Siemens Gamesa
AEP increase Solution

August 2017

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RENEWABLE ENERGY

Service Product portfolio - Optimization

Reliability To keep turbines up and running

- Maintenance: Scheduled service, trouble shooting, Standard and major corrective works etc.
- CMS & RDS: 24/7 monitoring of +25.000 turbines globally and world-class Vibration Diagnostic.

Reassurance To achieve maximum benefit and surpass expectations

- Time Based to Yield Based availability to maximize the operational availability.
- Weather Cover: Gives you added protection against adverse weather.

Optimization To improve the performance /capabilities of the turbines and wind farms

- Performance upgrades to maximize the profitability of your fleet.

Knowledge To gain access to additional wind farm data and expert knowledge

- Data and control: Remote access to turbine data and operational parameters.
- Knowledge transfer: Access to maintenance documentation and +100 technical and safety trainings.

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Gamesa turbines

OPTIMIZATION

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Energy Thrust is a proven Gamesa product designed to increase production of your whole fleet.

Already installed in more than 6,700 MW in 20 countries, representing 20% of the qualified Gamesa fleet, Energy thrust delivers Up to 5% in the oldest platform and up to 3% in the more recent ones.

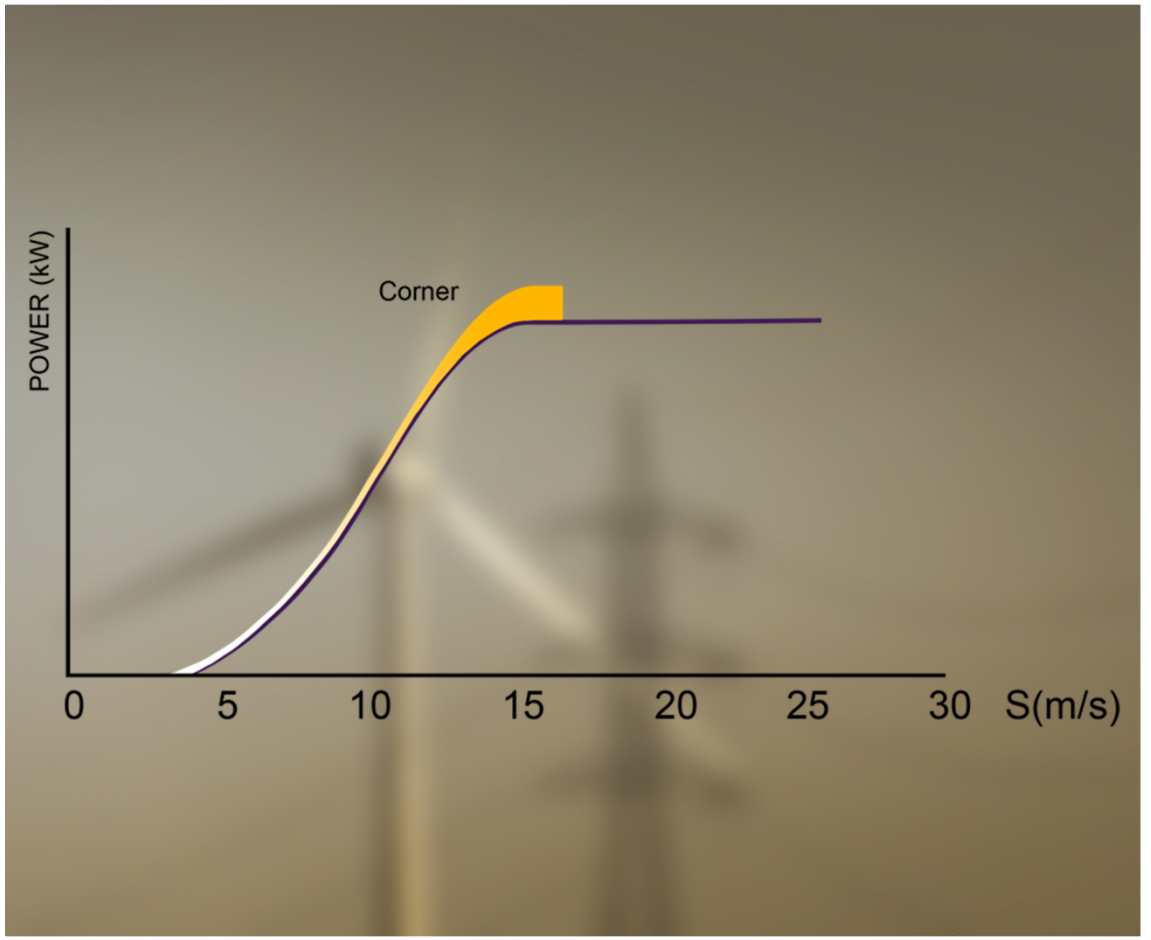
Energy Thrust

Introduction

- Energy Thrust upgrade is designed to **increase** Annual Energy Production (**AEP**) of existing 2.0 MW wind turbines of Brazil using the **newest software upgrades** available to **optimize operation**.
- Improved **AEP** is achieved by:
  - Fine-tuning the following **PLC** algorithms:
    - Enhanced Corner.
    - Extra Power.
    - Safe Mode (oldest turbines)
  - Updating **SCADA** to:
    - Work with the new software.
    - Include PI data adjustments for measuring process.
    - Regulate active power regulation to not overproduce.
    - Enable or upgrade Service Panel to activate Energy Thrust.

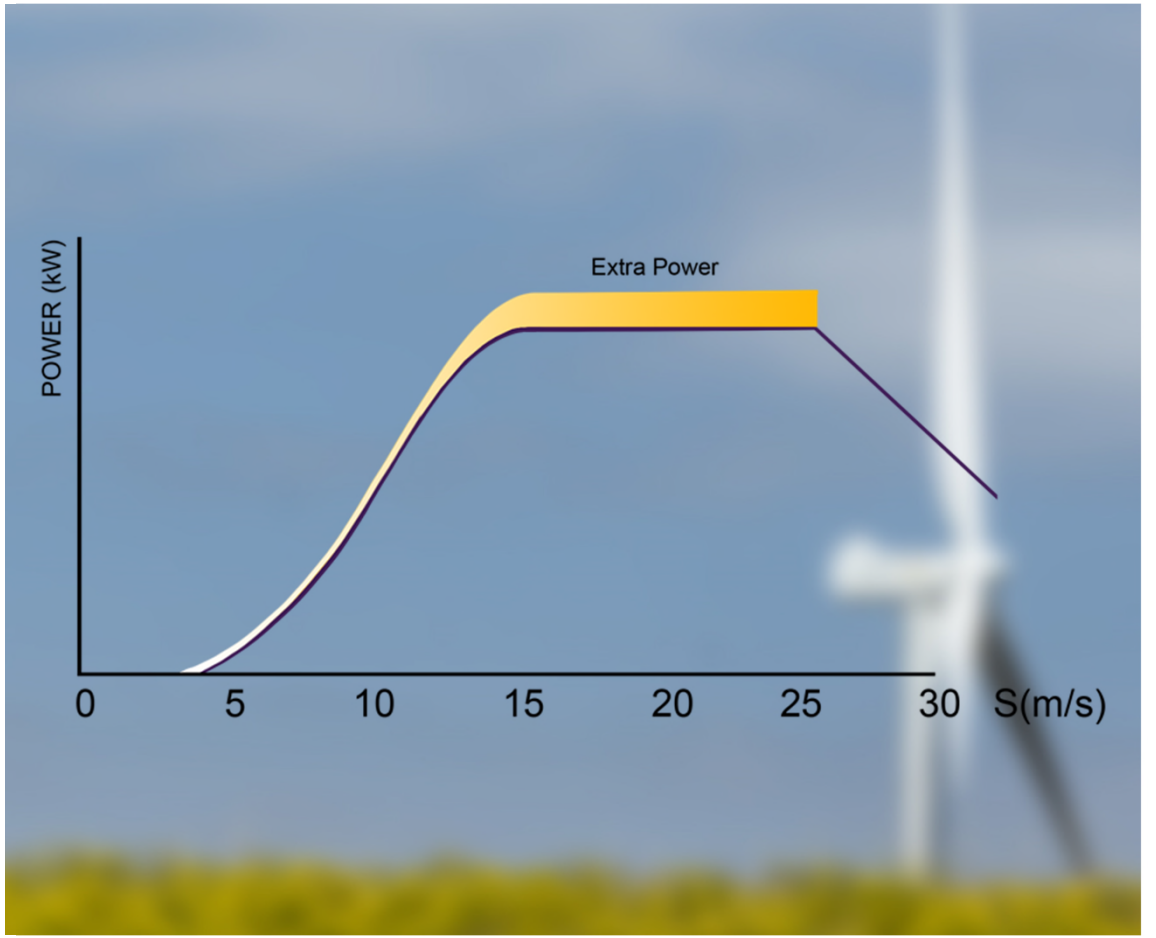
Enhanced Corner - Description and benefits

