



Further development of ENERCON's de-icing system

Winter Wind, Skellefteå, 2012-02-07

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Site Assessment

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Griessee: 1x E-70, 2465 m.a.s.l. – Europe's highest turbine



Photo: Swisswinds/ SIG

- **Unbalance of rotor blades** lead to oscillations causing higher loads and probably shut down.
- **Ice pieces can fall down** in a reasonable radius around the WEC.
- Degradation of aerodynamic efficiency resulting in **decreased yield**.
- **Total stop** of yield production due to ice detection.
- **Operating turbines in cold climate is not an easy task!**

- The ENERCON de-icing system is based on a **simple yet powerful idea** (hot air inside the blades).
- All parts can be **changed within hours** from failure by a technician.
- The technic is **well proven for years**. Third party validation available from Deutsche WindGuard.
- **All new models will have this feature** as an option.
- **It works great!**

- ENERCON's de-icing system **is not affected by lightning strikes.**
- **No crane is needed** to repair or perform maintenance work on the system.
- Air flow is limited to a specific area of the blade but **will heat the whole volume** it travels in.
- **No enhanced risk for electrical malfunction** in or outside of the blade.
- **The amount of possible problems is very low!**

- ENERCON's de-icing system can be **repaid in just a couple of months** (depending on the site).
- Spare parts are cheap and can be installed, changed, up-dated and repaired with **very small effort**.
- Costs for maintaining the de-icing system are **very low**.
- **It's a cheap way of increasing the availability!**

- ENERCON's first ice detection and de-icing system was installed in 2004.
- During 2009 – 2010 ENERCON added de-icing during operation of the turbine. This was a huge improvement.
- According to the validation performed by Deutsche WindGuard our customers can estimate to minimize the icing losses and **gain 10 – 15 % in annual energy production** due to the efficient de-icing system during operations.
- **On severe icing sites the gain from minimized icing losses can even add up to 25% of additional energy yield.**

Test of rotor blade de-icing system performance

The efficiency of the rotor blade de-icing system has been tested for 5 months in winter 2009/2010 in locations at

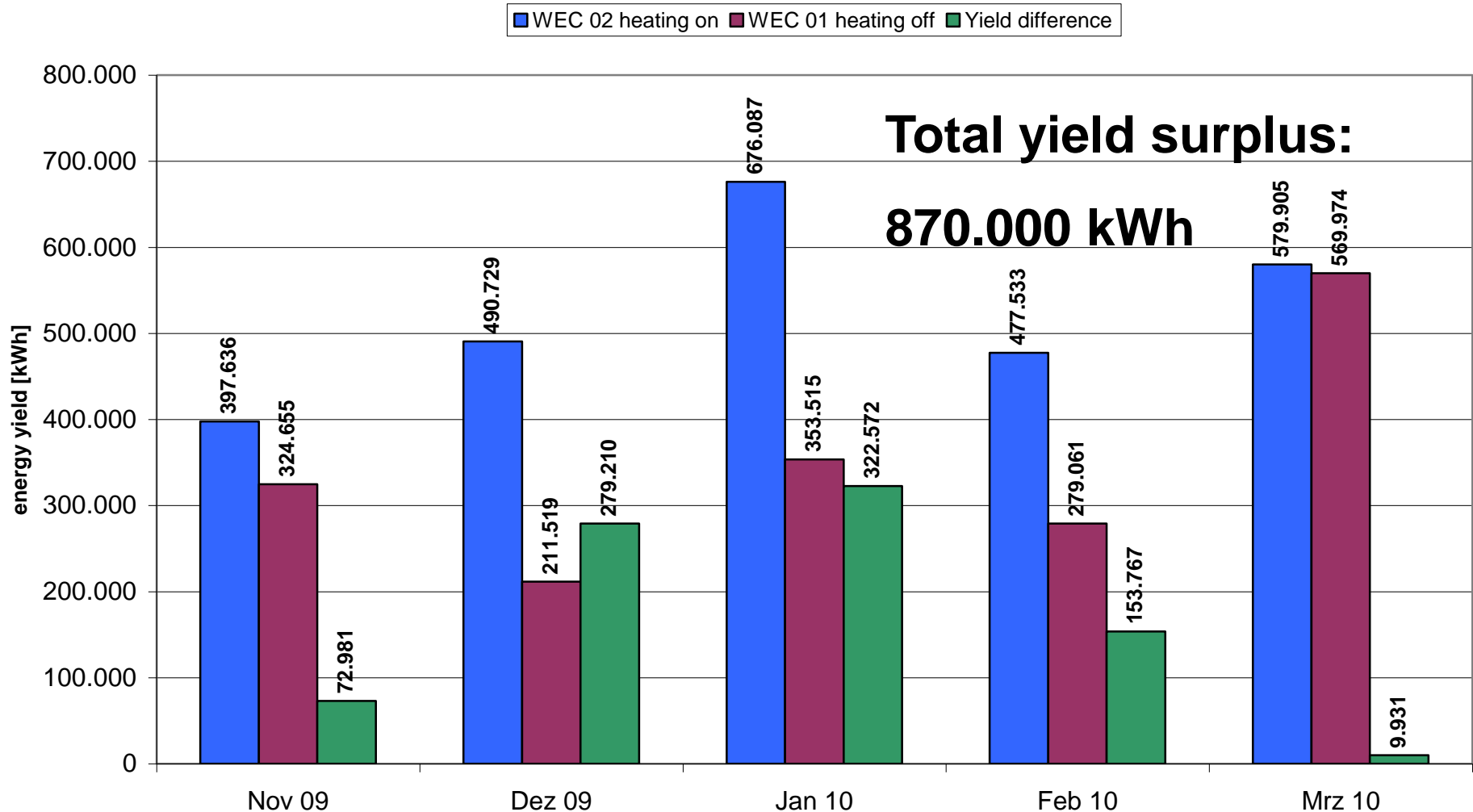
- a) Dragaliden in Sweden and
- b) Krystofovy-Hamry in Czech Republic.

