

DEWEK 2008

New Direct Drive Turbine WERG-85

using Advanced Cooling with Evaporating CO₂

Benjamin Theobald M. Eng., Prof. Dr.-Ing. Friedrich Klinger
Wind Energy Research Group (WERG)
Saarland University of Applied Sciences

Presentation outline

- Introduction Wind Energy Research Group (WERG)
- The direct drive evolution
- The WERG-85 in-hub generator
- The WERG-85 turbine
- The cooling system
- Tower head mass in comparison

Introduction Wind Energy Research Group (WERG)



Genesys 600 kW, 1997

- 1990 Foundation by Prof. Klinger
- 1997 Developing Genesys 600 kW
- 2000 Foundation Vensys



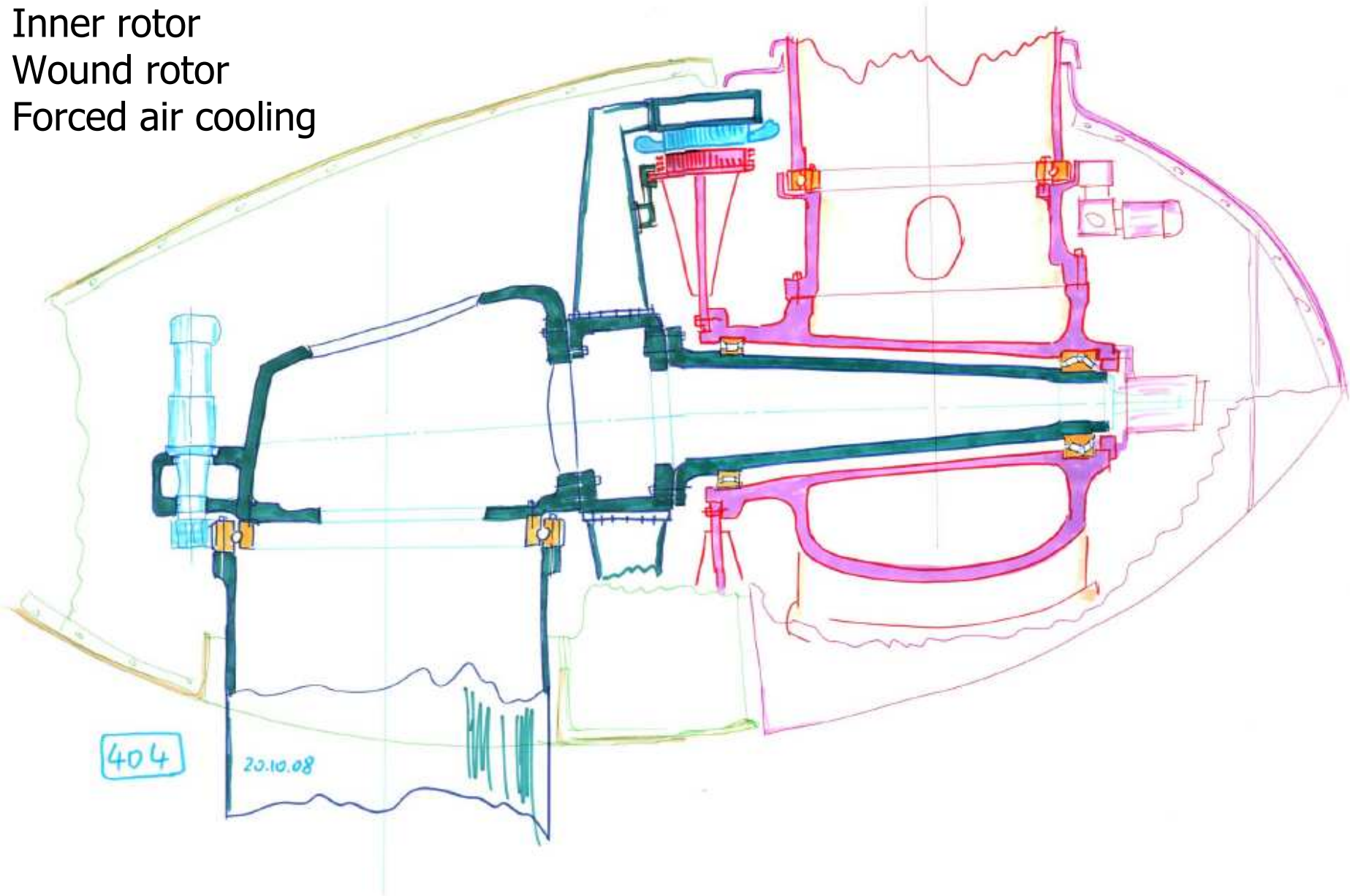
Vensys 62 (1.2 MW), 2003

- 2003 Vensys 62
- 2004/05 Vensys 90
- 2008 Chinese 2 MW
- 2009 European 2.2 MW

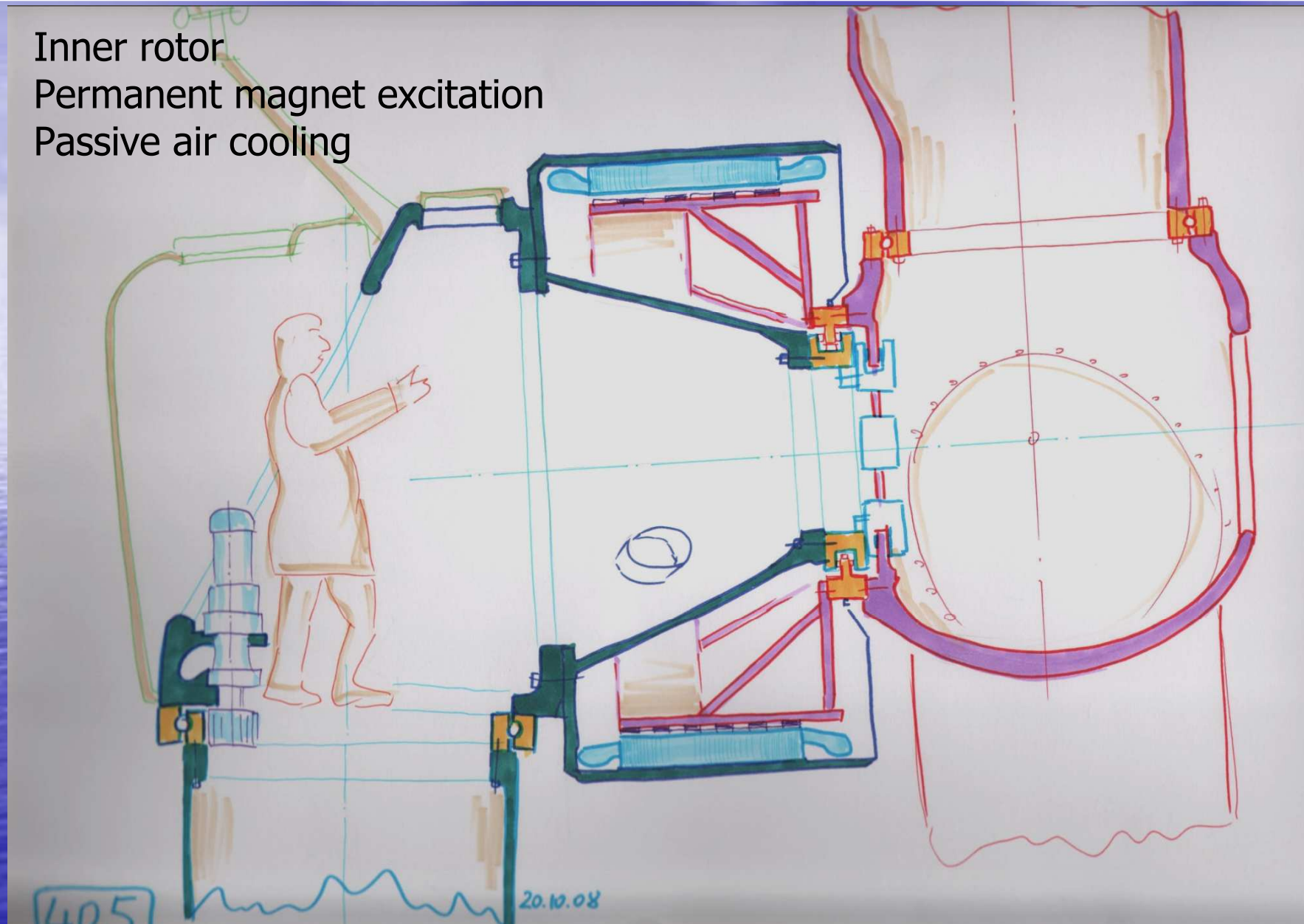
