

ELLE®

Leading Edge Protection.
Anywhere. Anytime.



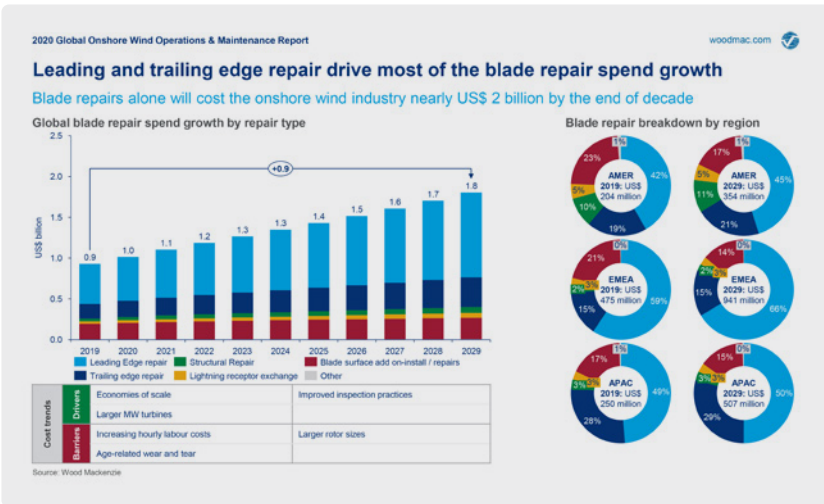
Leading edge erosion

A billion-dollar problem

Longer rotor blades. Faster tip speeds. Harsh weather conditions. And more remote locations. These drive an industry-wide problem: leading edge erosion.

Repair of leading edge erosion accounts for more than 50% of up-tower blade repair expenses and Wood Mackenzie¹ forecasts that it will cost the industry \$1 billion USD every year by the end of the decade.

ELLE® is the solution to change this trend. ELLE® is a polyurethane leading edge protection (LEP) solution with unmatched capabilities that puts an end to leading edge erosion. Anywhere. Anytime.



Leading edge repair will cost the industry \$1 billion USD every year by the end of the decade, as forecasted by Wood Mackenzie. Image source: Wood Mackenzie.

ELLE® – putting an end to leading edge erosion

ELLE® is a market-leading solution protecting blades from erosion caused by environmental factors, such as rain, hail, and airborne particles, accelerated by the damaging UV rays of the sun.

We have addressed the challenge of leading edge protection from a holistic point of view. You therefore get unmatched, site-optimized performance considering durability, functionality, and ease of application.

In the ELLE® family, we provide two solutions:

ELLE® Onshore



ELLE® Shells



Based on both solutions, you get the right LEP solution for your site.

- Superior, site-optimized durability
- First-class protection
- Improved aerodynamics

¹ Liu, D, Garcia da Fonseca, L. 2020 Global Onshore Wind Operations & Maintenance Report. Wood Mackenzie Power & Renewables; 03 February 2021.



WHAT TO CHOOSE:

ELLE® Shells or ELLE® Onshore?