- **Description**
  - **AEP increase of approximately 0-0.9%** is achieved by means of **increasing the nominal** power in short periods of time under certain grid and environmental conditions.
- **Benefits**
  - Obtains **more power** considering site conditions (K, Vm, turbulence, shear, up-flow, temperature, etc.).
  - **Compensates power losses** due to wind turbulence effect or grid losses due to wind turbine stoppages. **Greater wind turbulence equals greater AEP increase**.
  - **Improves transition** between partial to nominal power range.



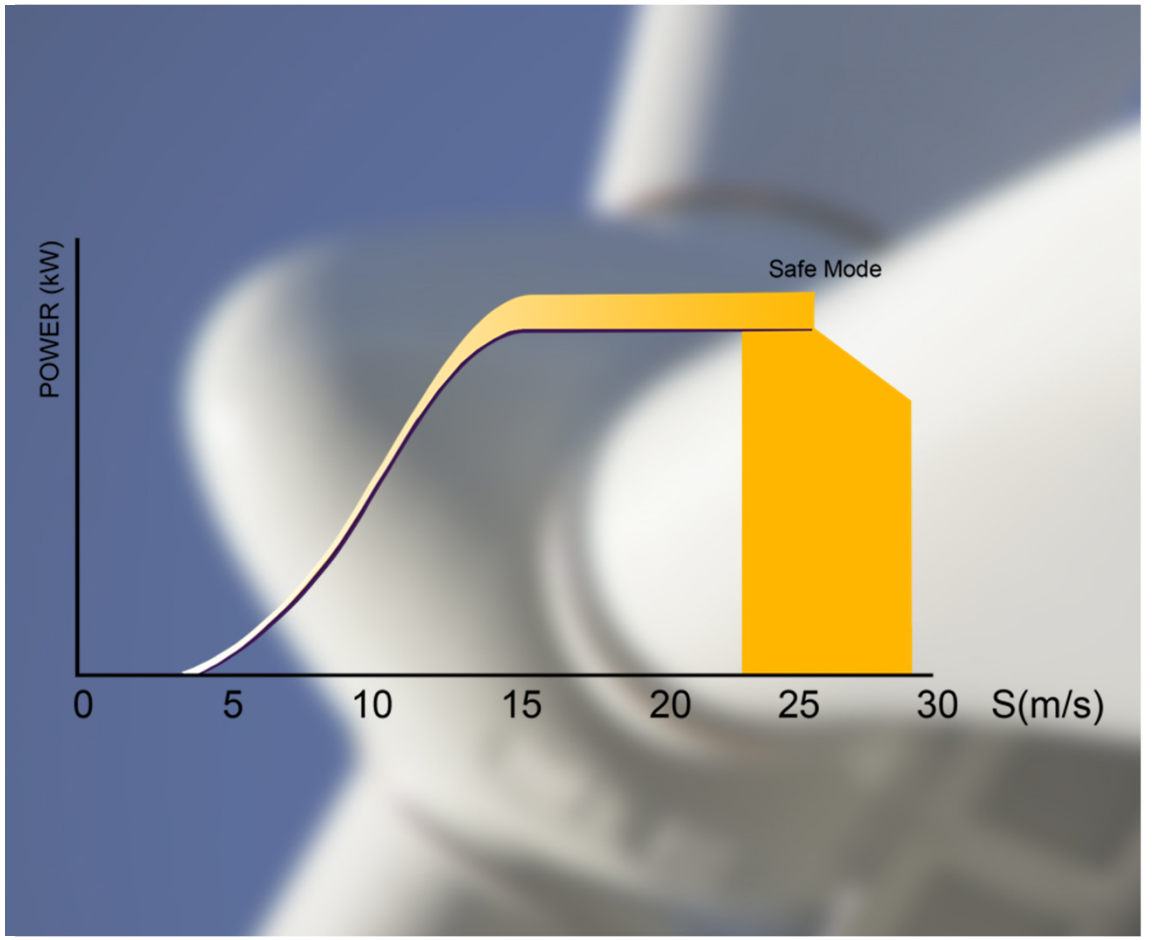
Extra Power - Description and benefits

- **Description**
  - **AEP increase of approximately 0.5-2.0% by increasing nominal power to 2,070kW** depending on the real time parameters of the wind turbines (temperature, voltage, reactive power, nominal power, etc.).
- **Benefits**
  - **Output power** produced **nearest to authorized power**.