Wind Energy Research Group WERG 2008

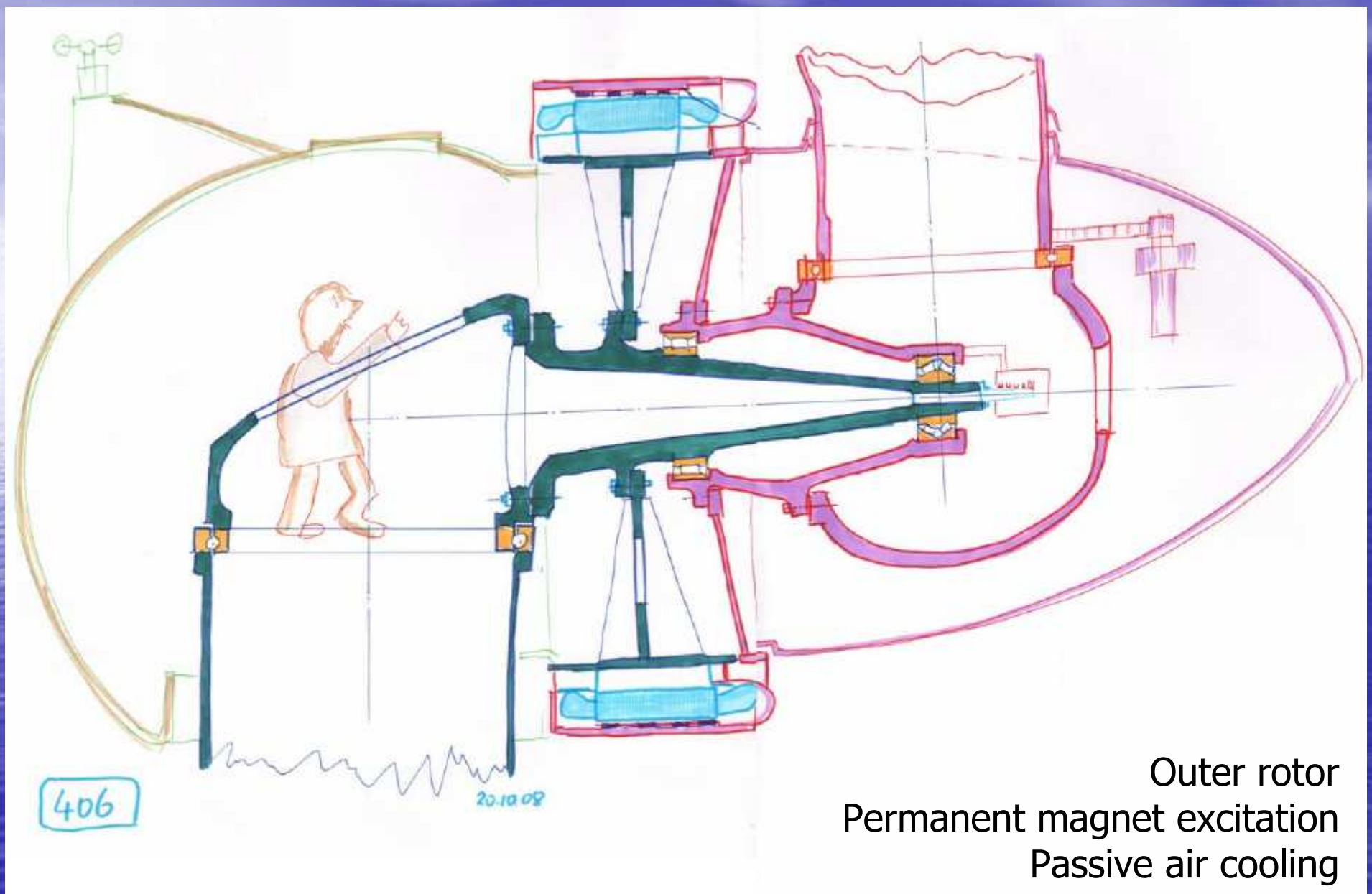


Inner rotor
Wound rotor
Forced air cooling

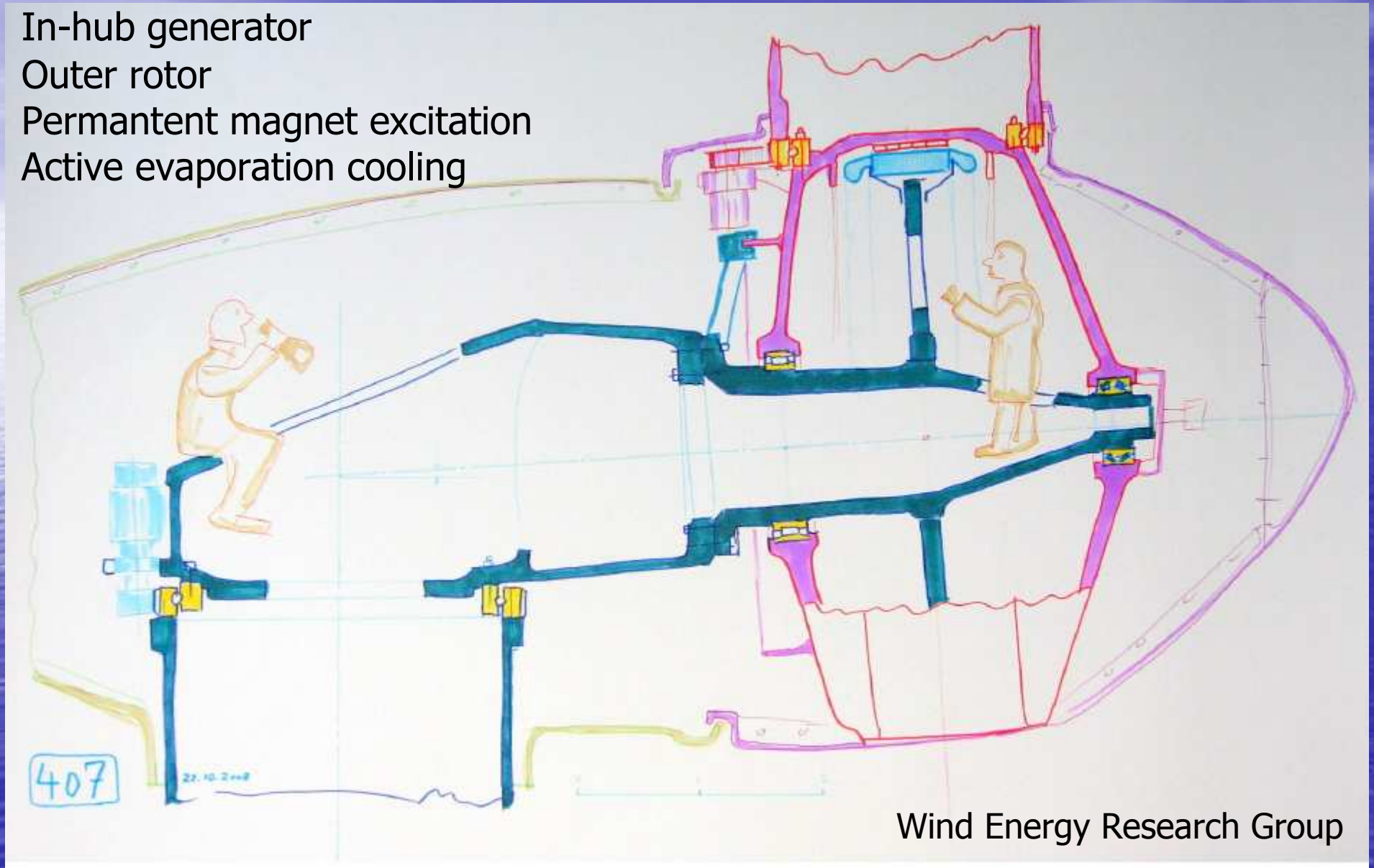


Inner rotor
Permanent magnet excitation
Passive air cooling



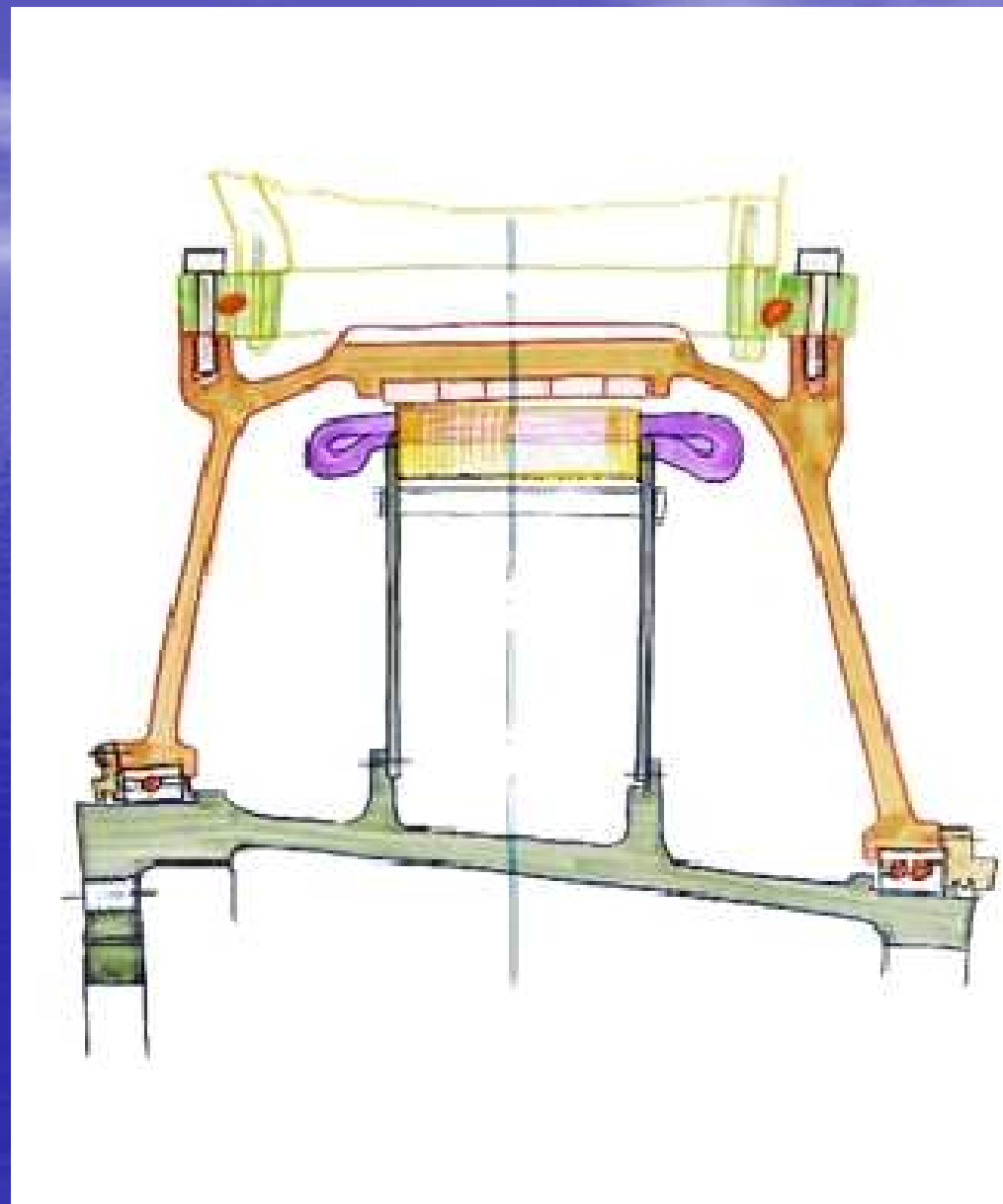
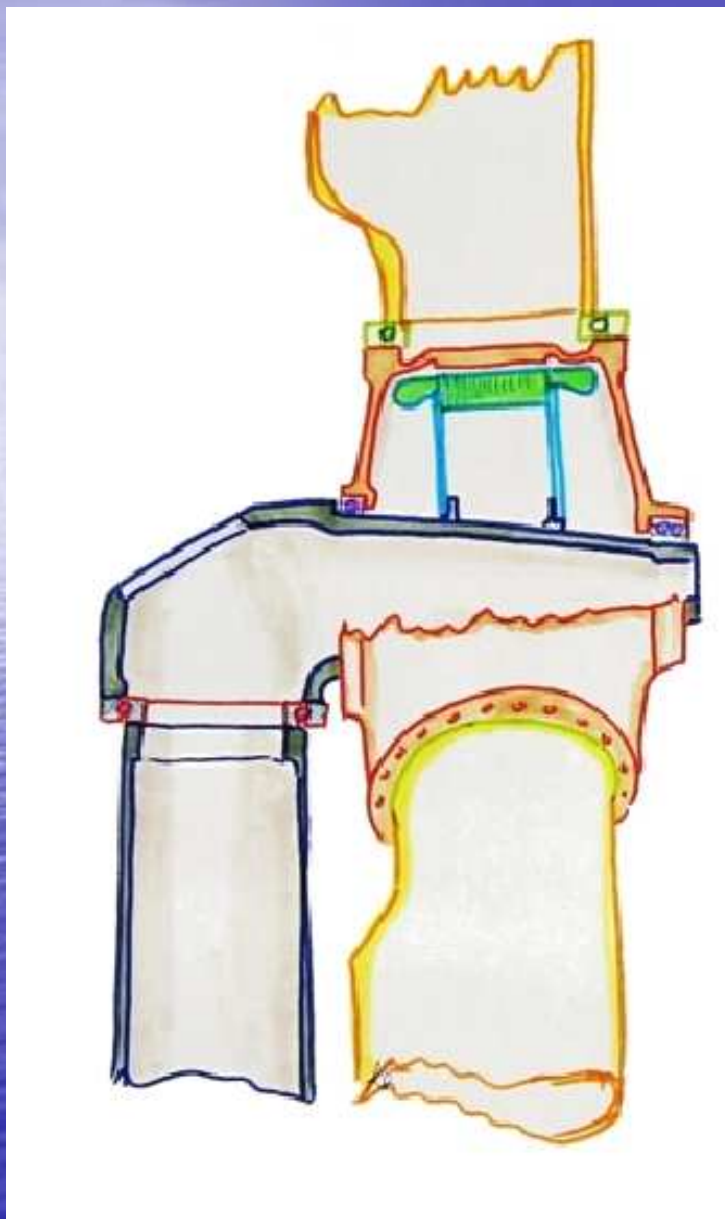


- In-hub generator
- Outer rotor
- Permanent magnet excitation
- Active evaporation cooling

