

3.5 million tons



55% primary
45% secondary



Copper makes a significant net contribution to the clean energy transition

A circular metal
Cu can be endlessly recycled without loss of properties. Almost 50% of copper produced in EU is obtained through recycling

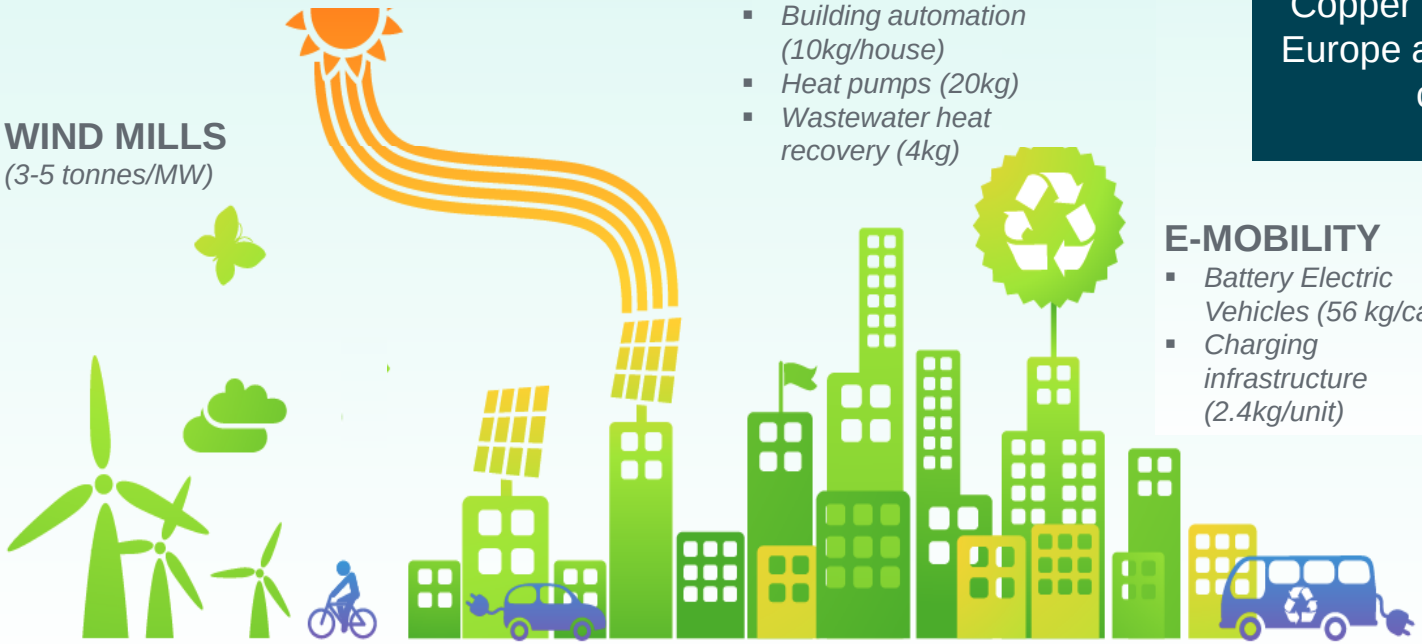
Decarbonising Cu production
Copper producers that ECI represents in Europe are committed to working towards carbon neutrality by 2050

Amount of copper used in:

SOLAR PANELS
(3 tonnes/MW)

BUILDINGS
- *Building automation (10kg/house)*
- *Heat pumps (20kg)*
- *Wastewater heat recovery (4kg)*

WIND MILLS
(3-5 tonnes/MW)



E-MOBILITY
- *Battery Electric Vehicles (56 kg/car)*
- *Charging infrastructure (2.4kg/unit)*

