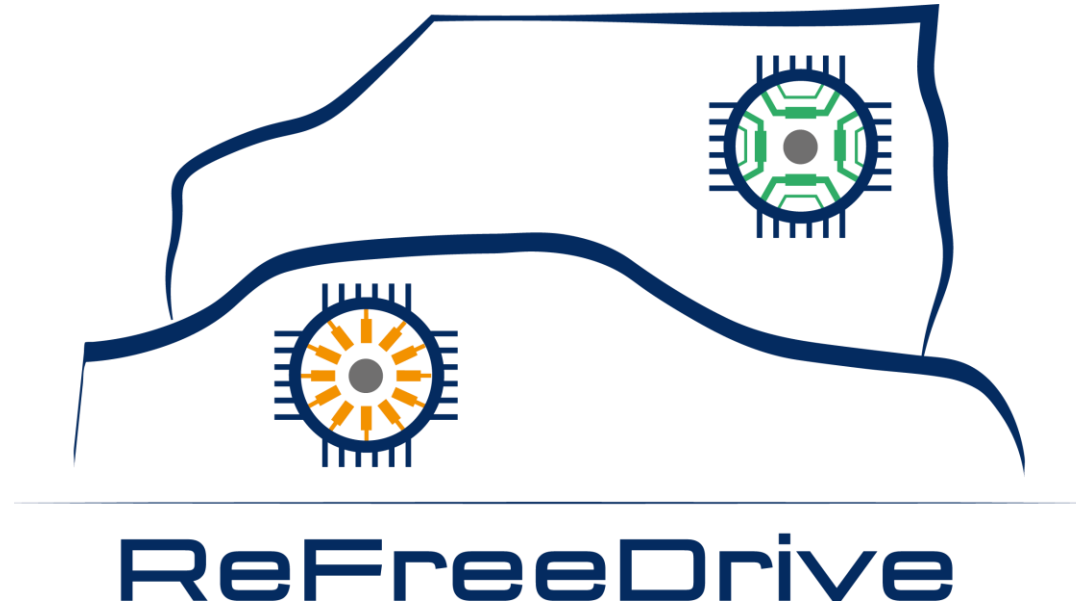




Copper in e-mobility

Manufacturing technologies for copper rotors

Agenda

- ECI – The role of copper in the energy transition and its availability
- Aurubis – Fabricated Rotor
 - CuAg
 - Portfolio
 - Production Process
 - Overview
- Breuckmann – Cast Rotor
 - Portfolio
 - Production Process
 - Overview
- Summary

