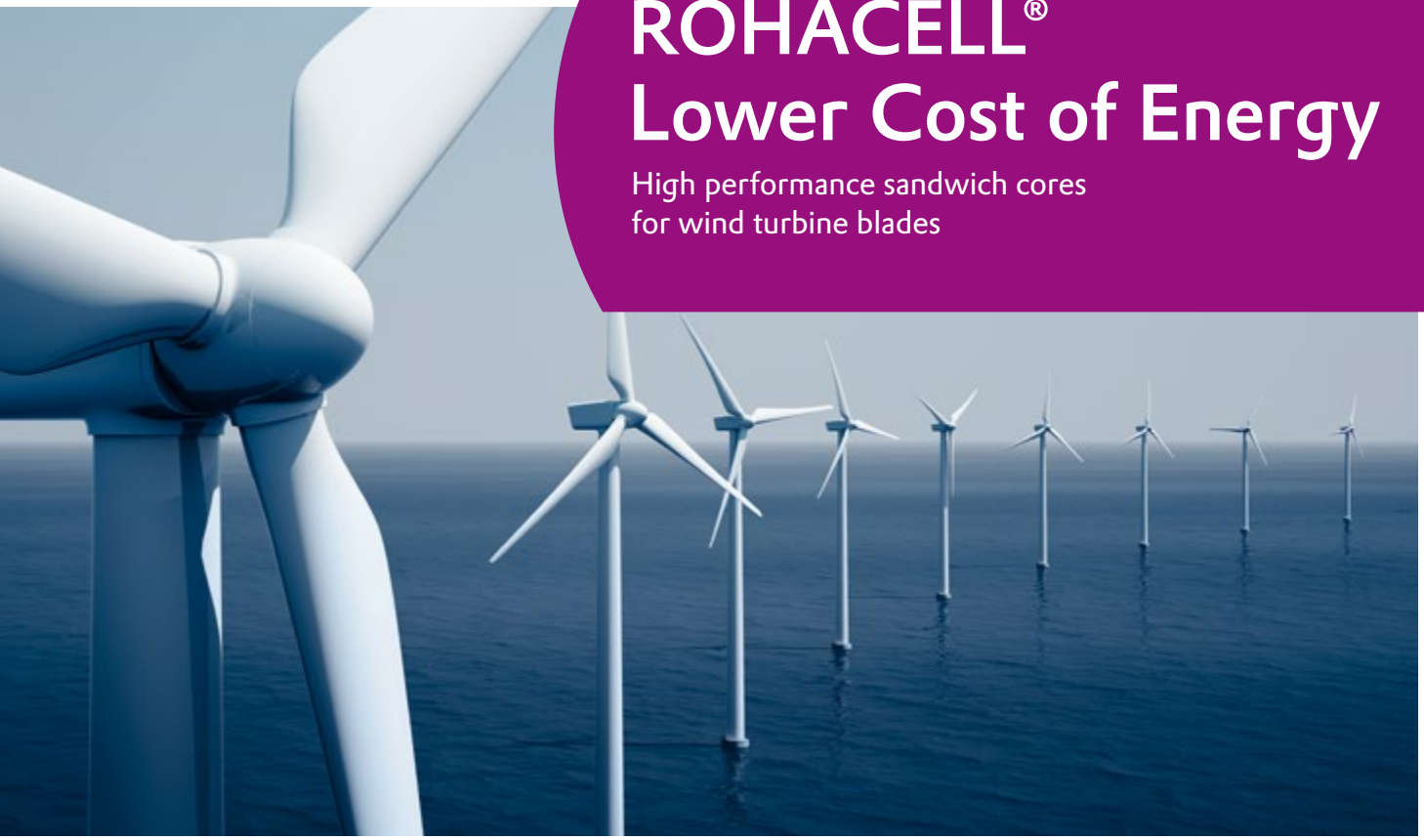
EVONIK INDUSTRIES

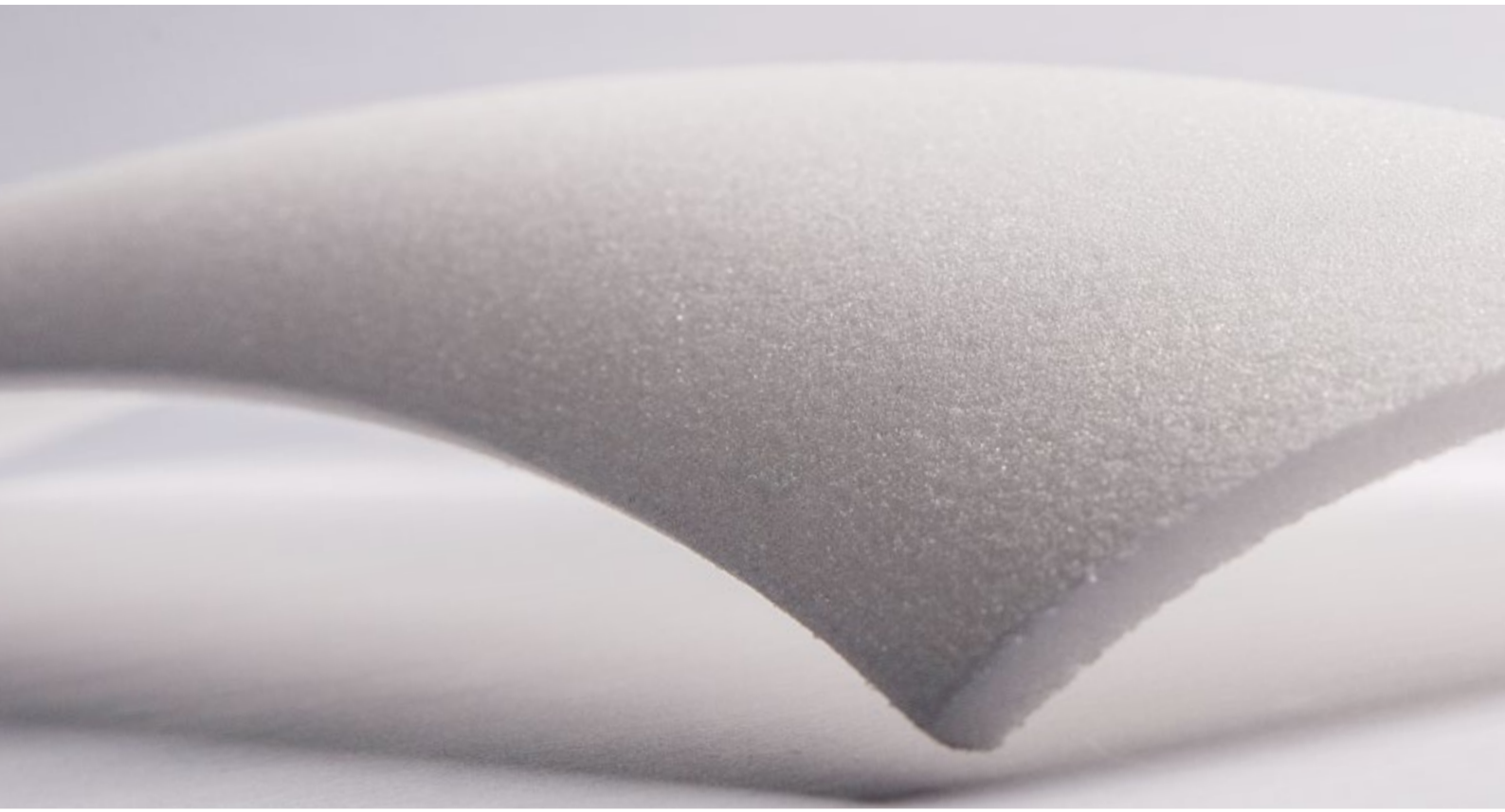
ROHACELL®
Lower Cost of Energy

High performance sandwich cores
for wind turbine blades



ROHACELL®

Evonik. Power to create.



High performance sandwich core for reduced blade mass and efficient manufacturing

A lower Cost of Energy achieved through efficient production methods and reduced blade loads are top priorities in WTG design. However, sandwich core material can often be a limiting factor in blade production efficiency.

New materials like ROHACELL® foam core offer an innovative solution to blade manufacturers facing these challenges. ROHACELL® WIND-F is specifically engineered to meet the demands of the wind energy industry.

Featuring a combination of high quality, very low weight and an ability to support highly efficient manufacturing processes, ROHACELL® WIND-F gives you the freedom to design a cost-efficient WTG system.