INDUSTRY
- *Electro-processing*
- *Motor systems*

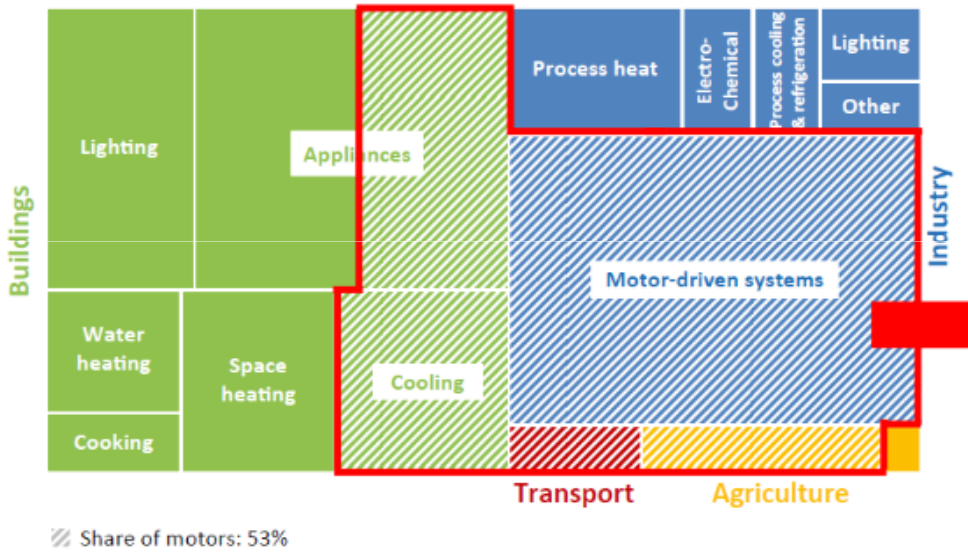
ELECTRICITY GRIDS
- *Underground cables*
- *Transformers*
- *Batteries*
- *Offshore grids*

2

The relevance of motors in electricity consumption

Electric motors are responsible for 53% of the world's total electricity consumption

Figure 7.9 ▷ Global total final electricity consumption by end-uses, 2014



Motors represent 74% of electricity consumption in industry

Source: IEA World Energy Outlook, 2019

Motors are mainly used in industry, large buildings and infrastructure systems. Also transport, agriculture and household appliances include motors.

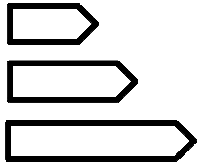
Source: IEA World Energy Outlook, 2016

Source: https://www.iea-4e.org/wp-content/uploads/2022/06/IEA_Global_EE_conf_2022_final.pdf

Electric motor systems policies

Aiming at the uptake of energy efficient electric motors

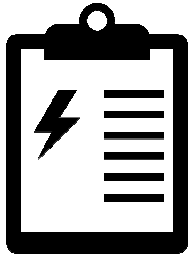
Minimum efficiency regulations



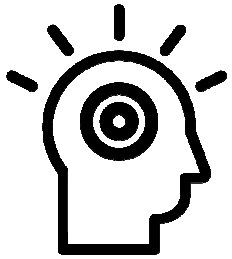
Financial Incentives

Energy Management Programmes

Energy Audit Programmes



Awareness raising and information provision



EU existing policy instruments

Ecodesign Regulation: Electric Motors

EC Regulations 640/2009 and 2019/1781

16 June 2011
- **Stage 1**: Motors with rated output 0,75 – 375 kW must meet **IE2** efficiency level

1 Jan 2015
- **Stage 2**: Motors with rated output 7,5 – 375 kW must meet **IE3** efficiency level or **IE2 + VSD**

1 Jan 2017
- **Stage 3**: Motors with rated output 0,75 – 375 kW must meet **IE3** efficiency level or **IE2 + VSD**

July 2021
- Motors (3-phase) with rated output 0,75 – 1.000 kW must meet IE3 efficiency level
- Motors (3-phase) with rated output 0,12 – 0,75 kW must meet IE2 efficiency level

July 2023
- Single-phase motors with rated output equal or above 0,12 kW must meet IE2 efficiency level
- Motors (3-phase) with rated output 75 – 200 kW must meet **IE4** efficiency level

EU existing policy instruments

Energy Efficiency Directive

Article 7 obliges Member States to develop an Energy Efficiency Obligation scheme or/and use alternative measures like energy certificates, minimum energy performance requirements etc.