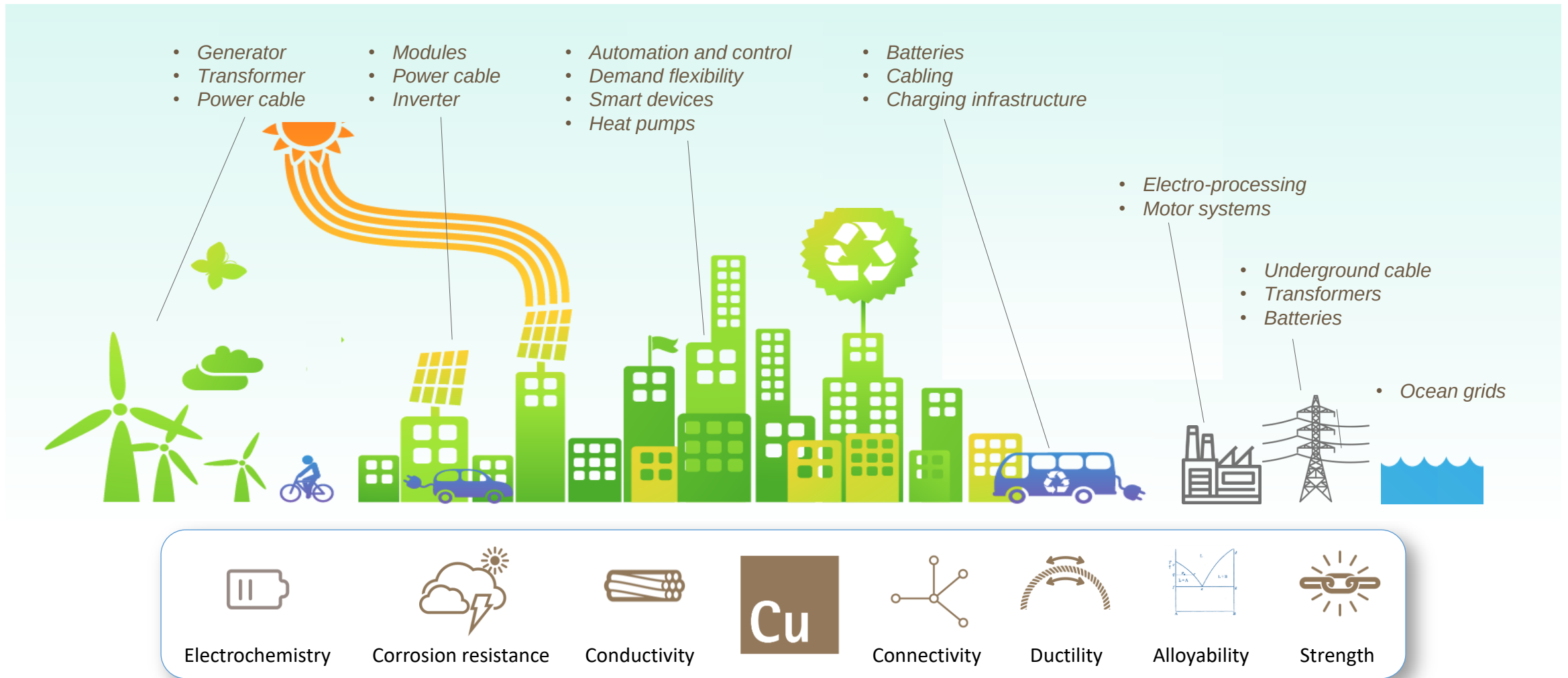


European
Copper Institute
Copper Alliance

The role of copper in the energy transition and its availability

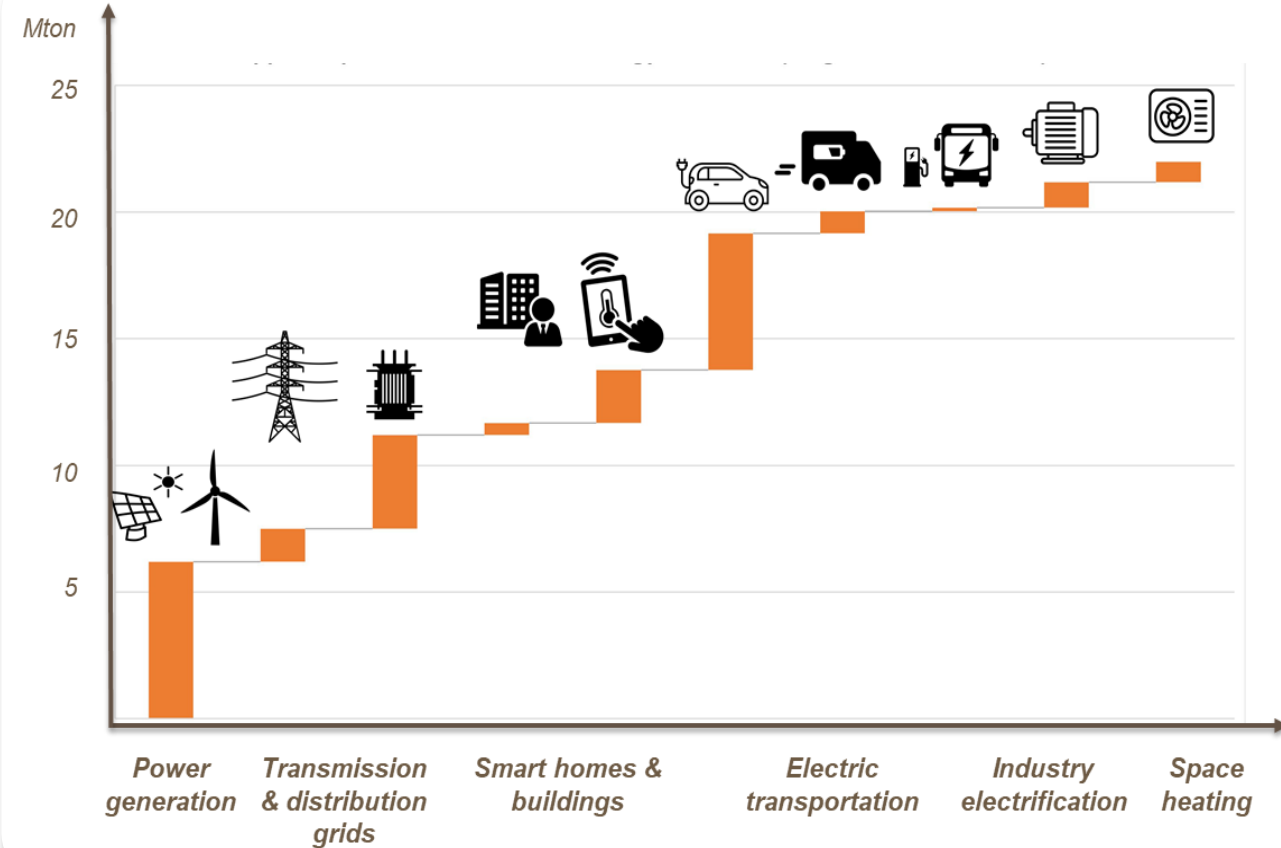
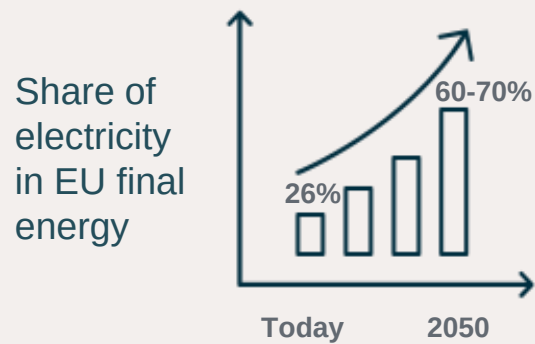
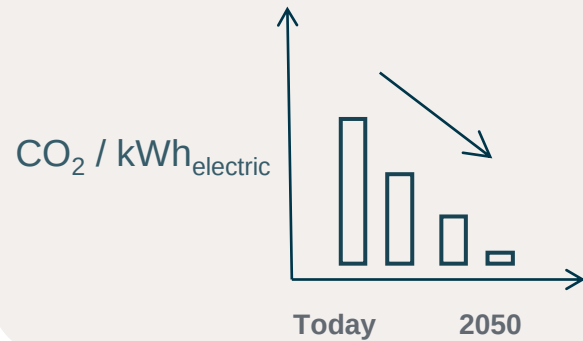
Thanks to its excellent conductivity and properties, copper plays a central role in the energy transition