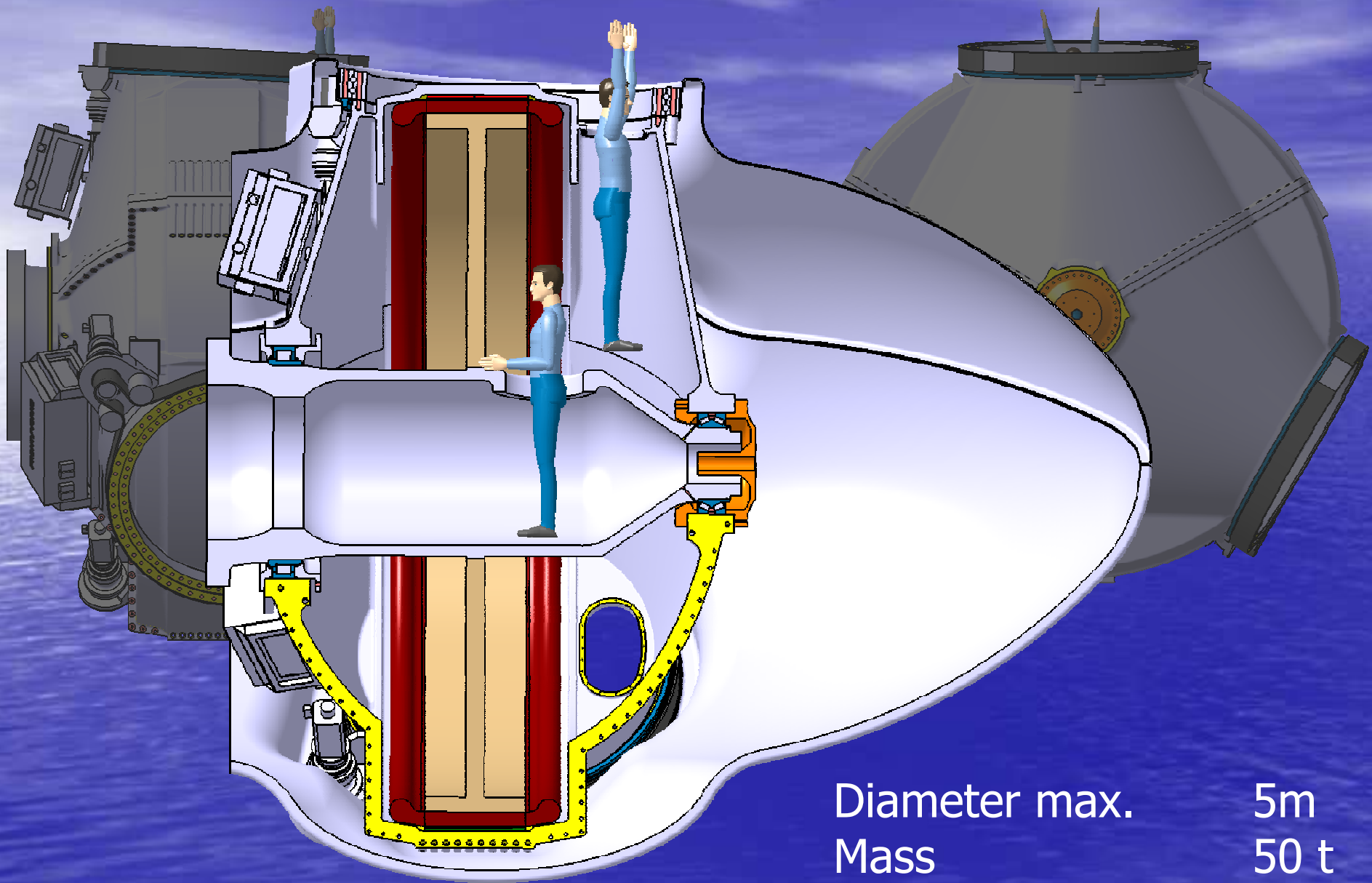


Wind Energy Research Group

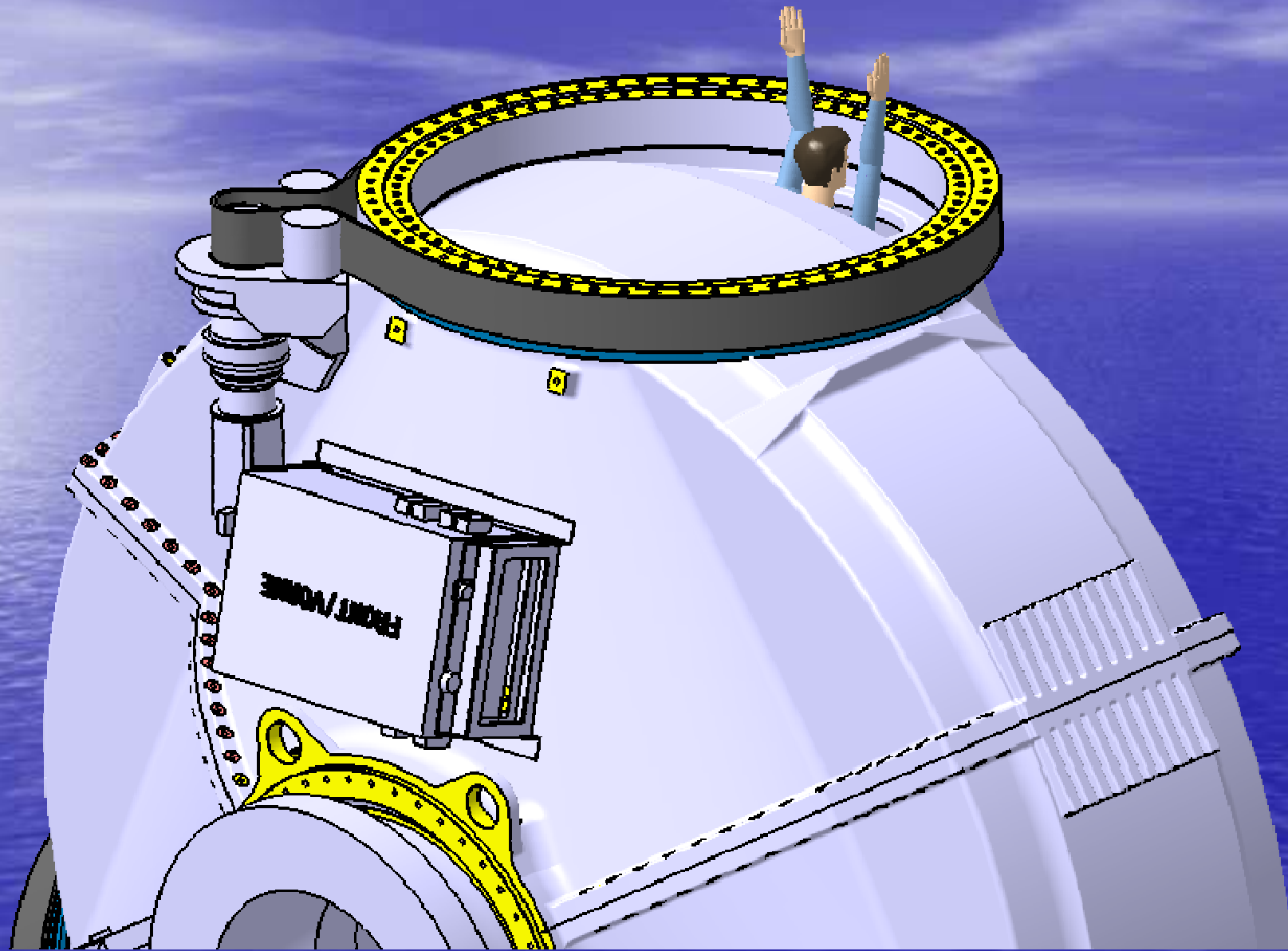
The in-hub generator concept



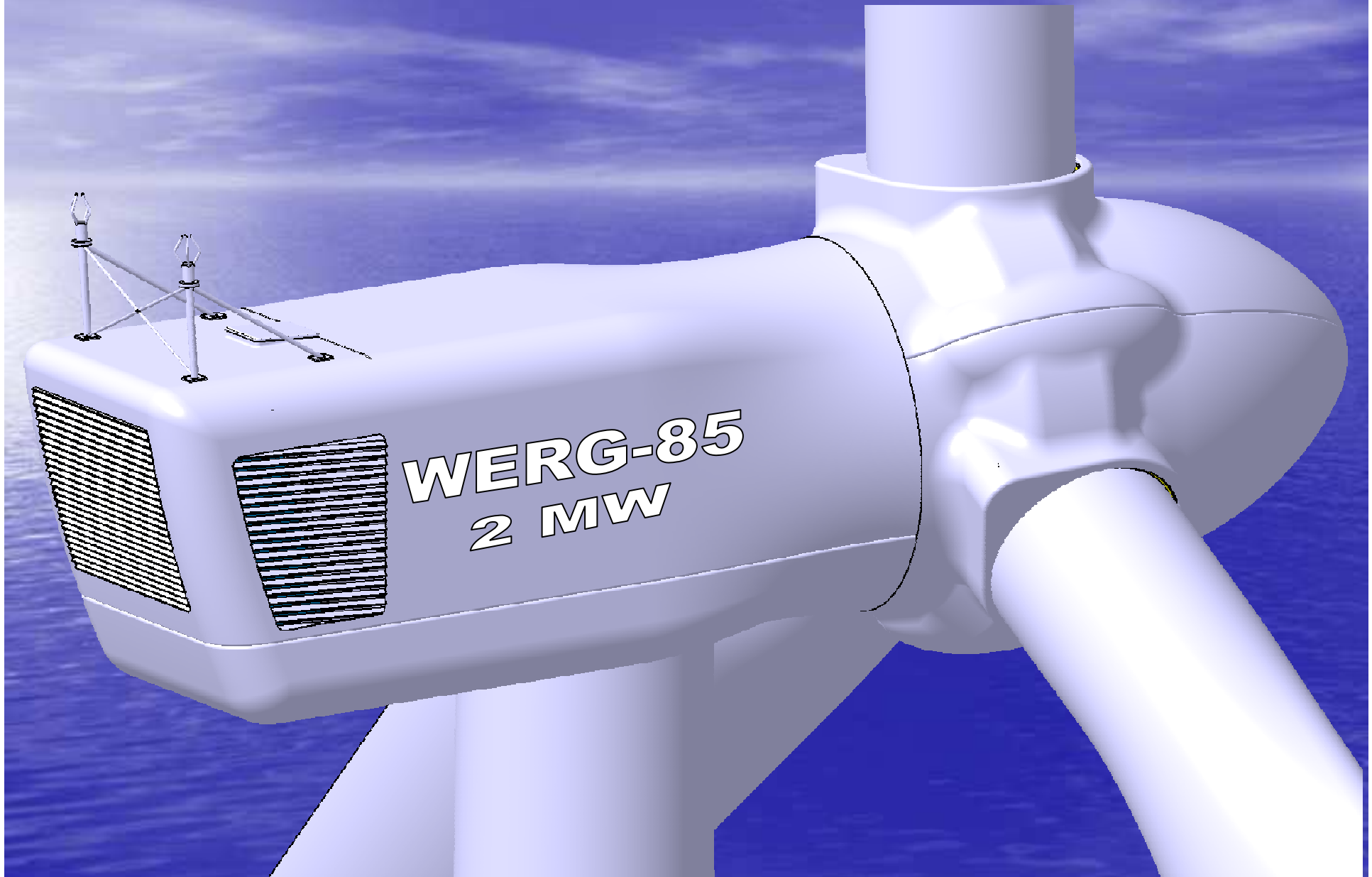
The in-hub generator WERG-85



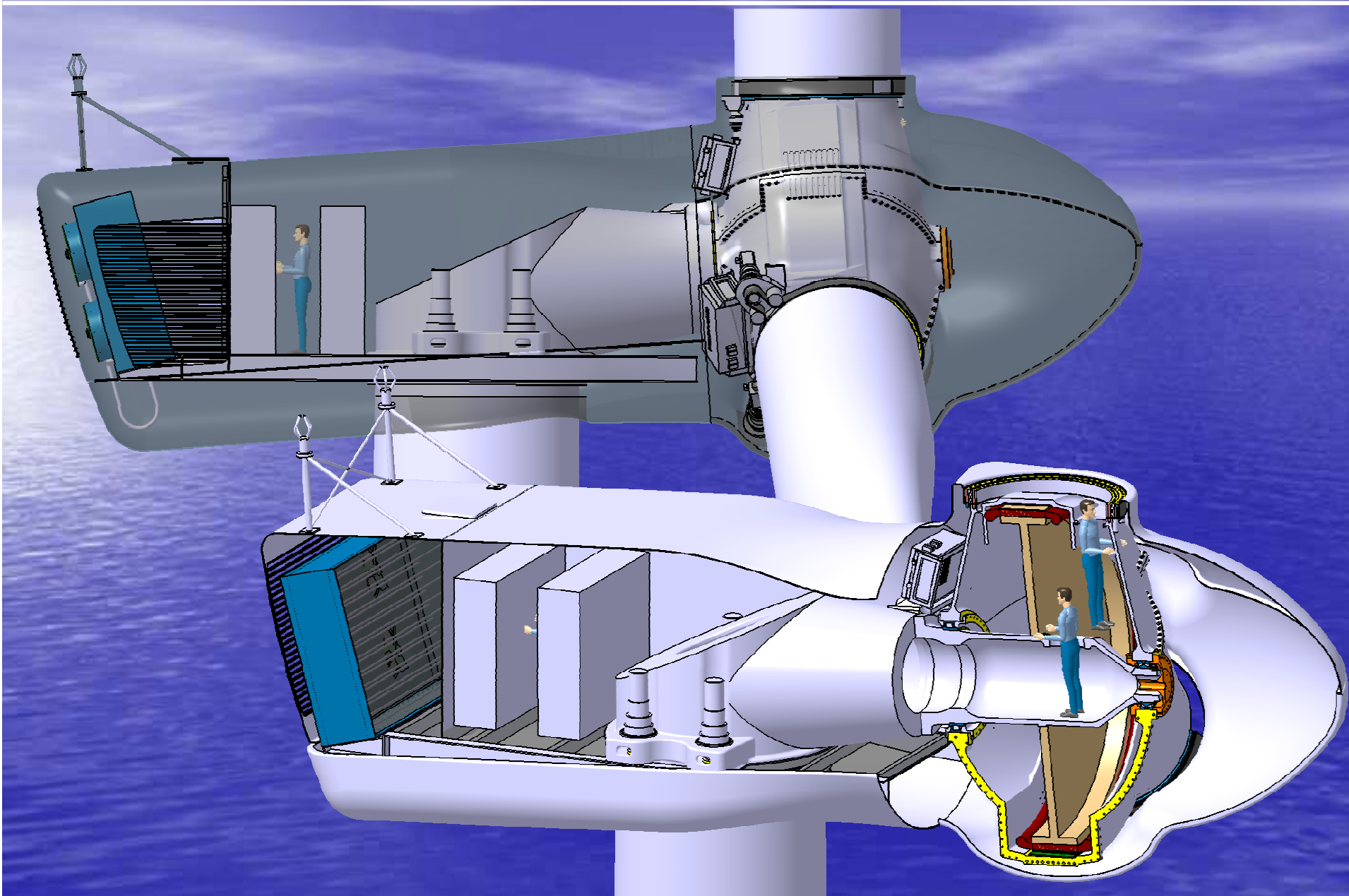
Tooth belt pitch drive



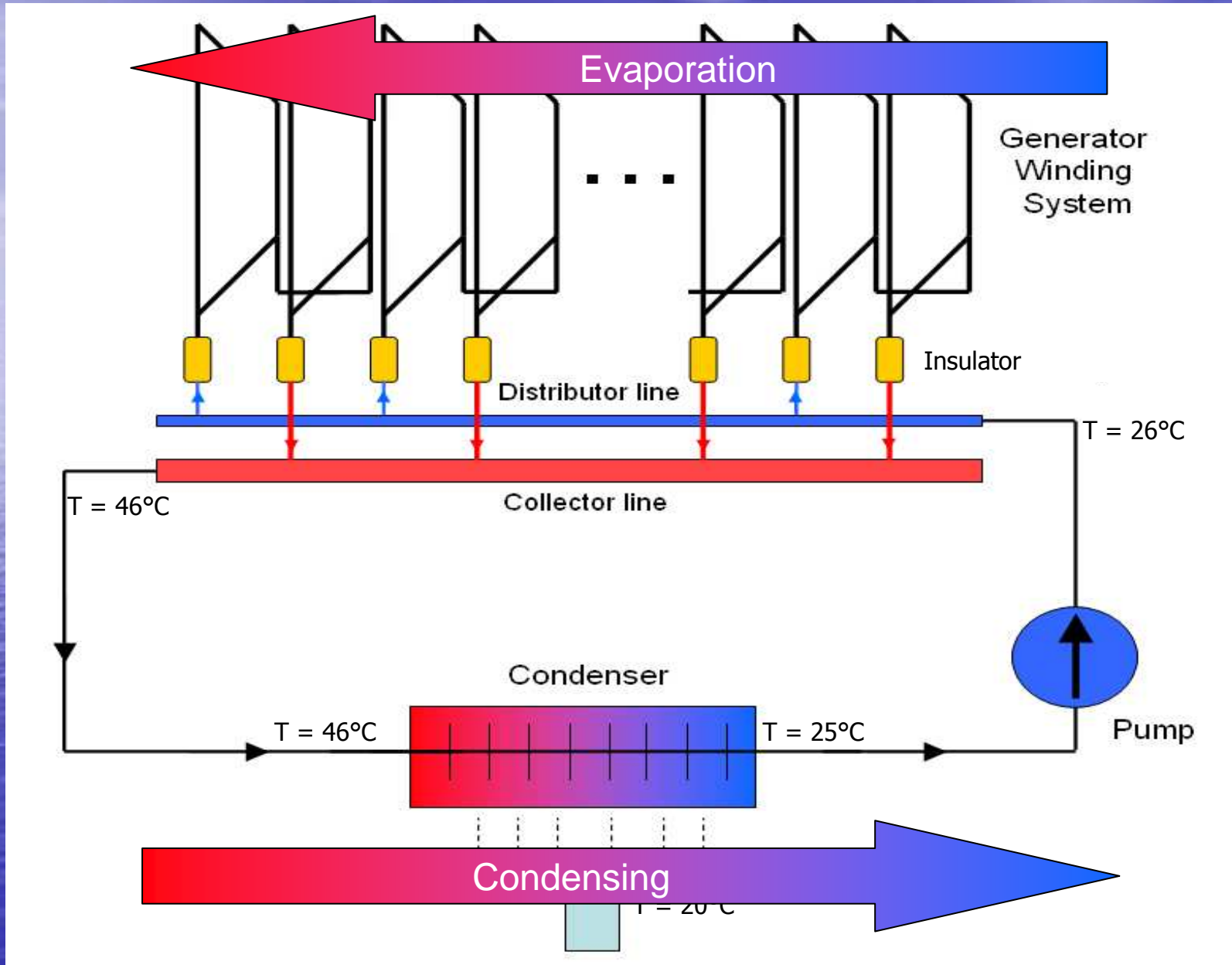
WERG-85 turbine