Article 8 Energy audits and energy management systems

3

Motors stay for longer than expected

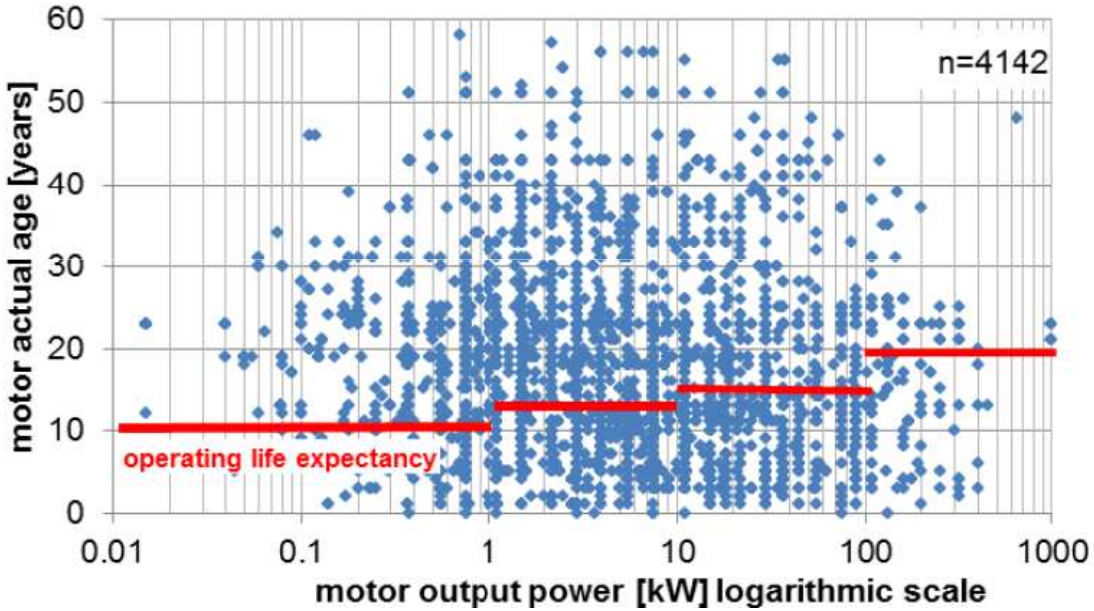
Motor Lifetime
Common assumption

The average lifetime of motors (including repairs) in previous EU studies have been estimated to be:

1.0 – 7.5 kW:	12 years
7.5 – 75 kW:	15 years
75 – 250 kW:	20 years

Motor Lifetime

Swiss Energy Agency S.A.F.E. (2013)

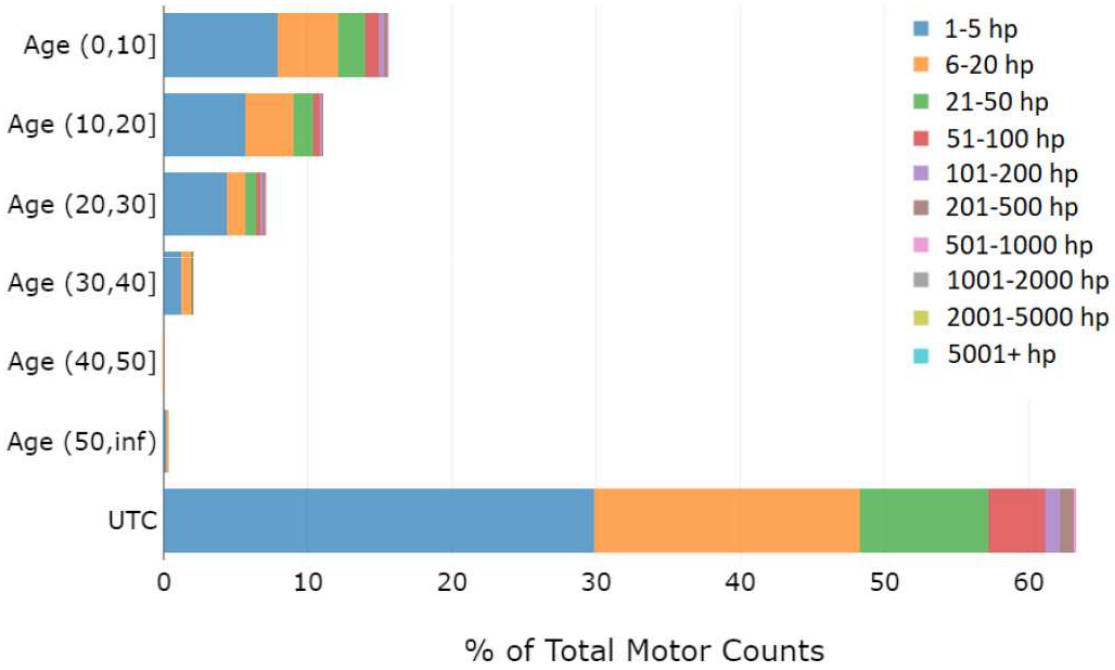


Source: Impact Energy, Switzerland, 2014

- In 2013 the Swiss Energy Agency S.A.F.E. assessed 4124 separate motor systems in 18 factories.
- The analysis shows that 56% of all motors and their respective systems were older than their expected operating life time (some were twice the expected age).