Cu



The future is electric - Expected net addition of copper by 2050: 22 Mtonnes

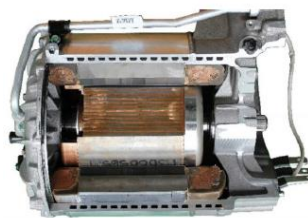
Cu



New electromobility components need copper to operate efficiently, driving demand up



Battery
(copper foil, connectors)



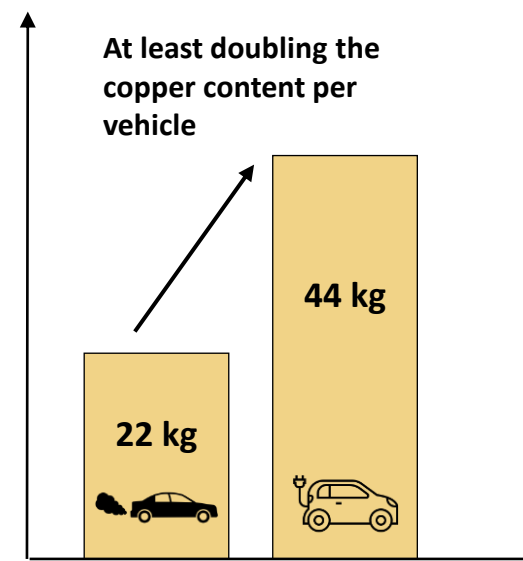
Electric motor
(stator windings and, in some cases, rotor)



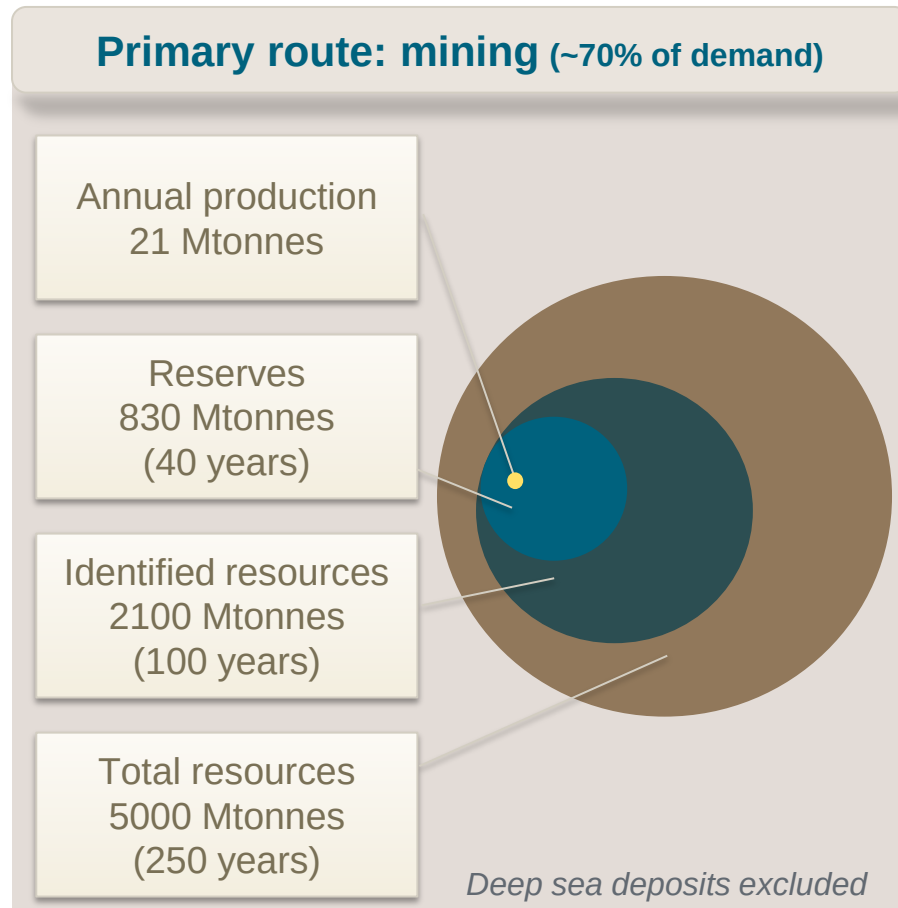
High voltage wiring



Low voltage wiring



There are sufficient mining and recycling copper reserves & resources worldwide to cope with growth

