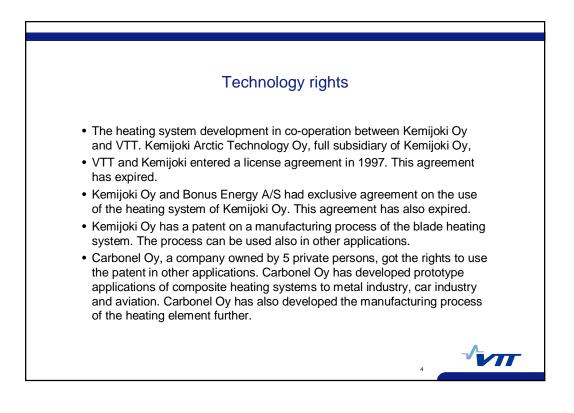


Technology Heating elements

- The selected technology is based on carbon fibre heating elements that are integrated into a blade structure.
- The first experiments were made using heating foils with conductive elements in Al or Cu inside thin epoxy films.
 - Tend to break due to blade bending even if the shape of the metal mesh was designed to withstand the bending.
- Up to now the carbon fibre elements have been laminated onto the surface of a blade after which the surface is finished with thin layer of the primary blade material and final surface finishing. Resulting blade with anti-icing is visually similar to a standard blade.

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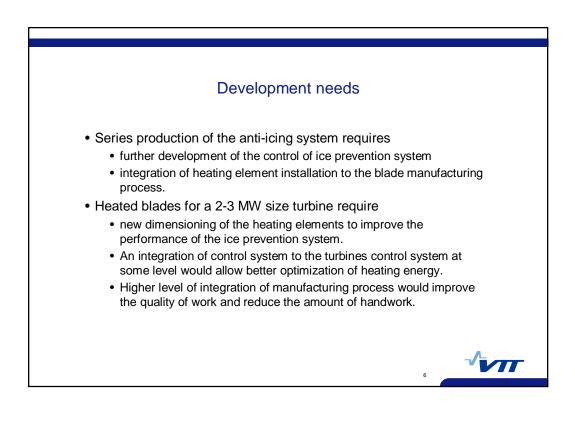


Manufacturing process

• Prefabricated carbon fibre elements

- delivered to blade factory for installation
- include connections between heating elements and conductors
- sensor wiring is done in connection to blade manufacturing process.
- The first series heated blades using carbon fibre
 - Lamination of the elements was done to the surface of unfinished blades.
 - After integration of carbon elements and lamination of protection layer for mechanical wear and tear the blades were coated normally.

VT



Wind energy in cold climate esp. icing environment

- Need: ice-free solutions for 1-3 MW variable speed turbines with modern control capabilities
- Steps
 - Evaluation of wind resources and evaluation and verification of icing risks (work carried out partly within IEA Task 19)
 - Performance of wind turbines in icing conditions, verification of models

VT

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- Technology and product development for ice free blades
- Demonstration in sites with different conditions