Choosing the right LEP strategy

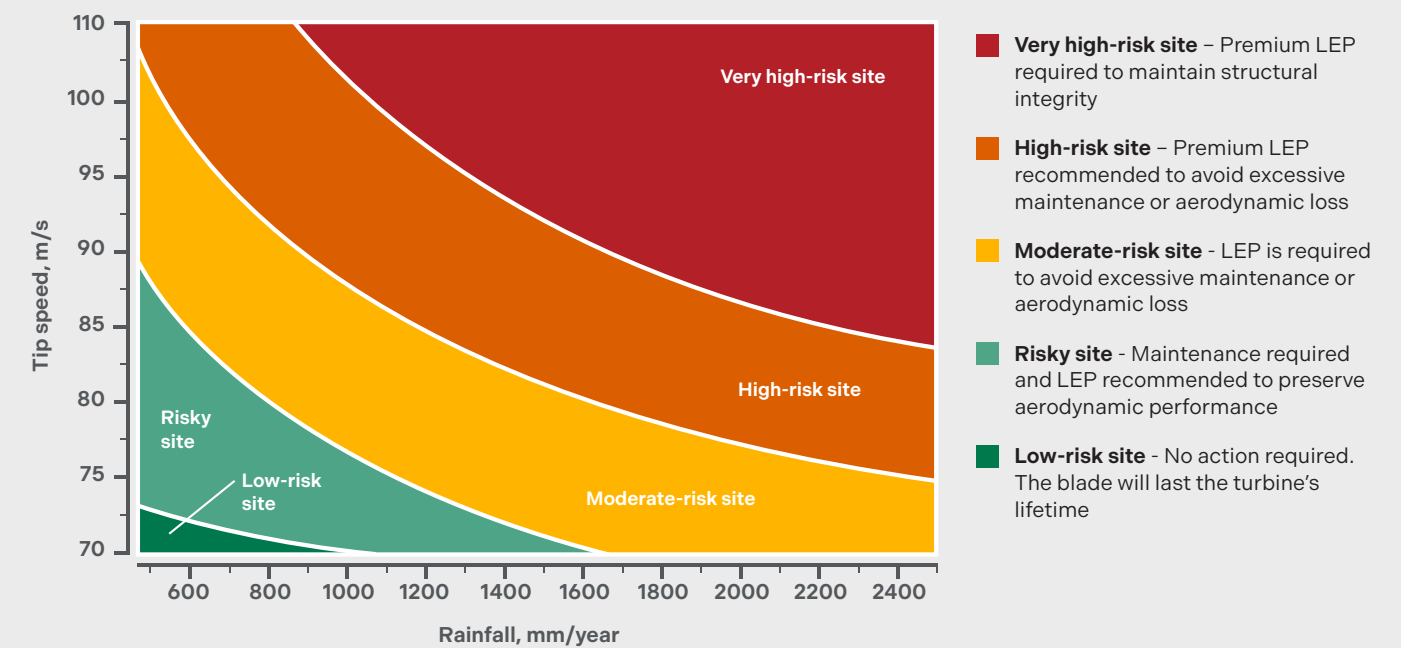
Your LEP strategy can directly affect your operating expenses and levelized cost of energy. That is why it is important to choose the right LEP solution for your site.

Your turbines will experience significantly different leading edge erosion rates depending on their location and type. The interaction between these two

factors (i.e., environmental and operating conditions) influences your erosion risks and the durability of your chosen LEP.

Our ELLE® solutions are designed to cover all risk conditions and can therefore protect your wind turbines anywhere in the world.

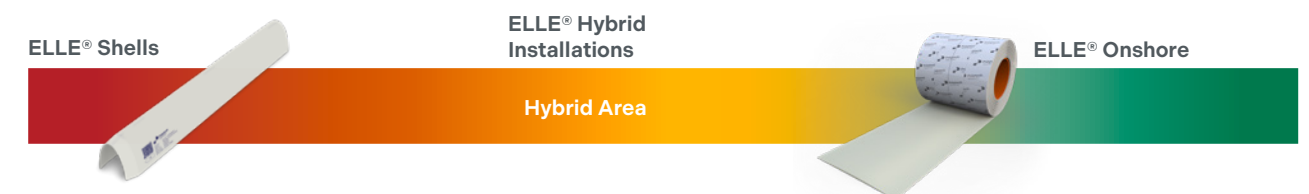
Site risk - leading edge erosion



Lifetime based on DNV RP-0573
for a standard top coat

- ELLE® Shells for **offshore** environments and **high to very high-risk sites**
- ELLE® Onshore for **onshore** environments and **moderate-risk sites**

Depending on the site conditions, a hybrid installation could also be considered to provide an optimal protection. Consult our experts for the right LEP strategy for your site.





The unique serial number and QR code on each ELLE® Shell ensure complete traceability from production batch to installation.

Try our erosion calculator tool to support your LEP strategy

Our leading edge erosion calculator was developed according to the DNV-RP-0573 to evaluate and predict the durability of LEP systems. The tool also incorporates field experiences to ensure that the calculations reflect real-life conditions.