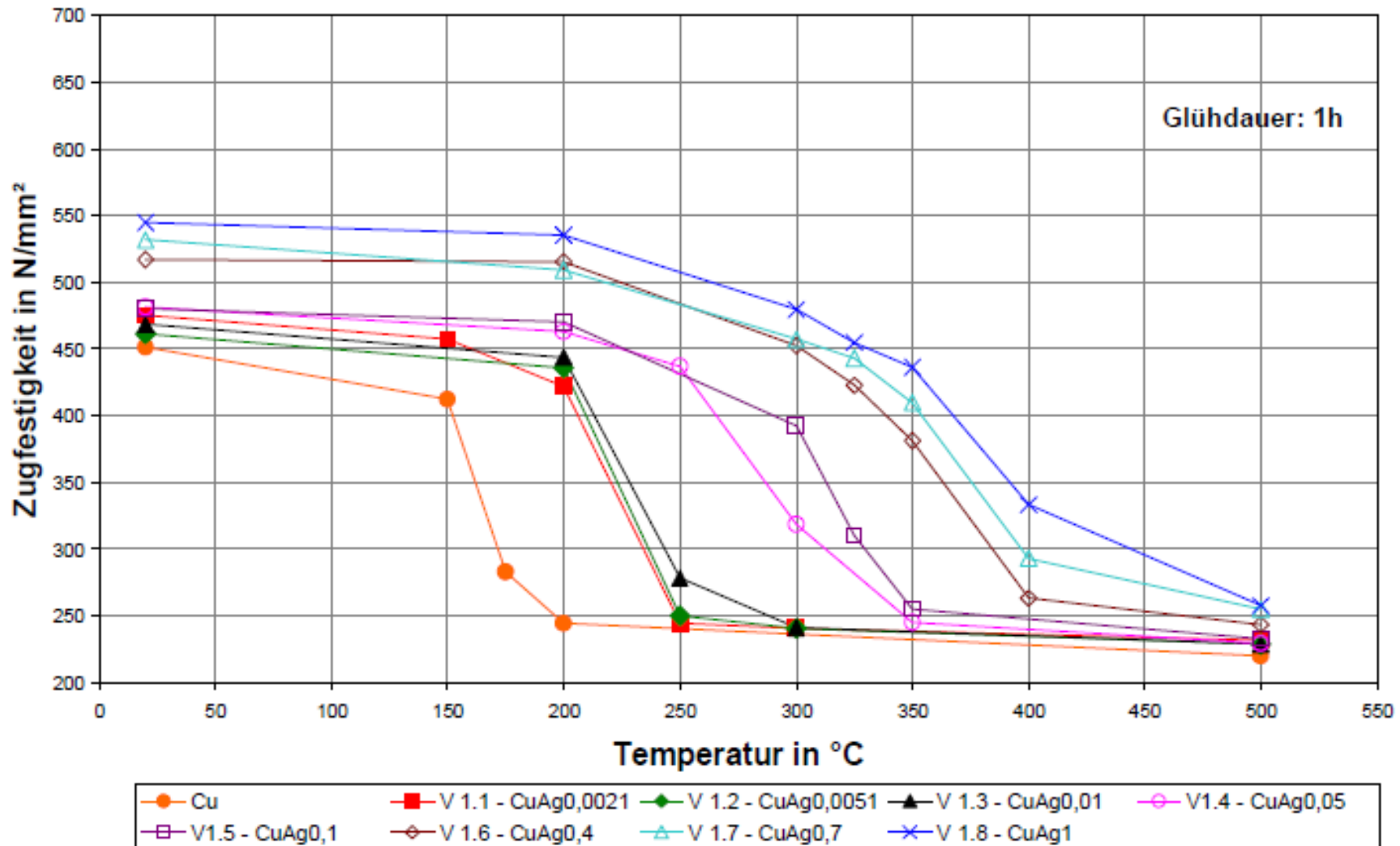


*Estimated 110 to 330 megatonnes
needed for the world energy transition*

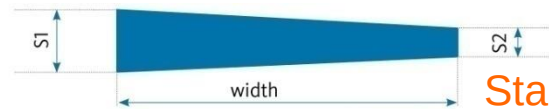
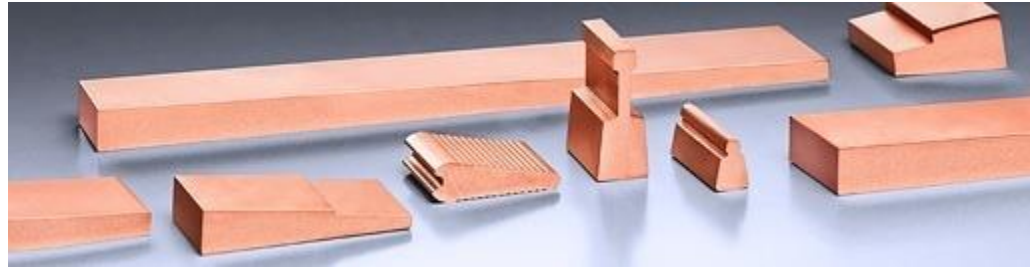