  - **Power compensation** when grid losses occur or wind turbines stoppages.
  - **Controlled operation** when extra-power is produced.



Safe Mode - Description and benefits

- **Description**
  - With the software upgrade, **AEP increase of approximately 0.5/2.0%,** by broadening the range of operation by more than 10% and raising the hysteresis cut-in limit by 3 m/s. The software takes into account all mechanical and electrical limits of turbines, adjusting the output and revolution in each moment.
- **Benefits**
  - **More output power** produced as turbines will not stop due to gusts of wind over cutout limit.
  - **Controlled operation** when extra-power is produced.



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Siemens turbines

OPTIMIZATION

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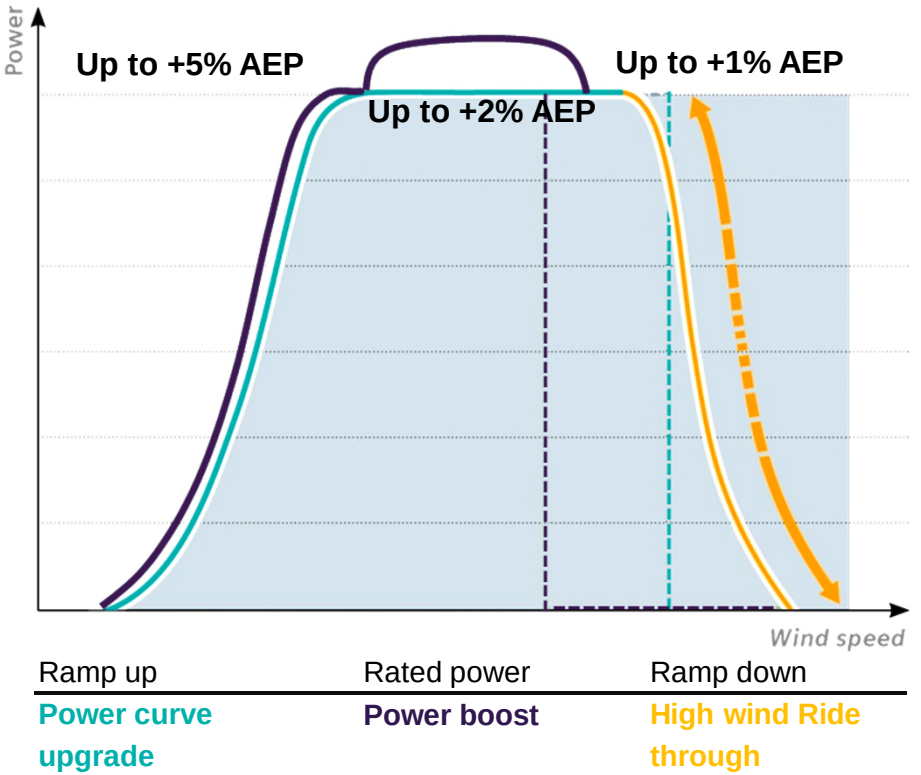
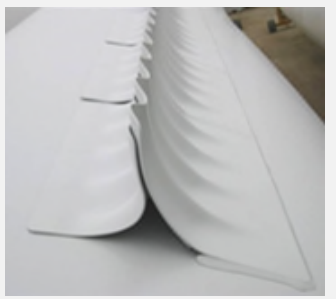
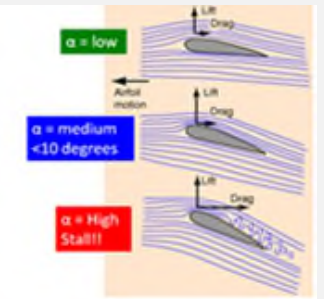
Siemens Gamesa can also maximize AEP of the Siemens fleet combining:

- Power boost feature (Extra power for SWT-2.3-93, 101 & 108, SWT-3.6-107 & 120, SWT-3.0 DD turbines with STC-1 and DD22 turbines)
- With power curve upgrade (aerodynamic upgrades available for SWT 2.3 – 82VS, 93 & 101 and SWT 3.6 – 107 turbines)
- And high wind ride through® (Safe mode up to 39 m/s for SWT-2.3-82VS, 93, 101 & 108, SWT-3.6-107 & 120)



Power curve upgrades

- The power curve upgrade consists of 3 components and a software update.
- The upgrade allows the turbine to operate with a new power curve, generating more energy with less noise in some specific cases.
- New Siemens Blades come with the same upgrade from factory.

	Vortex Generator	Dino Tail®	Dino Shell®	Software updates
Component				
Application				1. Parameter settings 2. Pitch lubricate Motion 3. Constant torque Boost

Components Vortex Generators

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What is a Vortex generator?

- Injection molded thermoplastic components made out of a compound polymeric material (pic 1).
- Small vertical fins with heights of 4 – 24 mm (five sizes) that jut out of the surface of the blade.

Where is it located?

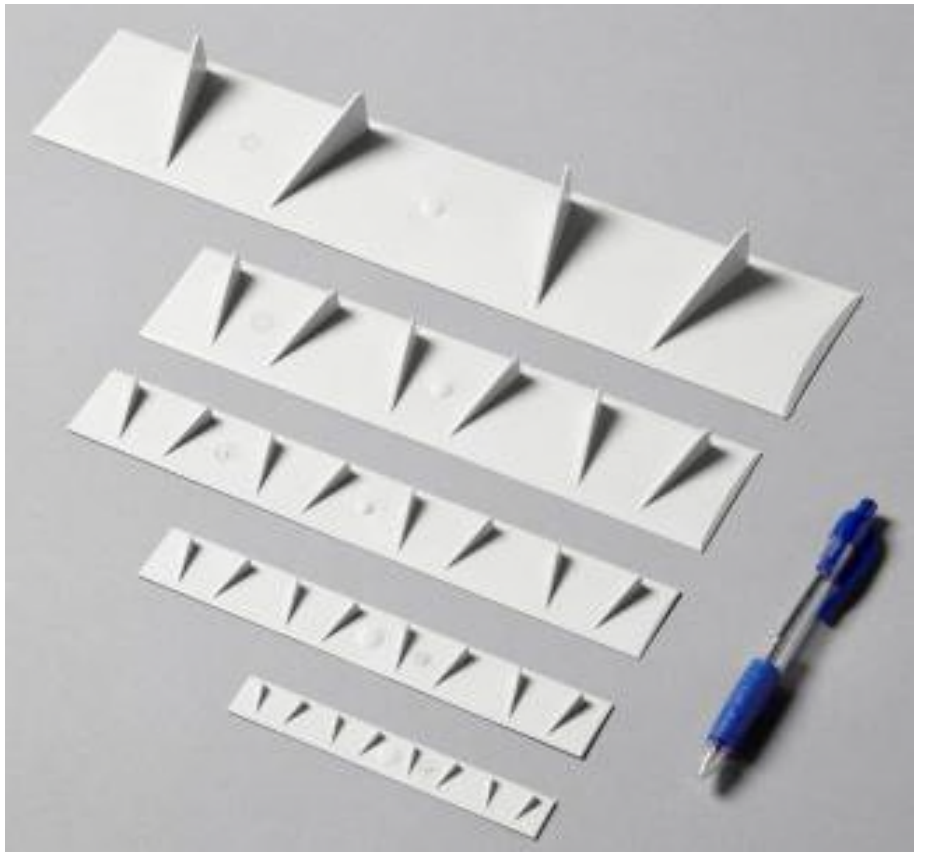
- They are mounted both inboard at the root section of the blade as well as outboard at the tip of the blade.