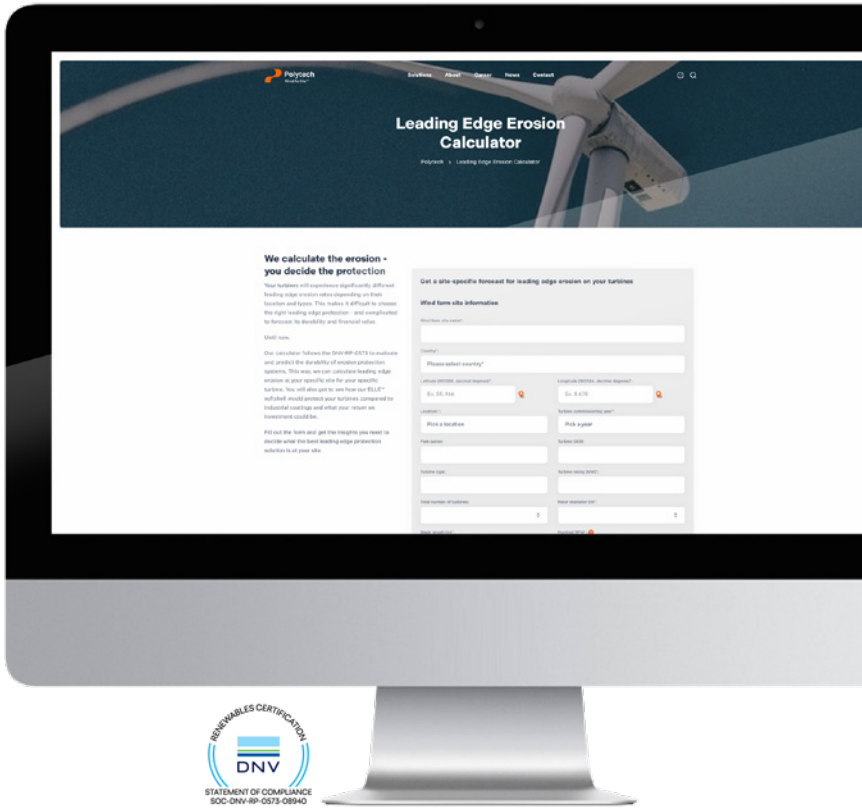
Our wide range of test results that underline the tool and the tool itself have been verified by DNV. As such, this is the first calculation tool on the market that has received a DNV verification.

With this tool, you can see the leading edge erosion risk at your specific site for your specific turbine and the length on the blade that needs protection.

Try our Leading Edge Erosion Calculator!



Fill out the form on our website and get the insights you need to decide what the best leading edge protection solution is at your site.



When to use the erosion calculator?

The tool can be widely used in three cases:

- 1

Before blade design
during the risk assessment phase, especially considering how fast the erosion would progress with the increasing tip speeds
- 2

Wind park design phase
(before installation)
to understand how does the site environment impact erosion
- 3

Post installation
(turbine operation phase)
when erosion starts to occur and affects operations (how many meters of blade service needed, what LEP solution is necessary)

The tool can therefore help OEMs, asset owners and operators to make the right choice of LEP based on the site's erosion risks.



Meet the ELLE® family

ELLE® Onshore

Leading edge protection – Made simple.

ELLE® Onshore is an easy-to-apply leading edge protection for onshore environments. Launched in 2024, it was born out of decades of material expertise and hands-on field experience gained from our first LEP solution, ELLE® Shells. ELLE® Onshore is specifically designed to simplify leading edge protection, ease of application, provide outstanding durability, and minimize aerodynamic disturbance for onshore wind turbines.

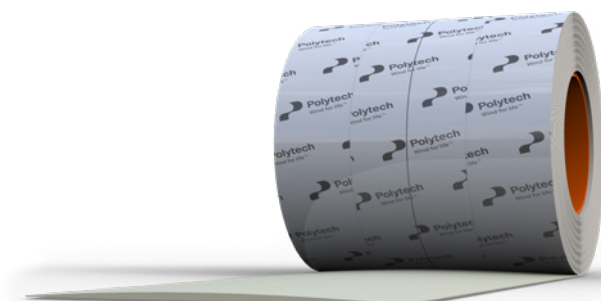
Durability to eliminate frequent repairs

Erosion impacts your turbines' performance and operations even on land, so you need a durable solution to protect your blades.

We have developed ELLE® Onshore specifically for onshore conditions. Keeping durability in mind, you get a protection that lasts over a decade at most onshore sites (calculated according to DNV-RP-0573). This means that you can eliminate frequent repairs and save resources.