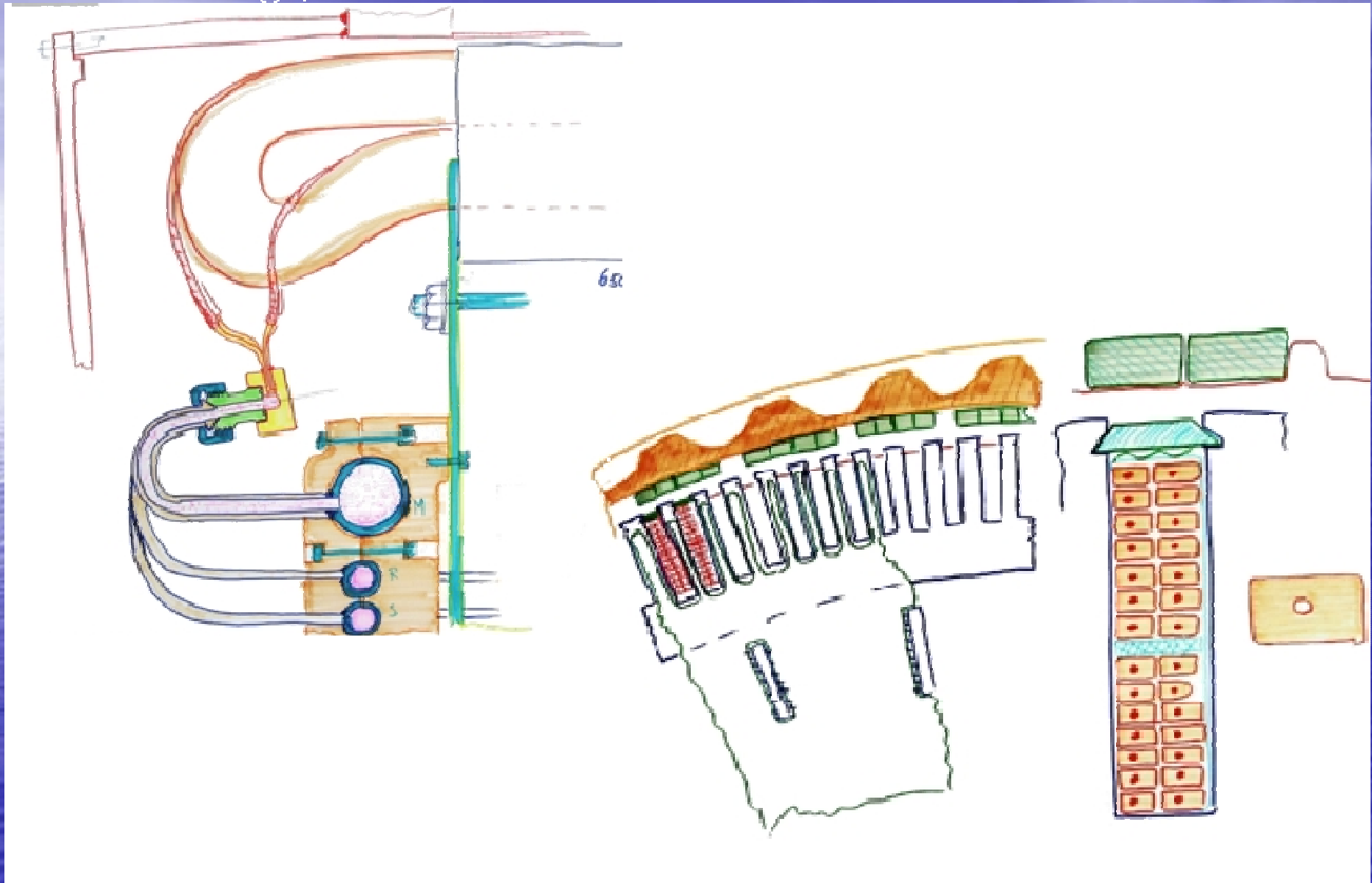
WERG-85 turbine



Principle of the new cooling system using CO₂



Hollow conductor winding system



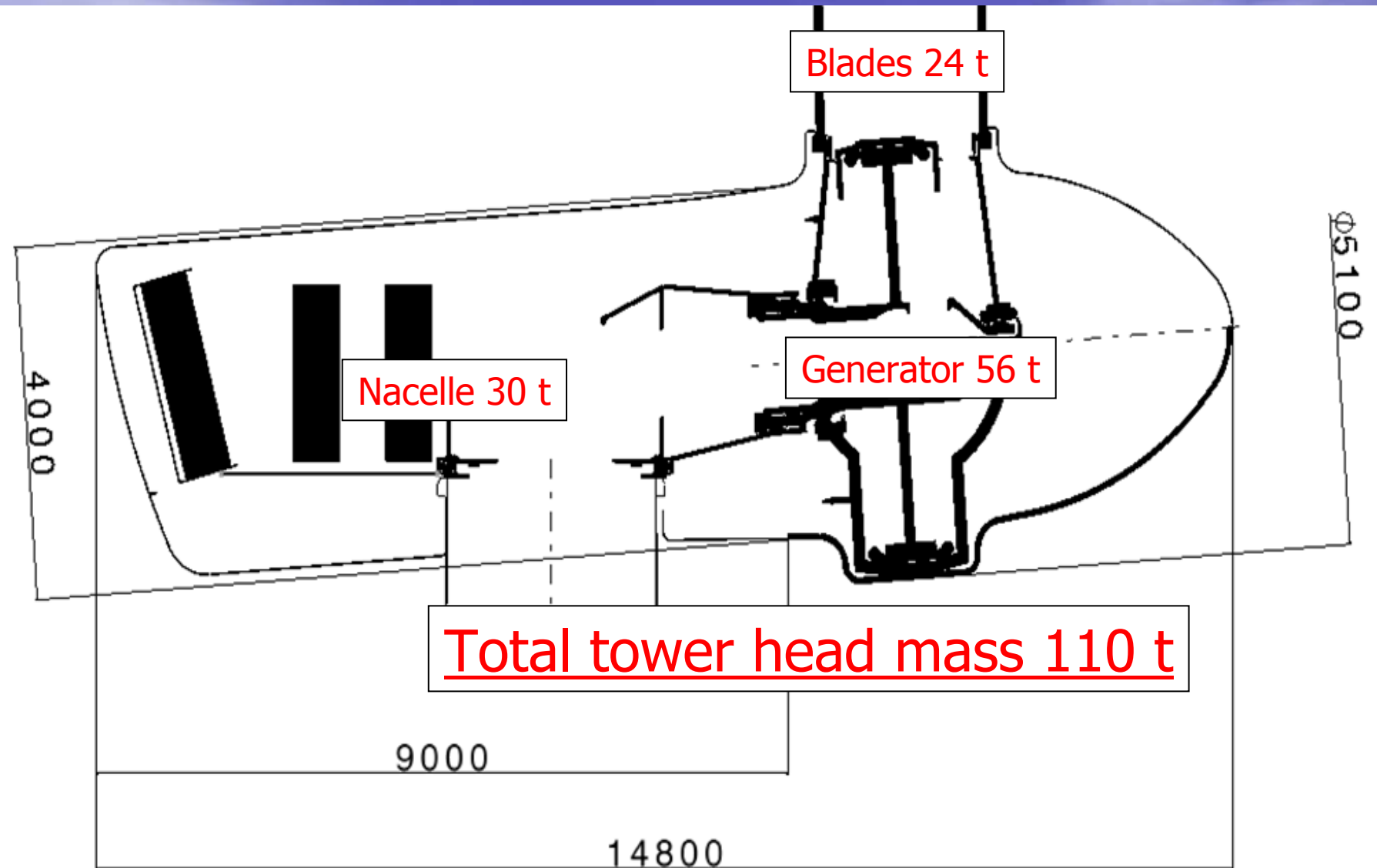
Advantages of in-hub generator WERG-85

- Direct drive
 - > no gearbox problems
- Permanent magnet
 - > no energy for excitation