Fabricated copper rotors

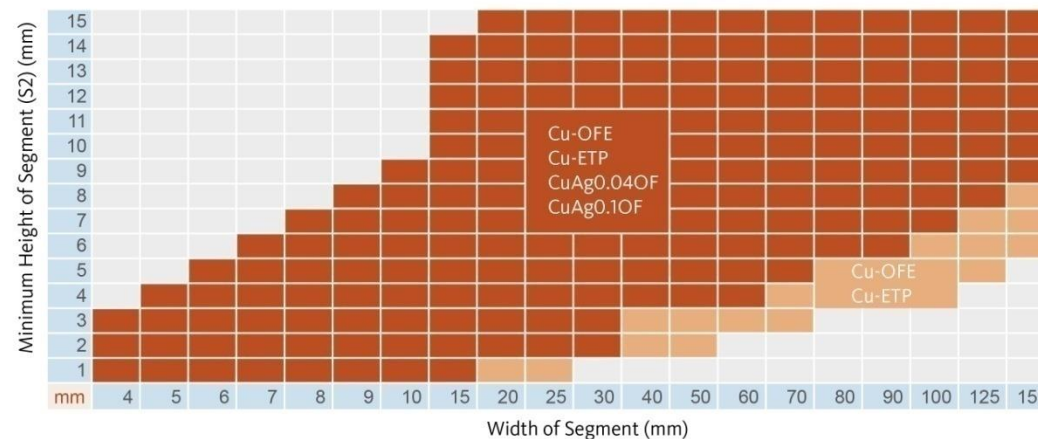
Alloys – Cu vs CuAg



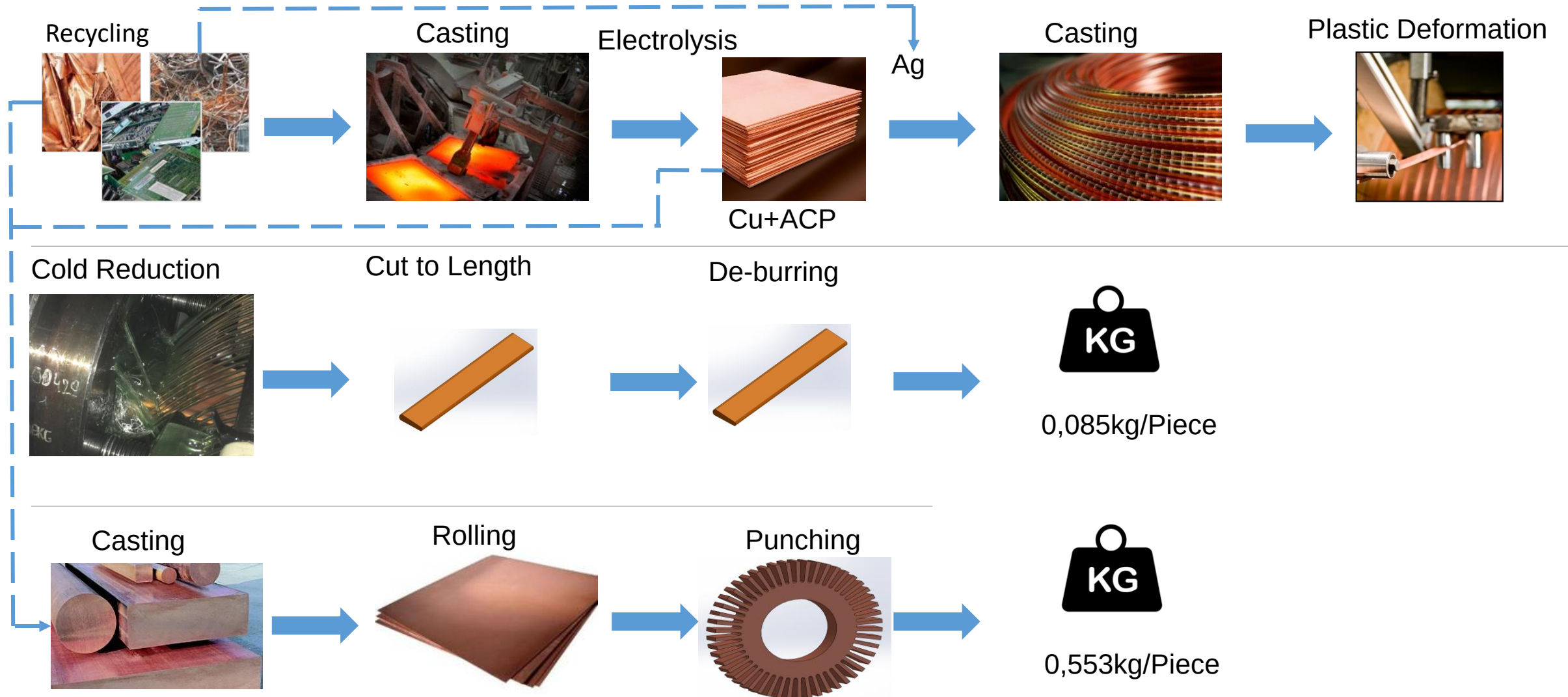
Aurubis Specialities provides a wide range of copper segments from simple to complex designs