Motor Lifetime
US Motor System Market Assessment

Age of industrial motor systems broken down by size



Source: (DoE, 2021) US Motor System Market Assessment

The new US MS Market Assessment found that the majority of motors is over 10 years old, even for small motors under 20hp

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Reasons why

Barriers to motor replacement

- **Efficiency perceived low importance.** When considering options for efficiency improvements in a company, motor efficiency is seen as being of low interest.
- **Economic barriers.** Split incentives; low budget for energy efficiency; relatively long paybacks.
- **Higher upfront costs.** Companies often decide based on purchase cost instead of life cycle costs.
- **Lack of awareness about the co-benefits of energy efficient motors.** The advantages of higher efficiency motors, such as lower maintenance due to lower operating temperatures, process improvements, are often not taken into account in the decision-making process.
- **Split goals between different company departments.** Different departments within a company (production, energy, maintenance, financial, etc.) may have different immediate goals. Sometimes, miscoordination between these departments, in addition to the low budgets for energy efficiency projects, may lead to inaction.

Barriers to motor replacement
(cont.)

- **Quick availability.** The need for vital plant equipment to be brought on-line again as soon as possible, will mean that when a motor fails they will do whatever is quickest. This often means repairing the motor or replacing it with an old motor in stock. Repairing a motor is seen as the lowest risk option too.
- **Stocks of old motors.** Many sites have stocks of older motors, and there is a natural tendency to use these “free” motors rather than purchase new motors.
- **Increase in length.** Higher efficiency motors will generally have greater active material than less efficient motors, usually seen as an extended stator frame. Longer motors may not fit into all applications.
- **Energy audits.** Energy audits are, sometimes, not anchored in the reality of installations leading to recommendations that are not practical.

Stocks of old motors

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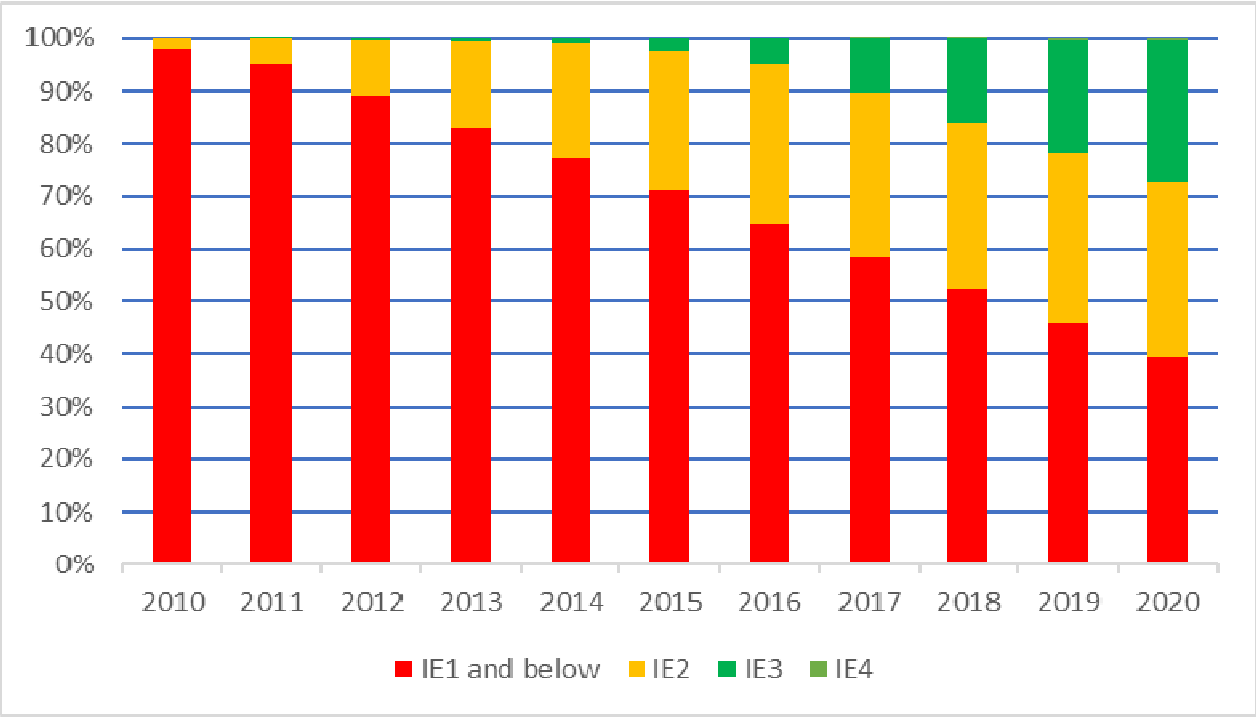
Benefits of accelerated replacement