- Advanced bearing concept
 - > minimized air gap deformation
- Reliable pitch system using tooth belt
 - > nearly no maintenance
- Pitch control boxes can be reached from nacelle
 - > maintenance friendly

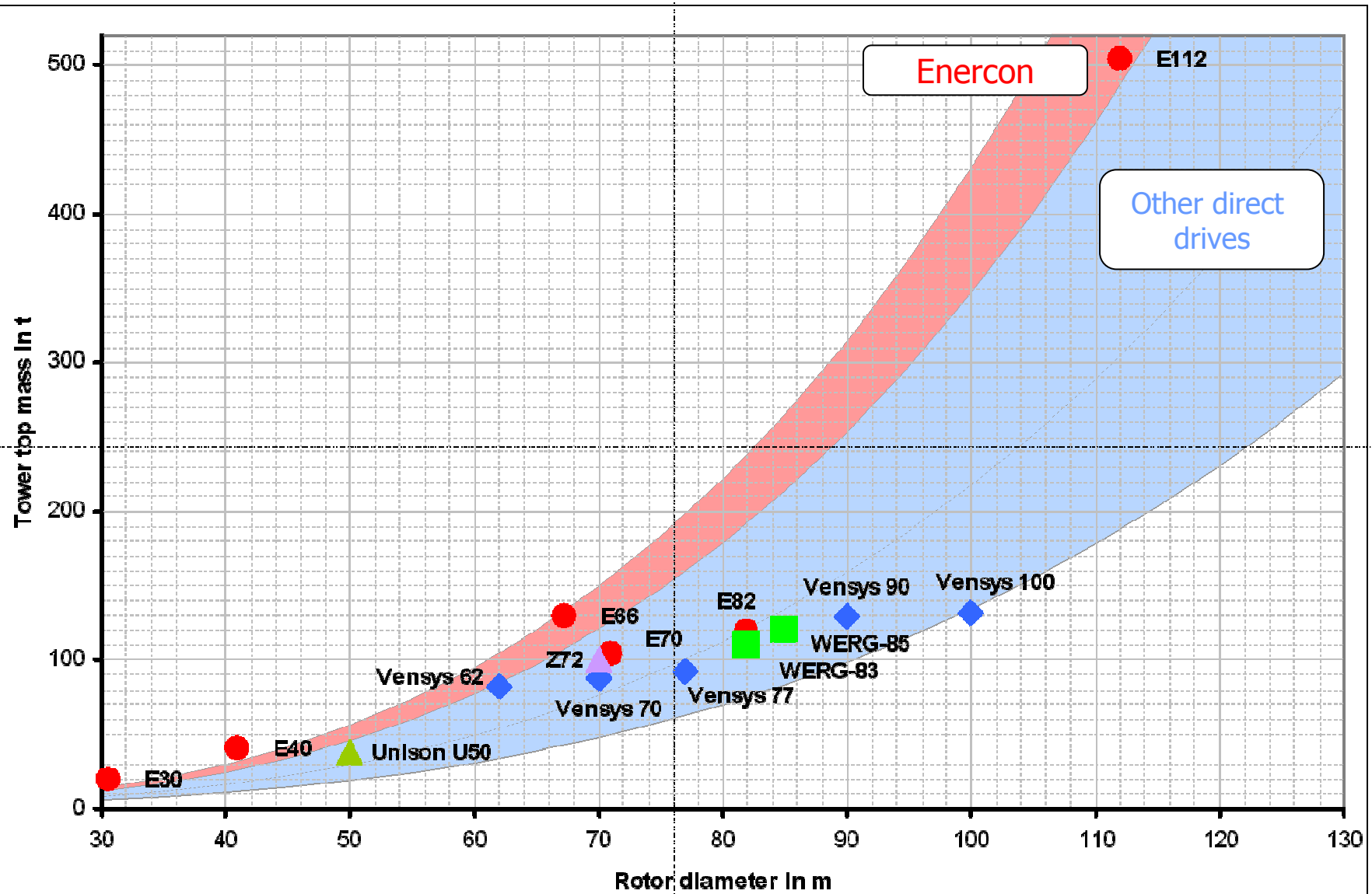
Advantages of CO₂ cooling

- Compact, fully closed generator
 - > *No corrosive ambient air in generator*
 - > *ideal for offshore application*
- Low winding temperature level
 - > *Increased winding life time*
 - > *Reduced winding ohmic resistance*
- CO₂ evaporates in hollow conductors
 - > *No hot spots*
 - > *heat is directly absorbed where it is produced*
 - > *Low winding temperature*
 - > *Increased lifetime of insulation*