Standard Dimensional Range

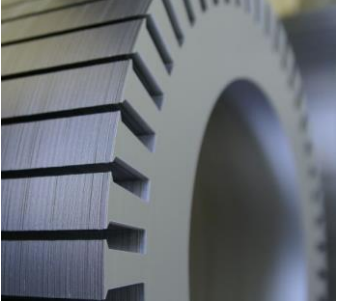


Production Process – Cu Parts

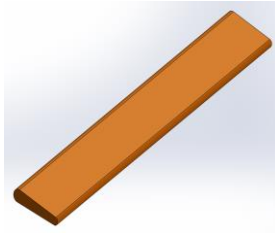


Production Process – Squirrel Cage Assembly

Lamination Stack



Rotor x50



End Ring x2



Assembly +
Soldering



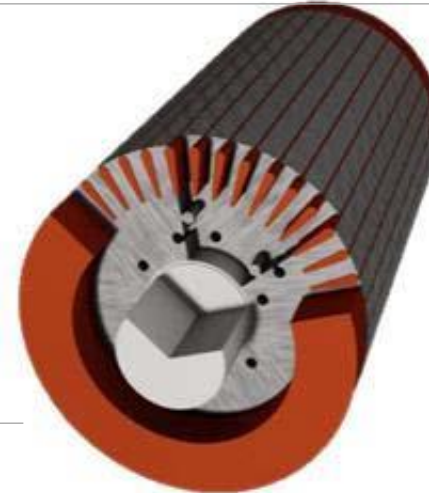
Shaft



Bearings x2 Sets

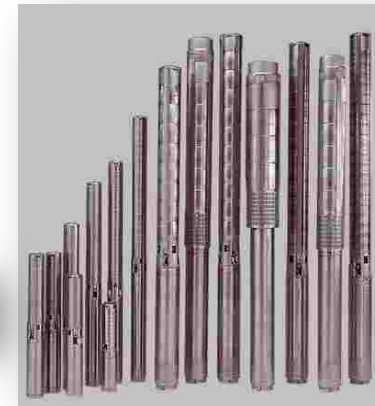
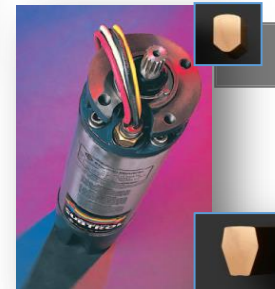
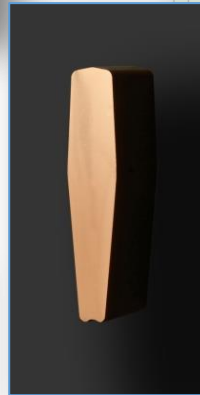
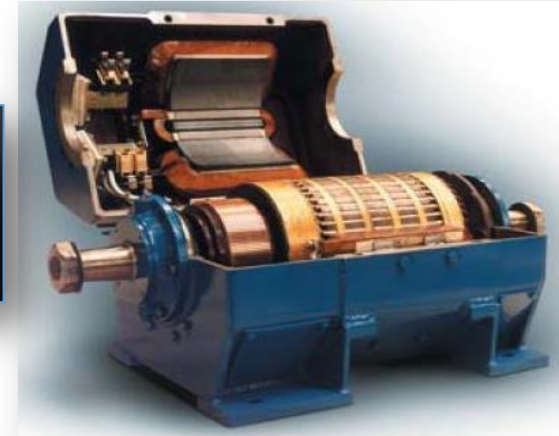
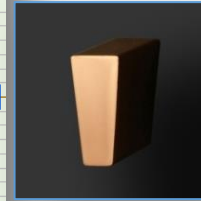
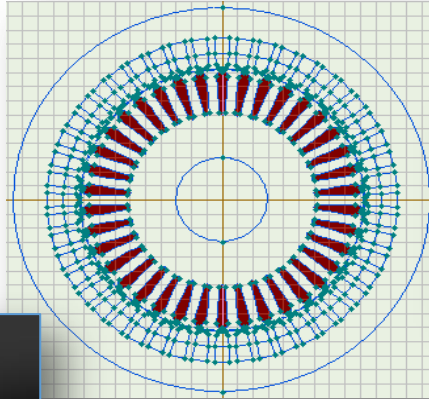
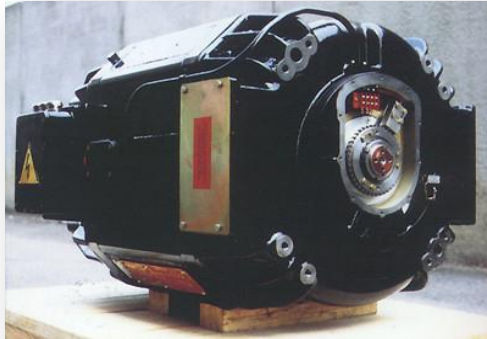