How does it work?

- It mixes the air very close to the blade surface with the air further away (pic 2).
- It thereby delays the airflow separating from the blade surface and thus increases lift.

Why is it of benefit?

- It reduces roughness sensitivity.
- It increases lift and thereby the energy production.



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Components DinoTail®

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What is a DinoTail®?

- Injection molded thermoplastic components made out of a compound polymeric material (pic 1).
- Siemens patented flaps with serrated edges that are glued onto the trailing edge of blade tip.

Where is it located?

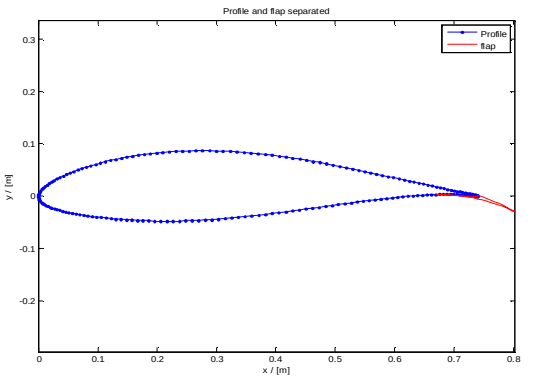
- They are mounted at the tip section of the blade.

How does it work?

- It enhances the lift by extending the blade chord (pic 2).

Why is it of benefit?

- It increases lift and thereby the energy production.



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Components DinoShell®

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What is a DinoShell®?

- Injection molded thermoplastic components made out of a compound polymeric material (pic 1).
- Siemens patented flaps that are glued onto the trailing edge of blade root.

Where is it located?

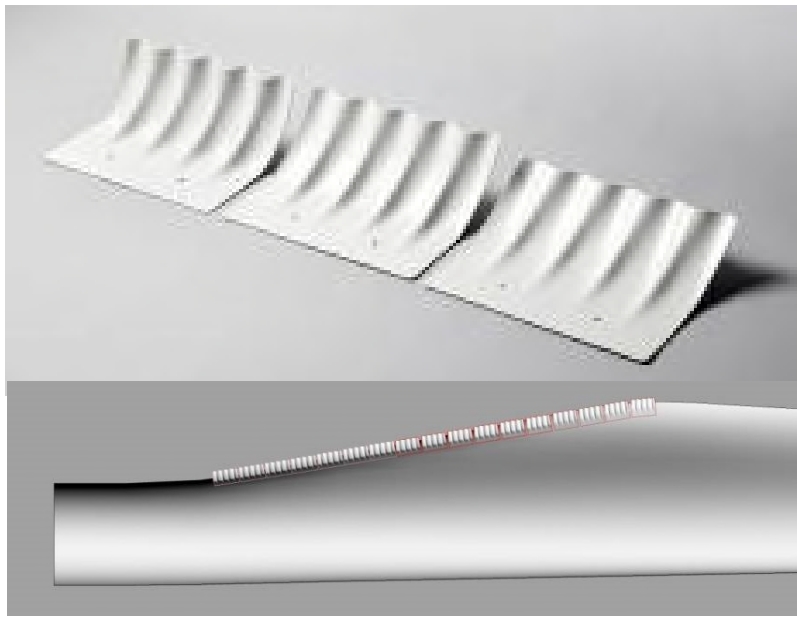
- They are mounted at the root section of the blade (pic 2).