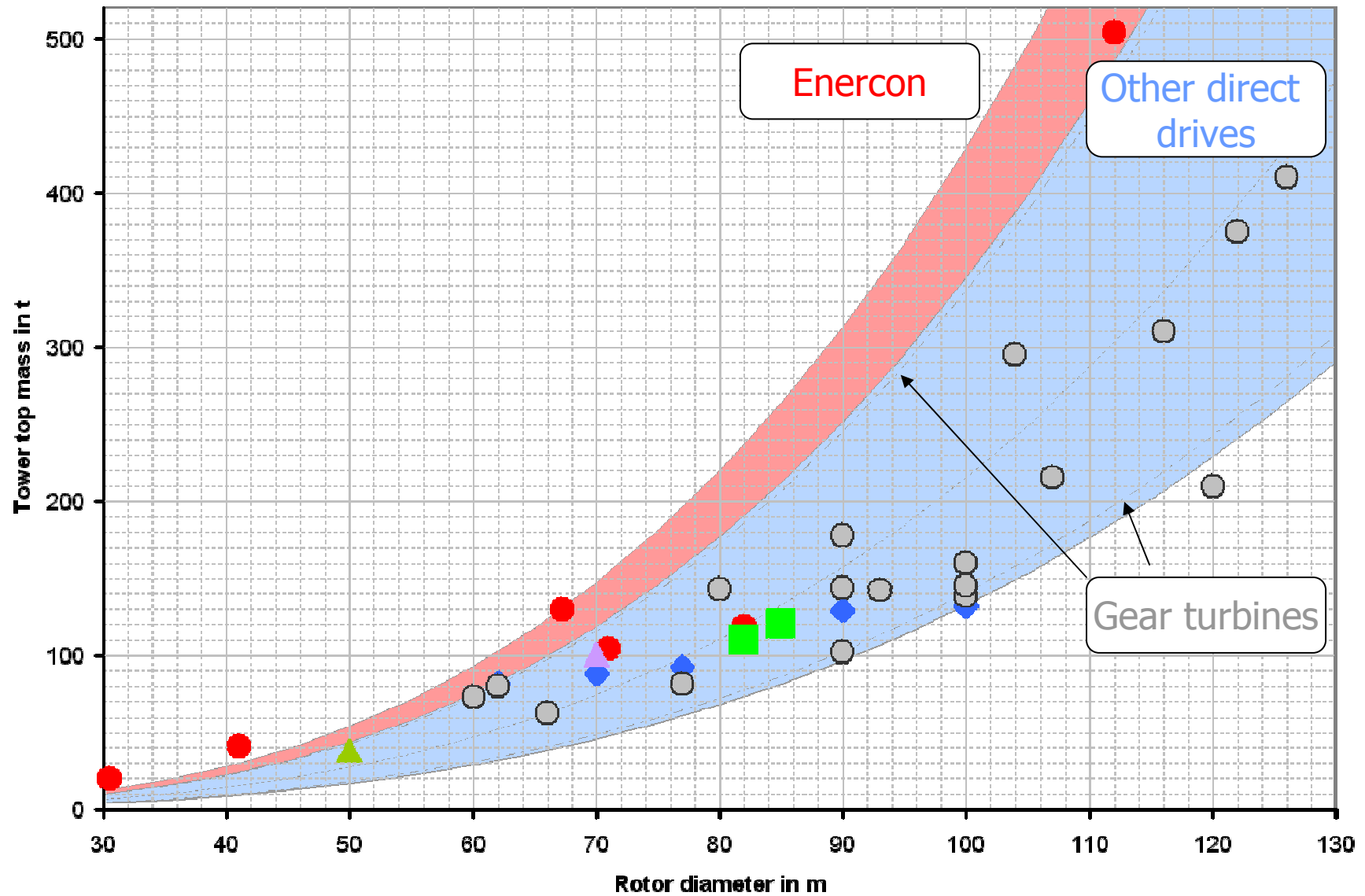
Total tower head mass WERG-85 110 t



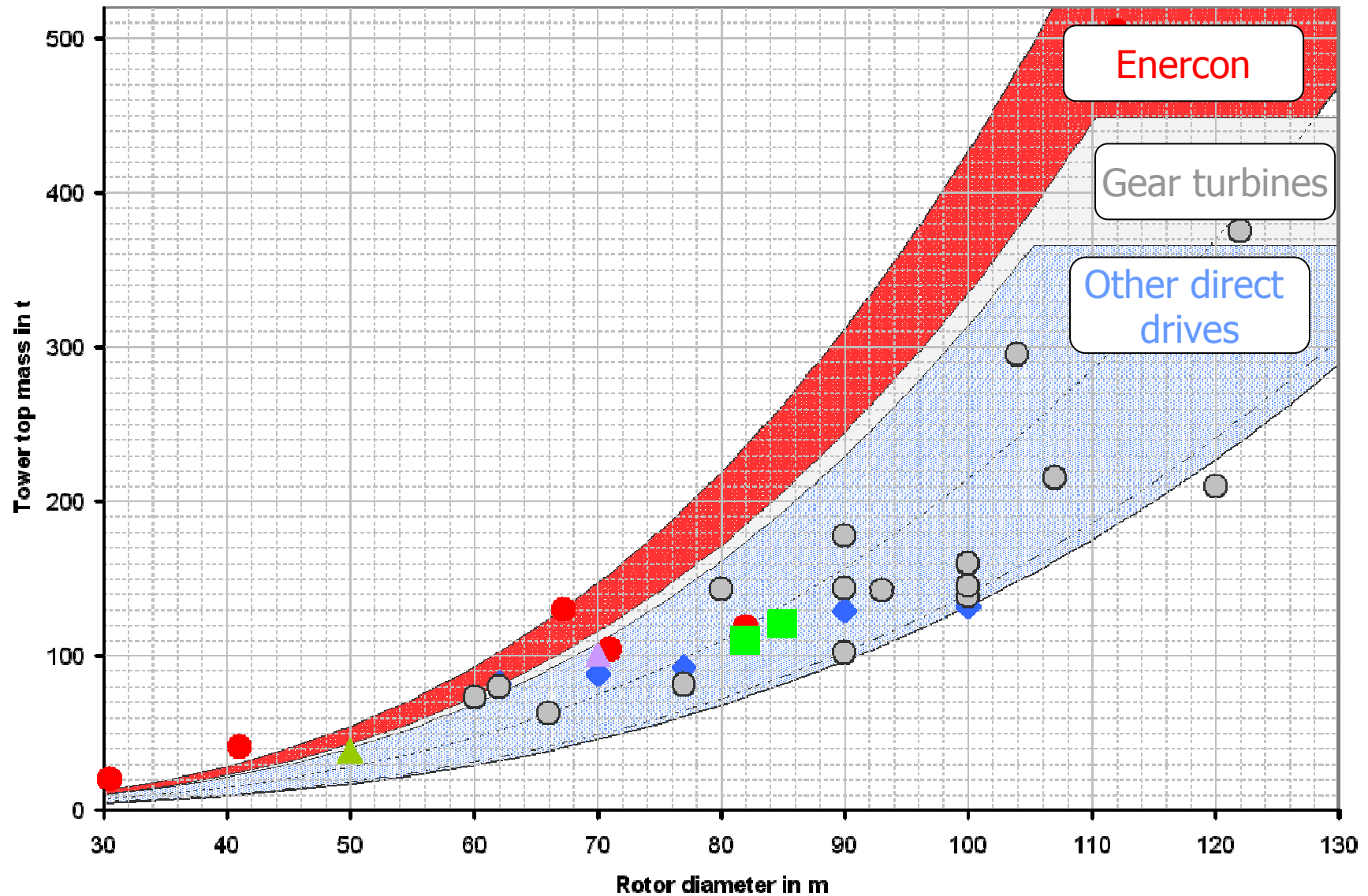
Tower head masses of direct drives



Tower head masses in comparison



Tower head masses in comparison



Direct drive turbine market players

Player	Country	Rotor diameters
• Enercon	Germany	40, 53, 66, 70, 82, 112, 126
• Vensys	Germany	62, 70, 77, 90, 100
– Goldwind		
– CKD		
– Eozen		
– Impsa		
– India		
• Zephyros	Netherl.	70
– Harakosan		
– XEMC		
• Leitwind	Italy	62, 70, 77
• MTorres	Spain	82
• Impsa	Argentina	
• Mitsubishi	Japan	75
• Unison	Korea	50, 54, 57
• Scanwind	Norway	
• Siemens	Germany (!)	

Thanks for your attention!

Contact:

Wind Energy Research Group
Saarland University of Applied Sciences

Postage Address:	Altenkesseler Str. 17/D2 66115 Saarbrücken, Germany
Phone	+49 681/970 425 0
Fax	+49 681/970 425 28
Email	info@wind-energy-research.de
Homepage	www.wind-energy-research.de