Improving performance with aerodynamics in mind

Thanks to its width and chamfered edges, ELLE® Onshore seamlessly blends in the blade's geometry to minimize aerodynamic disturbances. Choosing ELLE® Onshore, a protection solution over erosion, you can minimize the aerodynamic disturbances and maximize your power production.



ELLE® Onshore edge chamfer (exaggerated dimensions).

Made for simplicity and easy application

We know how much planning and resources are required when doing an LEP campaign. Every minute that the wind turbine is shut down costs. Having an LEP that is easy and fast to install can significantly make your planning and operations smoother (and more cost efficient).

ELLE® Onshore is designed as a continuous, 33 m roll with a three-part liner and center marking. The liners make installation extremely easy and fast.



No training **No sealing of edges** **No paint** **No mixing of products**

The fundamental tools you need for the application of ELLE® Onshore are inside the box you get. Just roll out, cut, and install. No mess, no fuss. That is ELLE® Onshore.



Thanks to its lightweight (<10kg) and small size of the box, you can fit 33 m of leading edge protection even in the trunk of your car.

Standard design to fit most blade designs

ELLE® Onshore has a standard design to fit most blade types on the market. Using the provided templates for tip installation, you can with ease order ELLE® Onshore for your upcoming LEP campaigns onshore.



ELLE® Shells

Leading edge protection for a lifetime.

ELLE® Shells is a market-leading LEP solution for both offshore environments and for onshore sites with high to very-high erosion risks.

ELLE® Shells in action

ELLE® Shells consist of pre-cast sections made of robust yet soft and flexible polyurethane shells. These shells are applied to the leading edge using a thin but sturdy, moisture-resistant adhesive (activated during installation) and sealer that match the blade material for optimum adhesion. The edge sealer ensures a smooth transition between the shells and the blade with the finest aerodynamical aspects.

Tailored to individual blade designs

ELLE® Shells are custom-made to fit every blade type on the market perfectly. With its seamless integration into the blade's geometry when fitted, you can avoid erosion-induced energy production loss and maintain your turbines' performance.

Quality and traceability at all times

To ensure that you always get an ELLE® Shell with the highest quality, we use automated, laser-based geometric metering to confirm consistent thicknesses across each ELLE® Shell and use automated quality control.

Each ELLE® Shell has a unique QR code and serial number that gather all data on each shell, including production date, material batch number, inspection documentation, quality measurements, consumption data, and test reports. We can therefore track every process from raw material batch to finished product, even after installation.

Proven lifetime durability verified by DNV

We have exposed the ELLE® Shell to extensive rain erosion testing according to the DNV-RP-0171 and applied the DNV-RP-0573 to calculate its lifetime. In addition to this, we also followed the extensive methodology outlined in DNV-RP-0573 to evaluate the



ELLE® Shells is a market-leading LEP solution for both offshore environments and for onshore sites with high to very-high erosion risks.

risk of delamination of the ELLE® Shell. And the result? It remains intact and will show no erosion during the lifetime of the turbine at most sites in the world.

In 2022, DNV verified these lifetime calculations, ELLE® Shells' estimated durability, and all related test results according to DNV-RP-0573. DNV also highlighted that our predictions in fact underestimate the durability of the ELLE® Shells.



PROVEN LIFETIME PROTECTION
with ELLE®



LIFETIME ESTIMATION
verified by DNV



Field studies prove stabilized energy production with ELLE® Shells

One thing is to be certain about ELLE® Shells' durability given its DNV verification. But how will its installation affect the turbine performance during operation?

Two benchmark studies on operating wind turbines analyzed the turbines' performance after ELLE® Shells were installed and compared these results to either unmodified turbines or their pre-installation performance.

Installation records

85,000+

ELLE® installed worldwide since 2016



in all climate zones from the arctic environment to tropical climates



BENCHMARK STUDY on near-shore turbines in Denmark, verified by DNV



BENCHMARK STUDY on onshore turbines in Canada

Both studies proved that ELLE® Shells not only protect the blades from erosion, but stabilize, and even increase the energy production and turbine performance slightly.