A ROHACELL® WIND-F core delivers excellent mechanical properties at foam densities as low as 50 kg/m^3. Even at these low densities, the GL requirements for core materials can be met.

The lightest core with the lowest resin uptake

Lower blade mass means lower turbine loads and reduced overall structural requirements.

- Lower foam core densitiy
- Significantly scales down resin absorption, and thereby cost, compared to other cores (45 % less than PVC)

Processing up to 150 °C makes high temperature curing possible (e.g. +20 °K on a VI process)

- Up to 35-55 % shorter curing cycles
- Decrease of fixed cost base with up to 30 % higher blade output per year using the same set of molds
- Compatible with all common epoxy and polyester resin systems

Core shaping versatility

- Can be machined like wood – including grooving, drilling and scrimming
- Thermoformable
- CNC machinable

Excellent fatigue properties (m ≥ 18)

- Extended blade lifetime
- Less uncertainty in full-scale blade testing

GL certified

- Core material certificate
- Fulfills all blade related requirements

Higher densities available upon request

- Can be used as an alternative to Balsa

ROHACELL® WIND-F application at EUROS

The advantages of ROHACELL® WIND-F sandwich cores are brought to use in EUROS GmbH lightweight onshore blades in lengths of 58 meters and offshore blades with lengths in excess of 80 meters. The production facilities of the Berlin-based blade designer make use of an optimized infusion process that reduces cycle times and increases quality levels as compared to typical production methods.

Less weight, less resin, more processing efficiency

ROHACELL® WIND-F plays a key role in reducing the overall mass of EUROS blades due to the low core density and minimized resin uptake. An added benefit is that less resin uptake lowers resin costs.
Turbine loads are also reduced which, in turn, determine the structural requirements of other wind turbine components - from the blade bearing to the tower foundation.
Processing efficiency benefits are another advantage. Since ROHACELL® WIND-F can withstand increased processing temperatures, high quality can be achieved with a shortened cycle time.

World's second longest blade uses ROHACELL®

In May 2013, EUROS delivered an offshore blade from its prototype production facility on the German Baltic Sea island of Rügen. The 81.6-meter blade weighs 32.5 tons and is currently the world's second longest blade.
The blade was designed to last 25 years for an offshore turbine featuring a 167-meter rotor.
The blade designers were also able to achieve the low blade weight by using ROHACELL® WIND-F 50 kg/m^3.

"ROHACELL® WIND-F core material is an innovative new kind of foam, characterized by low specific mass and reduced resin absorption.
Innovative materials, tailored production processes and a focus on the highest possible manufacturing quality all contribute to the optimal strength, stiffness and durability, plus favorable blade mass, of our new onshore and offshore blades."

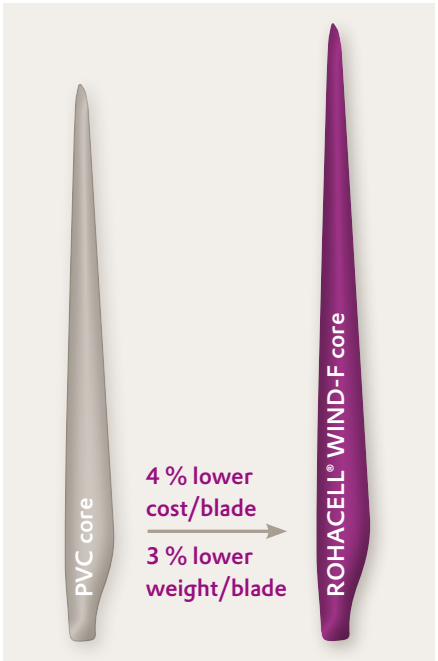
Hinrich Graue, Technical Director, EUROS GmbH

Business Case: ROHACELL® vs. PVC core in a certified 50 m IEC III blade by StrucTeam Ltd.

A detailed evaluation of two blades designed by Structeam Ltd. confirmed significant improvement in blade production profitability is possible when using ROHACELL® foam core – a core material offering low density, reduced resin absorption and high temperature compatibility.
The business case is based on the original Bill of Material (BoM), material costs, tooling and auxiliary cost, as well as manufacturing process data. It compares two GL-certified blade designs:
One with PVC as core material and one with a ROHACELL® WIND-F core.