Balancing



Copper Mass:- 5,36kg

Aurubis Bars & Profiles provides constant product quality and cut to lengths



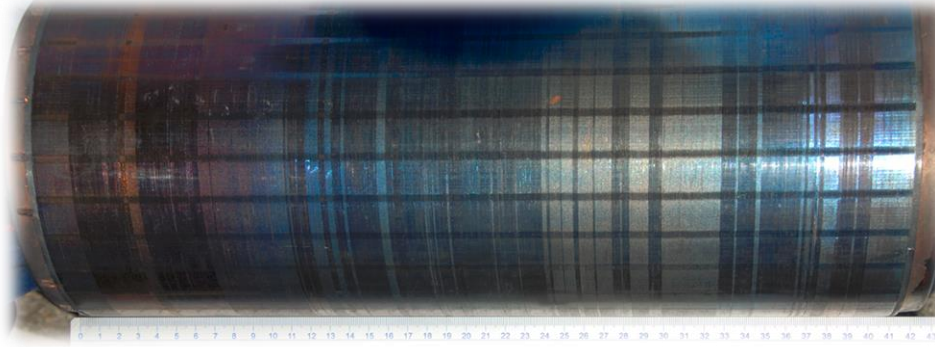


Cast copper rotors

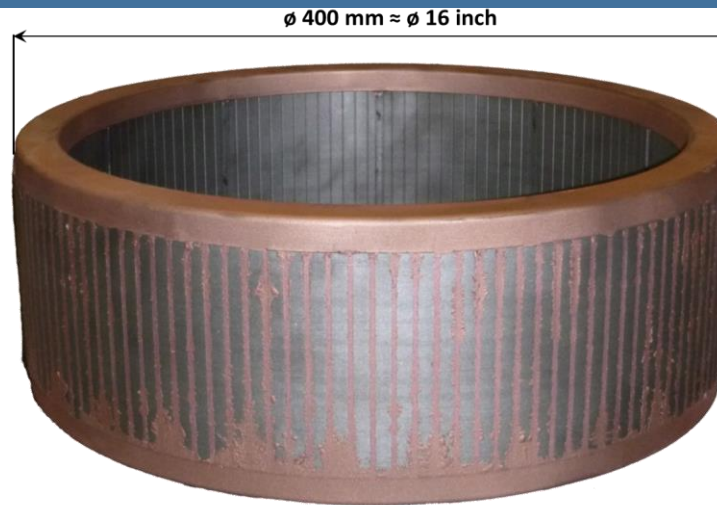
Manufacturing capabilities



**Frame size: 30 – 225
up to ~ 35 kg net
copper weight**



Stack length: 416 mm

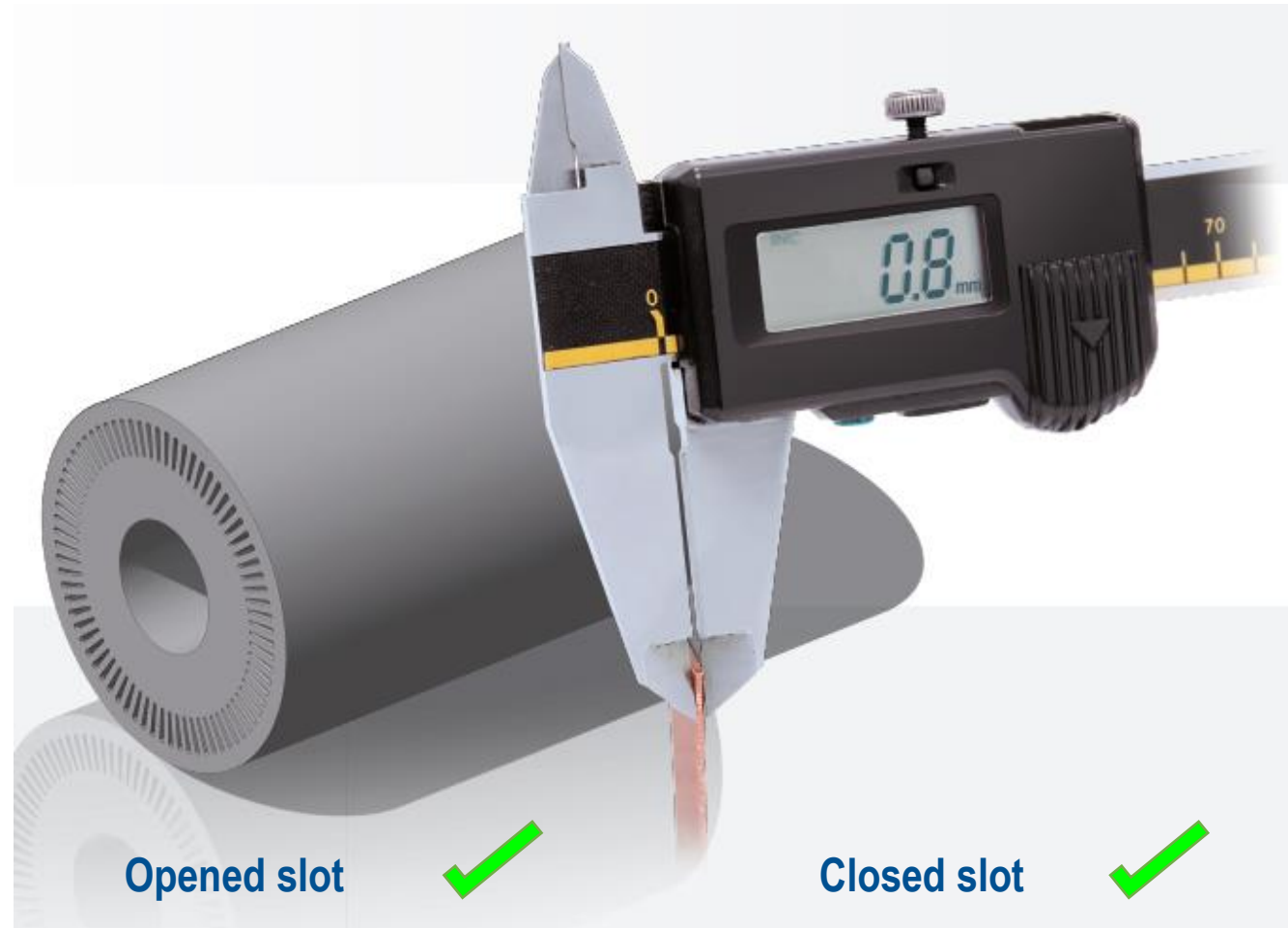


Rotor diameter: 400 mm



**Stack length: 350 mm
Rotor diameter: 55 mm**

Slot width: 0,76 mm
 $L_{Fe} \approx 200$ mm



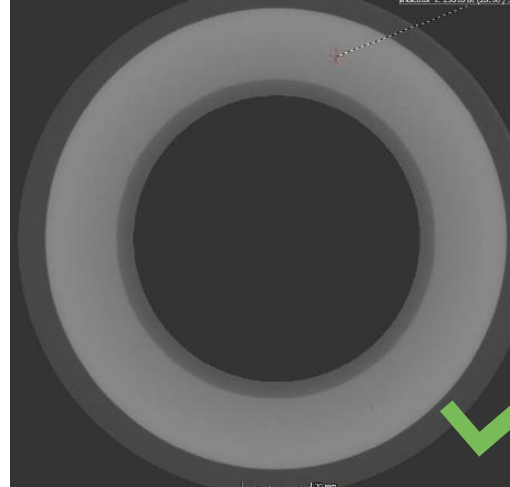
Production Process – Squirrel Cage Casting



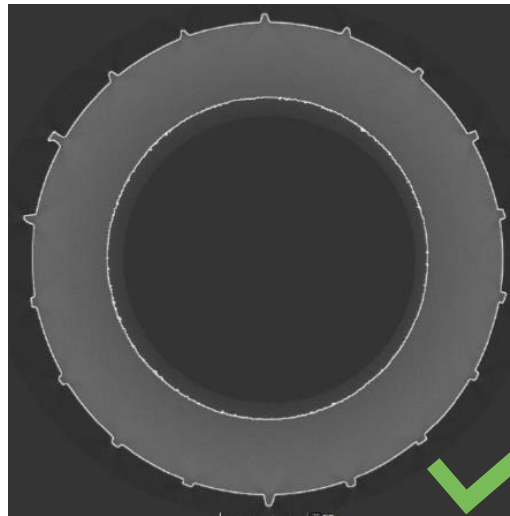