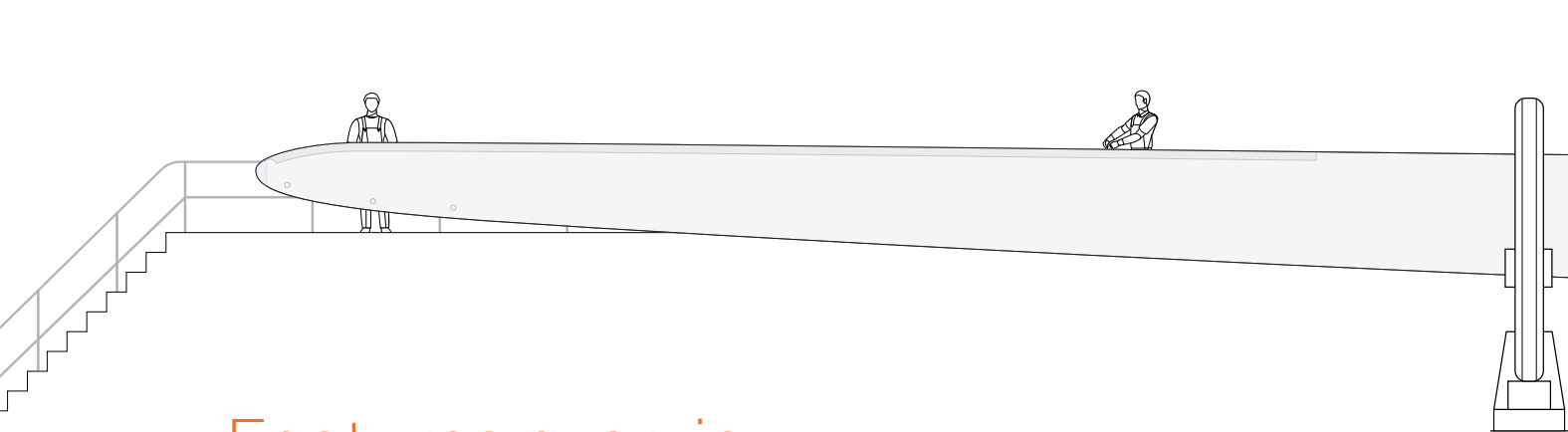
We offer specialized ELLE® application training for technicians at our dedicated training facilities in Denmark. We also offer trainings on-site.

ELLE® training

We offer specialized ELLE® application training at our dedicated facility in Denmark or at your site. The purpose of the trainings is to qualify third-party subcontractors and/or direct customers in installing/replac-

ing ELLE®. We provide all the materials for the training and flexible training times to fit your needs.

To enquire about ELLE® training, please contact Sales at polytech.com/contact.



Features overview

Polytech’s two leading edge protection solutions, ELLE® Onshore and ELLE® Shells, offer reliable protection for wind turbines in all climate and environmental conditions. Both solutions are available for

factory and retrofit installations, but some features are different to allow a more flexible LEP strategy. Below is a comparison of the main features of ELLE® Onshore and ELLE® Shells.

	ELLE® Onshore	ELLE® Shells
Installation during manufacturing	✓	✓
Retrofit	✓	✓
Application conditions – relative humidity (RH)	0-100% RH	30-90% RH
Application conditions – temperature	10-35°C	5-35°C
Sealer		✓
Pressure-sensitive adhesive	✓	✓
Aerodynamic performance achieved by...	Chamfered edges and wide design	Blade-customized design, chamfered edges and sealer chamfering
Fit	Standard that fits most blades	Custom to fit specific blade design
Delivery	On continuous, 33m-long rolls (cut and install)	1 m pieces in sealed vacuum bags
Shelf life	Up to 14 months	Up to 18 months
Training	No	Yes
Installation time (approximate) – in factory	Under 10 minutes/meter	~ 15 minutes/meter
Installation time (approximate) – uptower	~ 10 minutes/meter	~ 20 minutes/meter



Testing

Like with all other Polytech solutions, we thoroughly **test** the ELLE® family in our accredited test centers as well as external facilities to ensure the solutions’ high performance and durability.

For all tests, we followed the procedures of various international standards like DNV-RP-0171, DNV-RP-0573, and ASTM G73-10.



Rain erosion



Damage progression



UV exposure



Saltwater exposure



Adhesion strength



Sand erosion



Hail erosion



Wind tunnel

Contact

Are you interested to learn more about ELLE®
or get a site-specific evaluation for your project?
Then contact our Sales team at polytech.com/contact