On both locations 2 WECs E-82 2 MW have been compared. Both WECs are located next to each other.

On one WEC the rotor blade heating was activated while it was deactivated on the other WEC.

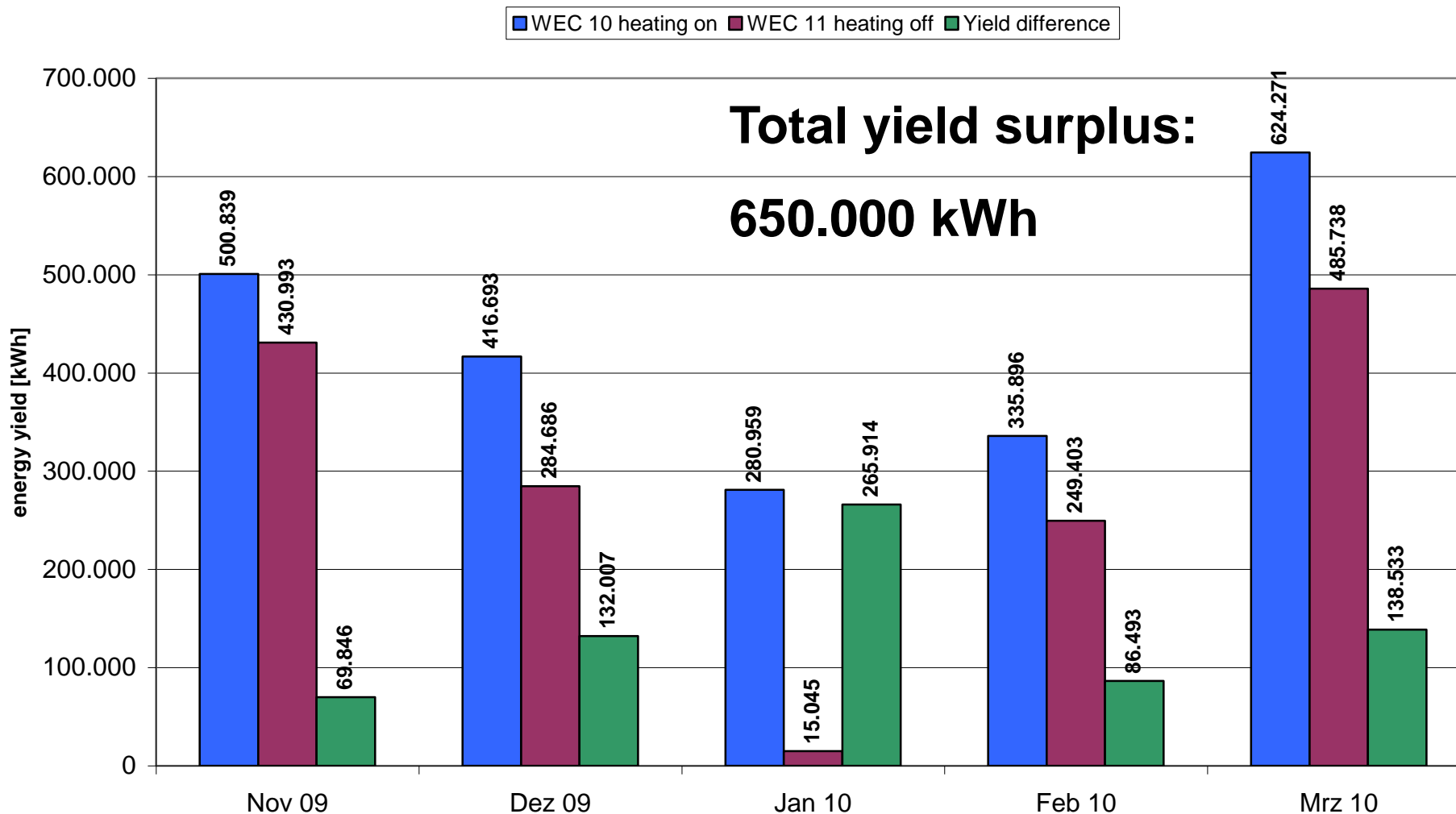
Energy yield surplus due to Rotor blade de-icing Dragaliden energy meter readings