- ❖ Parallel filling of all slots
 - ❖ No entrained air
 - ❖ Perfect connection between slot and end ring
- ❖ Zero Porosity in slots and end rings
- ❖ New quality standard
 - ❖ Higher conductivity
 - ❖ Higher mechanical strength
 - ❖ Higher process stability



Side A
0 %
Porosity



Side B
0 %
Porosity



Fabricated vs Cast

Aspects to consider

Slot Design

Copper Volume in Slots

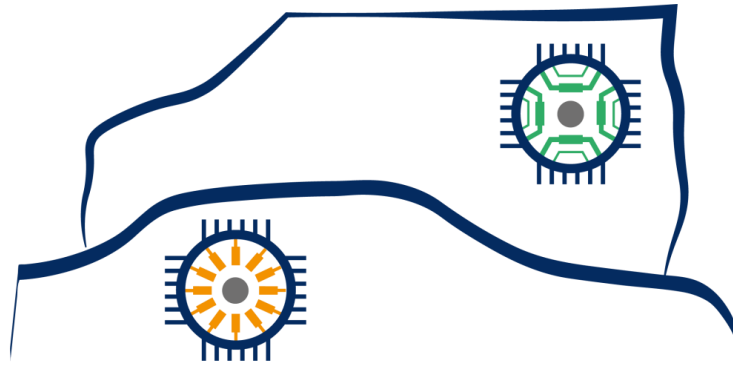
Noise Development in Motor

Production Cost >1000 units

Production Cost <1000 units

Electrical Performance

Mechanical Strength



ReFreeDrive

Thank you very much