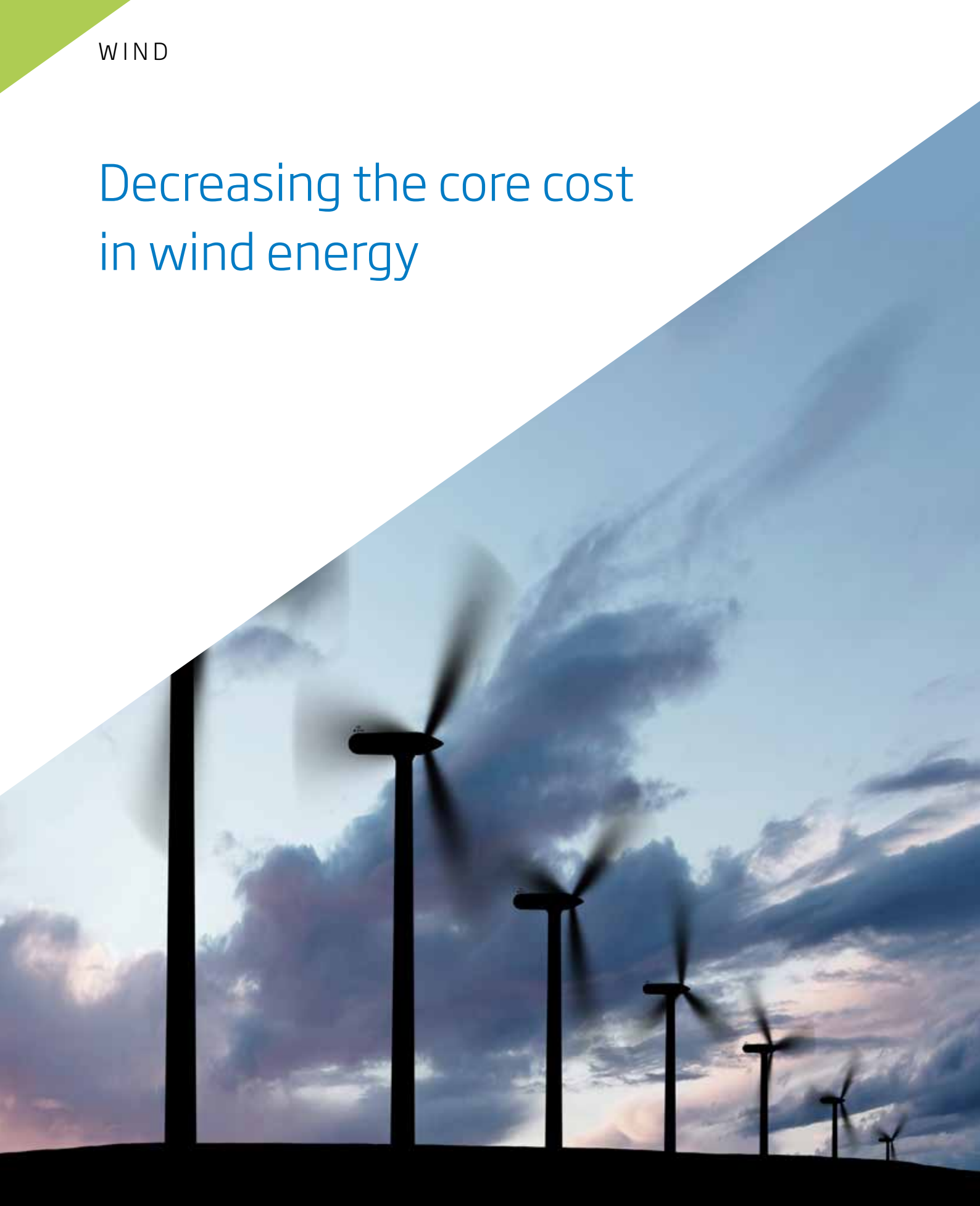


WIND

Decreasing the core cost in wind energy



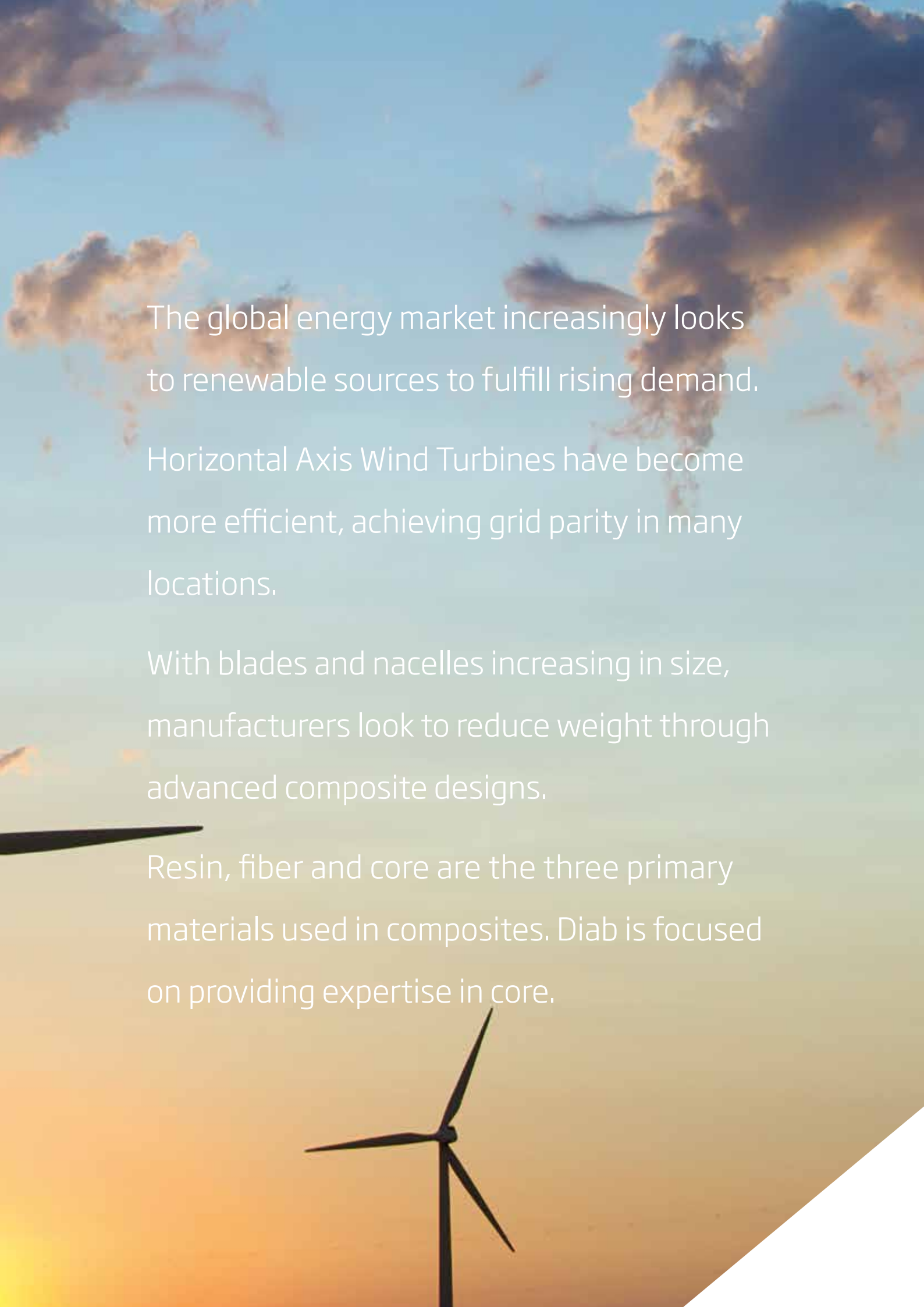
Sustainable, comprehensive sandwich composite solutions and high-performing core materials

Diab

A photograph of two wind turbines silhouetted against a sunset sky. The sky transitions from a pale blue at the top to a warm orange and yellow at the bottom. Several wispy clouds are scattered across the upper half of the frame. The wind turbines are positioned in the lower right and lower left corners, with their three blades clearly visible.

The smart way to help reduce the LCoE

DIAB, Divinycell, Matrix and ProBalsa are registered
trademarks in countries all over the world.



The global energy market increasingly looks to renewable sources to fulfill rising demand. Horizontal Axis Wind Turbines have become more efficient, achieving grid parity in many locations.

With blades and nacelles increasing in size, manufacturers look to reduce weight through advanced composite designs.

Resin, fiber and core are the three primary materials used in composites. Diab is focused on providing expertise in core.

Diab – complete solutions for the wind industry

Diab is a world leader in advanced sandwich composite solutions with extensive experience from working with the wind industry. We provide core materials, finishing and pre-cut kits specifically tailored to each application. In addition to our high-performance products, we support your efforts with technical expertise, structural engineering services and applications training. To further ensure you reach optimal results, our offer also includes our unique Diab Core infusion process.

A strategic partner

With decades of experience in wind applications, Diab probably has the highest competence level in the industry. Through the years, we have gained invaluable insight into your unique products and processes, which enables us to develop solutions adapted to your specific needs. From our work with all major turbine manufacturers, there are now approximately 250,000 Diab cored blades in service around the world.