Difference in yield per month between heated and unheated WEC E-82 2MW at location in Dragaliden (SE)



Energy yield surplus due to Rotor blade de-icing in Krystofovy-Hamry (CZ), energy meter readings

Difference in yield per month between heated and unheated WEC E-82
2MW at location in Czech Republic

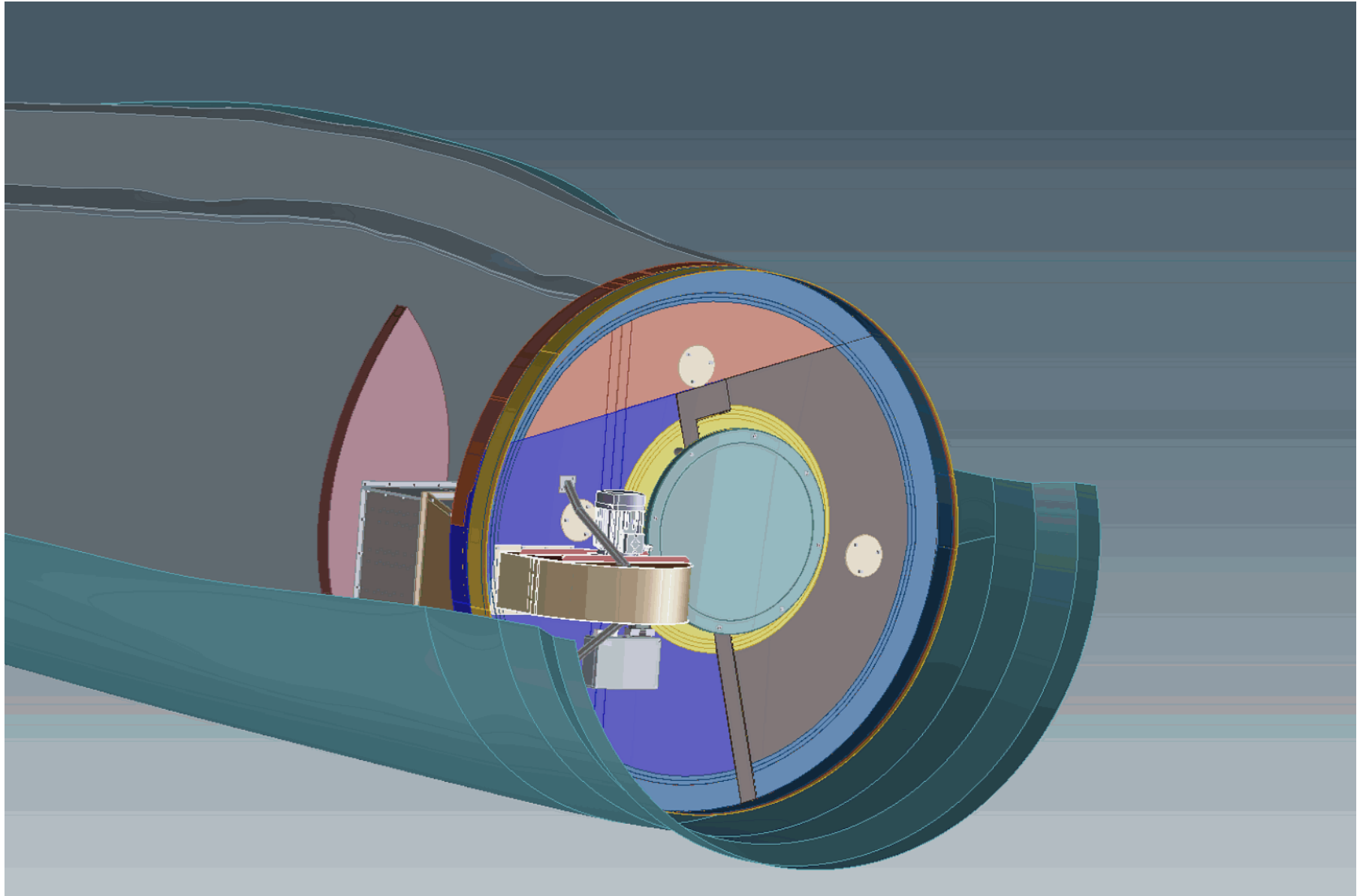


Location	unit	Krystofovy-Hamry (CZ)	Dragaliden (SE)
Amount of test month in winter	month	5	5
Energy meter difference between WEC with and without blade de-icing	kWh	870.000	650.000
Average monthly energy surplus in winter month with icing	kWh	174.000	130.000