Motor Stock by Efficiency Class

Preliminary estimate

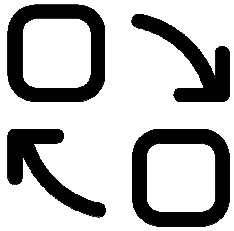


Even when taking the values of 12, 15 and 20 years for the average lifetime, depending on motor power range, it can be seen that, despite the Ecodesign Regulation in place, over 70% of the motors installed in the EU-27 were still IE2 efficiency class or below in 2020

Accelerate the replacement of old inefficient motors

Estimated impact

Replacing motors with IE2 Class or below



- Assuming an average 4% gain in efficiency, equal to the average difference between IE1 and IE3

The savings triggered would equal **25 TWh/yr.**

Accelerate the replacement of old inefficient motors

Estimated impact

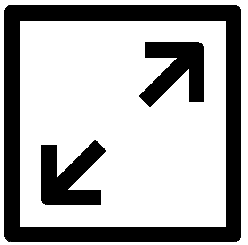
The savings would be even larger if the replacement is made with:

- IE4 or IE5 motors
- correct sizing of the motor,
- equipping the motor with variable speed drive
- digitisation / sensorisation,
- removing unneeded transmissions,
- …

Accelerate the replacement of old inefficient motors

Estimated impact

Correct sizing of motor at the time of replacement



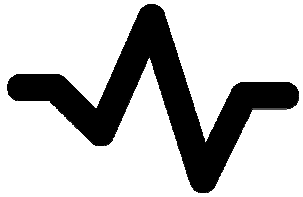
- Motors are most efficient at between 70% and 80% of rated output, with efficiency dropping sharply below 50% of rated output.
- Correct sizing of the motor can bring efficiency gains of up to 5%.

A conservative gain of 2% from correcting sizing when replacing old motors would bring additional savings of **12 TWh/yr.**

Accelerate the replacement of old inefficient motors

Estimated impact

Equipping motor with a Variable Speed Drive



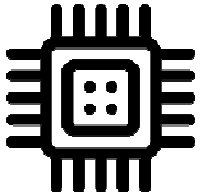
- Savings are typically in the range 15-35%.
- Applications with variable load profiles represent approximately 50 to 60% of all applications.
- Estimates for the market penetration of VSDs to be approximately 45% in 2020 (CEMEP).
- This means that 5 to 15% of motors with variable loads are operated under inefficient control methods.

If VSDs are installed in these motors alongside motor renovations, the savings would amount to between **4,75 TWh/yr** (in the worst case) and **33 TWh/yr** (in the best case).

Accelerate the replacement of old inefficient motors

Estimated impact

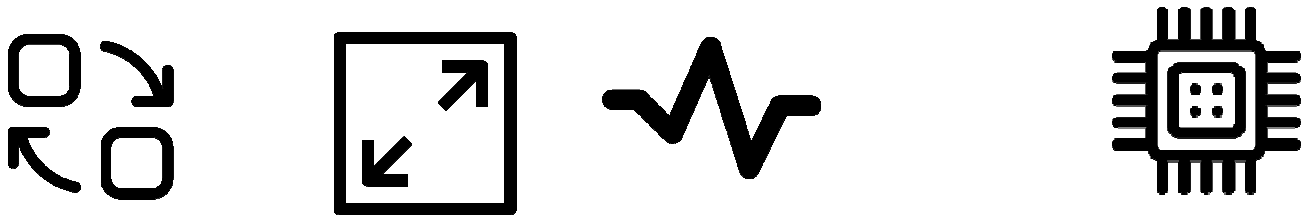
Digitisation / Sensorisation



- The Preparatory study for the Ecodesign and Energy Labelling Working Plan 2020-2024 identified electricity savings from digitisation of electric motors to be of around 5-10%.

