



Low-noise wind turbine design using DinoTails® Next Generation

Rob Kuilboer, NSG bijeenkomst, Oktober 2018

SIEMENS Gamesa
RENEWABLE ENERGY

Value of low-noise wind turbine design

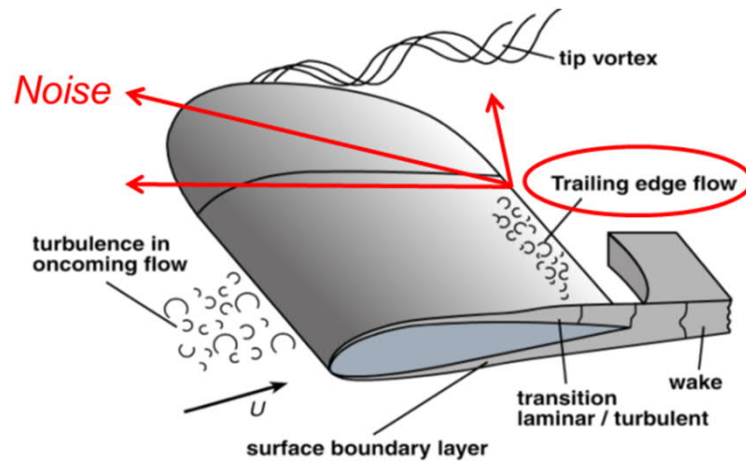
- Many onshore wind turbines must be curtailed to stay within noise limits.
- This results in lost energy production: roughly 2-4% AEP per dB.
- Quiet wind turbines can produce more power → lower cost of energy.



Wind turbine noise sources

Dominant source is aerodynamic noise from blades:

- Noise caused by turbulent air flow over blade surface.
- Most noise produced by outer part of blades.
- Noise generated at trailing edge of the blade.



SGRE noise reduction technologies

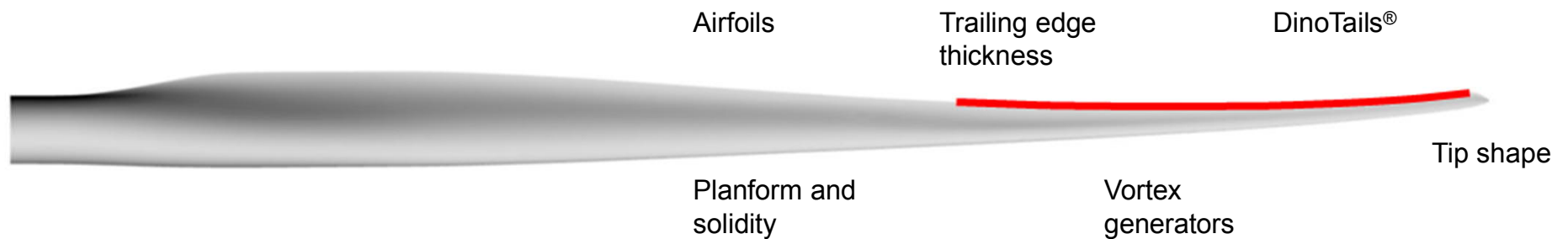
Low-noise turbine control settings:

- Minimize energy loss by tailored RPM and pitch curves.

Blade design optimized for performance and noise.

Low-noise blade add-ons:

- Applied to new turbines and existing fleet (retrofit).
- Can reduce noise and increase power output.

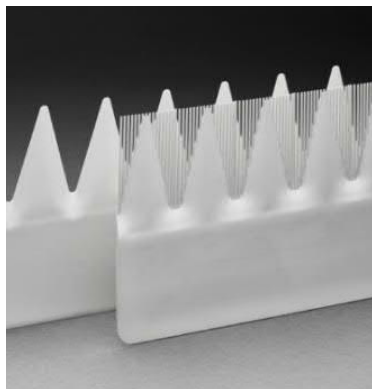


SGRE DinoTails® Next Generation



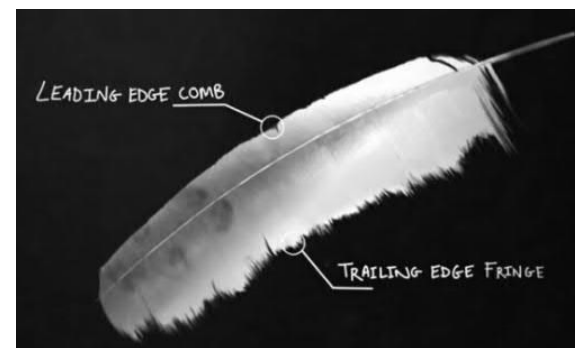
Trailing edge serrations:

- Introduced by SGRE around 2000, now industry standard.
- Different types to optimize noise and aerodynamic performance.