Percentage of energy surplus in relation to WEC without de-icing system	%	48	54

The energy yield surplus due to the rotor blade de-icing system strongly depends on meteorological conditions like icing and wind speed on site.

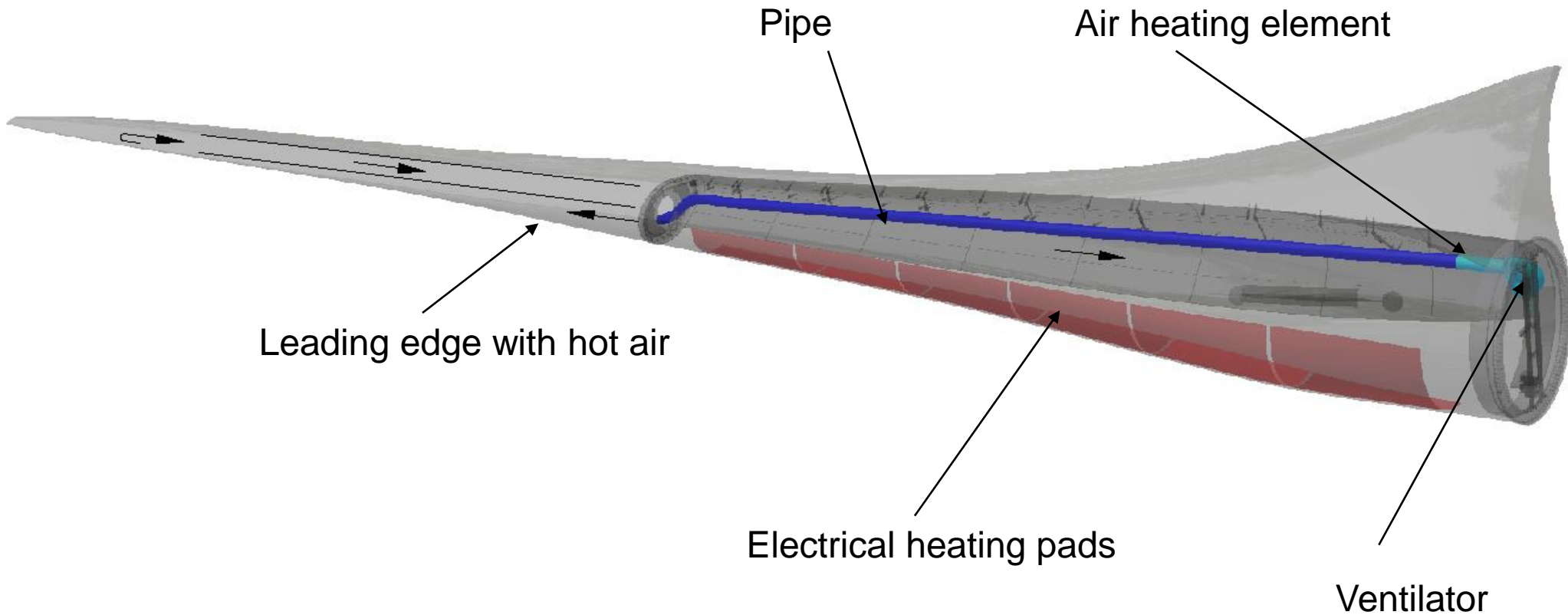
- ENERCON has developed ice detection solutions and de-icing systems for years.
- We see a growing interest for markets in cold climate since the world wide economic difficulties in 2008.
- ENERCON is well prepared and we have validated proven technology to support our customers needs.
- **The next step will be to include this de-icing system to our newer and bigger turbines...**