Using the same rationale as above the savings from digitisation of motor systems would be of **31 to 63 TWh/yr.**

Accelerated Replacement of Electric Motors
Conclusions



Replacement 25 TWh	Proper sizing 12 TWh	VSD 4-33 TWh	Digitisation 31-63 TWh

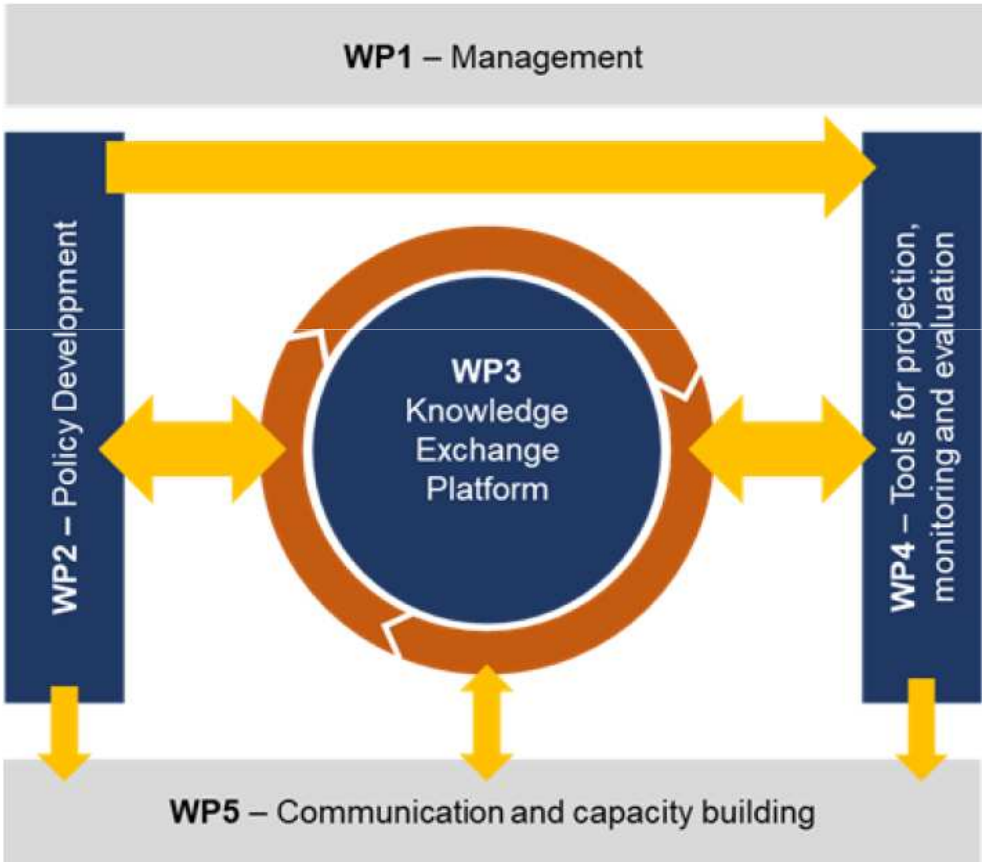
72 to 133 TWh can be saved through proper replacement and accompanying measures

Accelerated Replacement of Electric Motors
Further work

- Assess current motor stock (age, power, load, efficiency class) and trends.
- Review past and existing policy options for the acceleration of electric motor renovation identifying best-practices and shortcomings.
- Foster the discussion and knowledge exchange between stakeholders dealing with the promotion of energy-efficiency technologies and energy efficiency policy implementation.
- **Develop new policies** (adapted best practices or new concepts).

EU-MORE project – Promotion of motor replacement

EU-funded project October 2022 – April 2025



AUSTRIAN ENERGY AGENCY

ΚΑΠΕ CRES
CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

Fraunhofer

IEECP

European Copper Institute
Copper Alliance

UNIVERSIDADE DE COIMBRA

International Copper Association
Copper Alliance

Thank you!

fernando.nuno@copperalliance.org