In 2016 SGRE introduced DinoTails® Next Generation:

- “Owl technology” for even larger noise reduction.
- Small combs between teeth create small vortices: less noise.

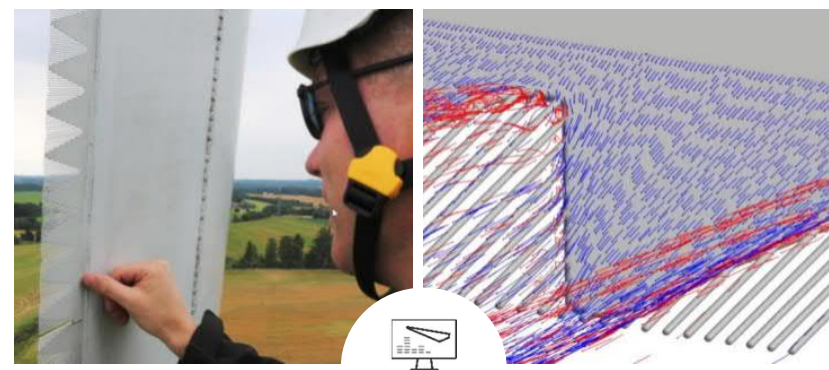


Design and performance



DinoTails® Next Generation now applied to most onshore SGRE turbines:

- DinoTails® Next Generation lay-out optimized for each turbine type.
- Optimized for acoustics, aerodynamics, and structure: minimize LCoE.



Advanced design and validation methods:

- Various computational aerodynamics/acoustics methods.
- State-of-the-art wind tunnel and field testing.

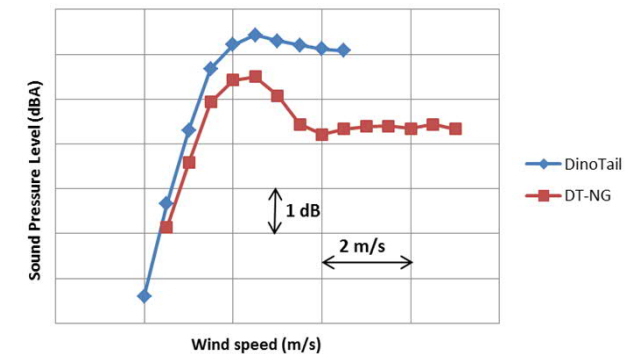
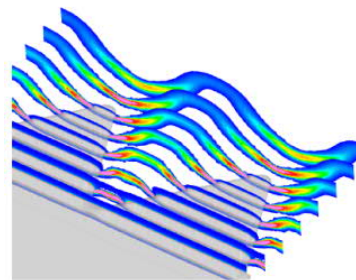
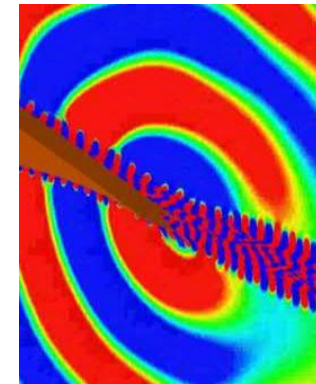
Robust performance on all platforms

Optimized DinoTails® Next Generation design for different blades:

- Tooth angle, length, aspect ratio, radial lay-out, etc.

Proven performance using different methods:

- Computational Fluid Dynamics and Aeroacoustics.
- Acoustic and aerodynamic wind tunnel testing.
- Structure: highly accelerated lifetime tests (UV, vibrations).
- Power and noise curve validation in IEC field tests.



Application of DinoTails® Next Generation in SGRE portfolio

DinoTails® now offered for most onshore SGRE platforms:

- **New turbines and existing fleet** (retrofit).

Substantial improvements to sales noise levels:

- Focus on noise reduction for same AEP.
- Siemens Gamesa 2.X platform: -2.0 dB.
- Siemens Gamesa 3.X platform: : -2.3 dB.
- Siemens Gamesa 4.X platform: : -2.3 dB.
- Legacy Gamesa (G90-2.0 MW and G97-2.0 MW): -1.5 dB.
- Direct Drive Platform: AEP & noise optimized.

→ **Lower LCOE** for noise constrained sites.



Conclusion



DinoTails® Next Generation offer **the best noise reduction performance** in industry.



DinoTails® Next Generation are now **offered for complete onshore SGRE product portfolio**.



DinoTails® Next Generation lay-out **tailored for each turbine type to maximize performance**.



Robust performance thanks to **state-of-the-art design and validation methods**.



SGRE will continue to develop **world-leading noise reduction technology**.



Thank you

SIEMENS Gamesa
RENEWABLE ENERGY