E-101 – Fan and radiator system

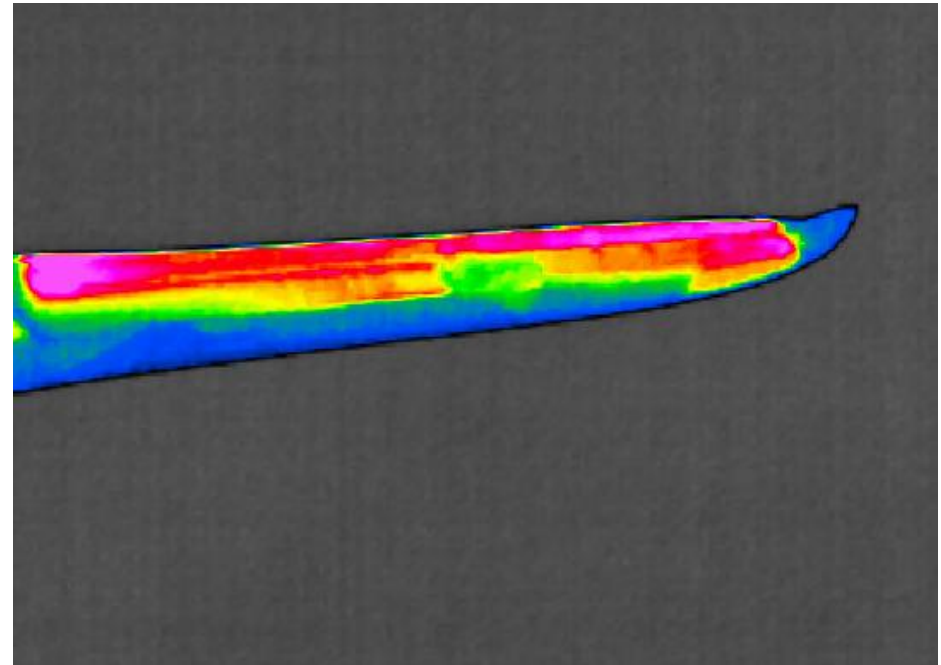
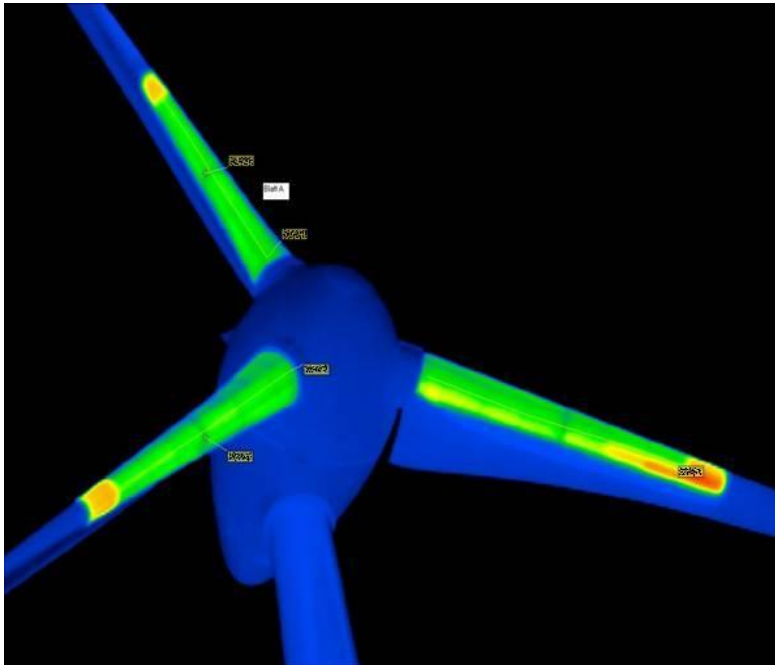


De-icing system for the ENERCON E-126 7,5 MW

- The new de-icing system for the E126 is under development.
- The de-icing system is divided in two different systems. A new inner blade concept and the approved concept for the outer blade.