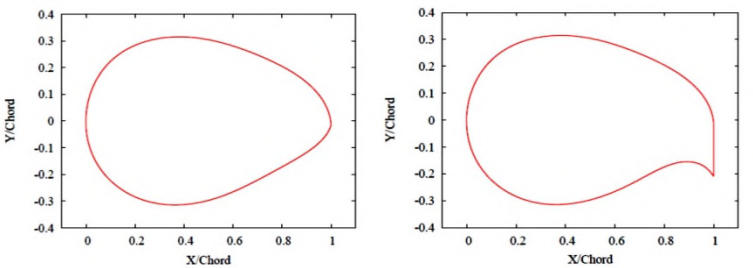
How does it work?

- It enhances blade lift. However, in contrast to other types of flaps, the DinoShell® does not extend beyond the original chord length (pic 3).

Why is it of benefit?

- It increases lift and thereby the energy production.





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Power Curve Upgrade Track record

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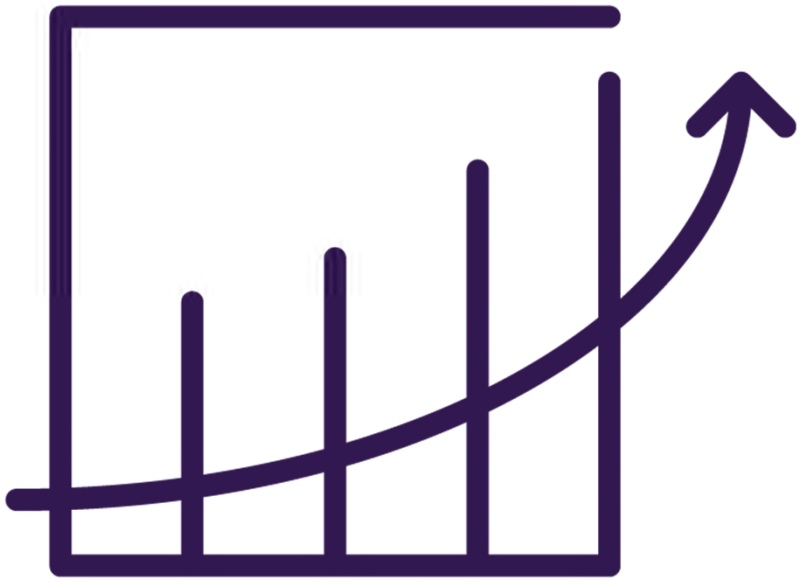
Multi-Technology:

- First at-site installation in 2010
- 100 + at-site installations & 2000 + factory installations
- Up to 5% AEP improvement compared to the original warranted power curve



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Siemens Gamesa turbines

OPTIMIZATION

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AEP increase solutions for Siemens & Gamesa turbines

- Siemens Gamesa upgrades require blade hardware and software upgrades for wind turbine PLC and SCADA.
- All software functionalities work in unison to increase power production and AEP at not risk for the assets.
- Siemens Gamesa provides proven solutions and with a solid track record that increase AEP of both fleet.
- Siemens & Gamesa will leverage experience and combine the best of the two portfolios to maximize customers' benefits.

Contact

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Thanks

August 2017

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