Process experiments
Extensive experiments validating assumtions on resin uptake and process efficiency were carried out to support the study.
Curing and post-curing cycle times were significantly reduced by increasing the vacuum infusion process temperature by 20 °K. As a result, the target T_g of 70 °C was reached 35-55 % faster.
Yearly production with one mold increased from 126 blades/year to 166 blades/year.
Directly influenced by this is the man-hour cost reduction of 2080 €/blade.
Tooling depreciation cost is reduced by 866 €/blade.

Overall, this results in a cost benefit of ROHACELL® WIND-F compared to PVC of 2862 €/blade.



Design longer blades with ROHACELL® WIND-F

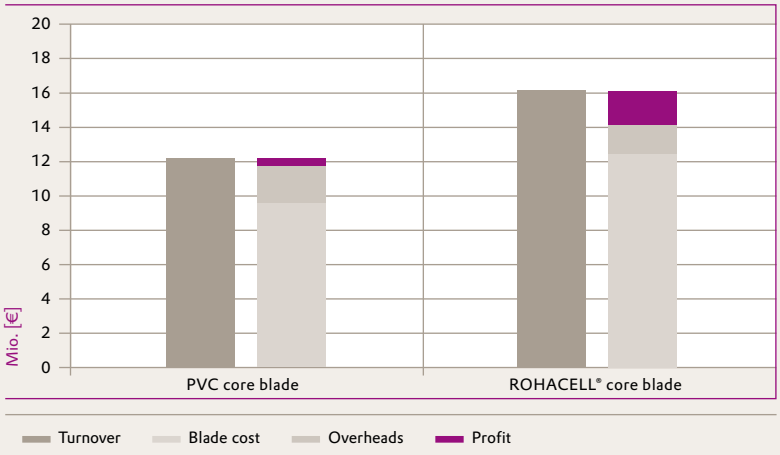
The bottom line impact: Increased profit

The business case was expanded to include the blade production CAPEX and OPEX perspective. This included fixed cost (about 13 % overhead) and varying blade costs determined previously.
As seen in the figure, the increased output per mold and year led to higher turnover resulting in a significant improvement in profit margin.
The PVC production environment realized a 3.5 % EBIT margin, while the ROHACELL® environment resulted in a 9.8 % EBIT margin based on its lower factored fixed costs and 4 % lower blade costs.

Conclusion

Moving to a high-tech material with a slightly higher material price can actually lead to a reduction in overall costs throughout the value chain and thereby lead to significantly improved profit margins.

Turnover and profit per mold



Material	Turnover [t€]	Blade Cost [t€]	Overheads [t€]	Profit [t€]	Profit in %
PVC	12.222	9.779	2.016	425	3.5
ROHACELL®	16.102	12.408	2.116	1.576	9.8

"Using ROHACELL® favors the reduction of cycle time for blade production. Its high specific mechanical properties combined with its outstanding thermal performance allows significant cycle time and processing savings which results in an overall cost reduction."

Julien Sellier, Engineering Director, StrucTeam Ltd.

ROHACELL® WIND-F technical data

Property		Test Method	Unit	ROHACELL® 50 WIND-F	60 WIND-F	80 WIND-F	100 WIND-F
Density		ISO 845	kg/m³	50 ± 8	60 ± 10	80 ± 15	100 ± 20
Shear strength	Nominal	ASTM C 273	MPa	0.8	1.1	1.6	2.1
	Minimum		MPa	0.6	0.8	1.2	1.6
Shear modulus	Nominal	ASTM C 273	MPa	25.9	33.6	49.0	64.4
	Minimum		MPa	19.6	25.8	37.4	48.9
Compressive strength	Nominal	ISO 844	MPa	0.9	1.2	1.9	2.7
	Minimum		MPa	0.5	0.8	1.3	1.9
Compressive modulus	Nominal	ISO 844	MPa	29.9	40.3	61.3	82.3
	Minimum		MPa	21.4	29.8	45.5	61.3
Tensile strength	Nominal	ISO 527-2	MPa	1.5	1.9	2.7	3.5
	Minimum		MPa	1.1	1.4	2.1	2.7
Tensile modulus	Nominal	ISO 527-2	MPa	69.3	88.3	126.2	164.1
	Minimum		MPa	54.1	69.3	97.7	126.2

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