- Infrared photo with a first result of heating tests of the inner blade **while the rotor is rotating.**
- Heating pads inside the steel blade heating up the outer surface and hot air heating up the outer blade.



- **Please notice that the mass of the inner blade ~ 60t !**

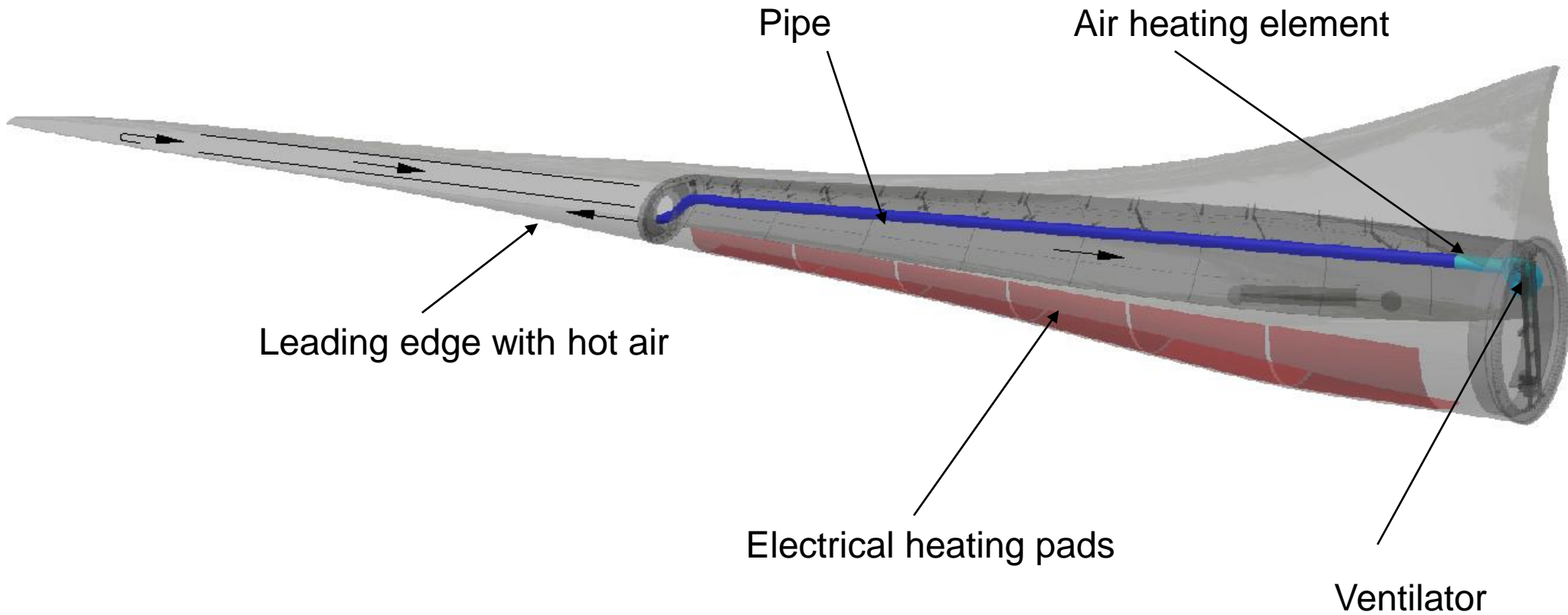
E-126, Inner blade - pipe



E-126, Inner blade - full system



De-icing system for the ENERCON E-126 7,5 MW



- All systems are safe against lightening
- There are only two additional approved components
- There is no need to use specially designed blades
- Inexpensive
- Easy to handle for maintenance (all components are exchangeable)
- High efficiency to reduce energy yield loss due to icing
- System can work while rotor is rotating => leads to minimize the power consumption from the grid
- **It is simple, safe and works just great!**



Thank you for your attention!

Simple

Safe

Low cost

Efficient

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