Sustainability

Ever since the beginning, we have been dedicated to constant innovation and promoting a widespread adoption of sandwich composite materials. What people say can't be done we do every day. Sustainability is one of our top business priorities and we strive to continually improve every aspect of our operations.

Innovation

DIAB is proud of its pioneering work in core technology. Several programs are underway, with new materials, finishing and kit solutions launched continuously.

Security of supply

We have positioned ourselves to serve our customers locally while offering all the benefits of working with a global company. With eight manufacturing plants in strategic locations around the world, all offering our full range of materials, Diab ensures high efficiency, quality and an optimal supply chain – giving you security and flexibility.

Committed to your needs

Diab is a long-established, stable company. We take our customers' trust very seriously and we honor our commitment by focusing on what is needed to make our customers' products stronger, lighter and smarter. Partnering with Diab gives you access to our full value now and in the future, allowing you to continuously develop your business.



Diab core materials

Diab provides a wide range of materials suitable for the wind industry - available in plain sheets with a variety of finishes and pre-cut kits. All of our materials are good environmental choices with high performance over time.

IPN foams

The unique composition of our IPN foams yields impressive mechanical performance to a very low weight.

▶ Divinycell H

Divinycell H provides excellent mechanical properties and low weight. It has a proven track record in virtually every application area where sandwich composites are employed. It is compatible with most wet resin systems and its low thermal conductivity makes it especially suitable as insulation at low or cryogenic temperatures.

▶ Divinycell HP

Divinycell HP is developed to meet demands in high temperature systems and low temperature prepreg systems. It features high strength and stiffness to weight ratio, even when exposed to high ambient temperatures. It also has excellent chemical resistance, low water absorption and good thermal/acoustic insulating properties.

▶ Divinycell Matrix

Divinycell Matrix is an all-purpose grade with high strength-to-weight ratio. High mechanical properties at lower weight bring many crucial benefits: lower fuel consumption, higher application efficiency, decreased environmental impact and decreased lifetime cost.



PET foams

All our PET foams have excellent thermal stability and impressive physical properties.

▶ Divinycell PN

Divinycell PN is a structurally strong PET sandwich core material perfectly suited in a variety of applications to increase their performance and to decrease their weight. In the wind energy segment, its excellent mechanical properties and good processing characteristics make it highly suitable for both blades and nacelles.



Balsa

Balsa materials are particularly easy to work using conventional woodworking tools. They can be drilled, milled, turned and sawn to close tolerances.

▶ ProBalsa

ProBalsa is a high-quality organic core material made from end grain balsa wood. Featuring exceptional compressive strength, it is used in a wide range of applications and can also be combined with polymer core materials in, for instance, wind blades. ProBalsa is compatible with most resin and manufacturing processes and suitable for elevated temperature cure systems.



Optimized finishing for perfect production

Composite structures are typically not flat so core materials need to be shaped or have sufficient conformability to match the part shape. Finishing refers to the possibility to shape and design structural core materials to suit application needs, whether related to processing, design, weight or surface finishing, for instance.

Save time, money and resources

Selecting the optimal finishing has a distinct and profound impact on your application's success - directly influencing weight, cost and quality. Diab helps you choose from a wide range of cuts, grooves, perforations, kerfs, etc. in different patterns, each serving a specific purpose to optimize your application.

Plain sheets: where finishing starts

If possible, using a plain sheet is the most effective way to utilize a core with regards to material properties. However, plain materials usually do not fit manufacturing processes or applications without machining (adaptation). In the machining or finishing process, a core material starts off as a plain sheet before it is perforated, grooved, slitted or whatever is needed to make it as functional as possible for the end user's applications or process.

Formable finishing options: creating curves

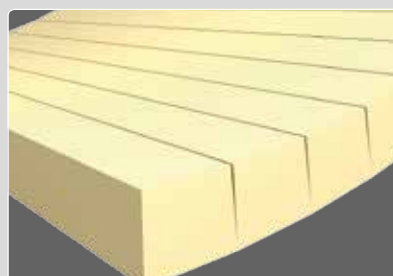
Grid-scored materials (GSC)

Grid-scored materials are commonly used to make the core material conform easily to the mold. They contain a cut pattern on one side of the core creating small blocks held together by a lightweight fiberglass scrim.



One directional cut materials (ODC)

One directional cut materials (ODC) have cuts in only one direction. This configuration creates "rods" rather than small blocks.



For more information, please see the Diab Finishing guide at diabgroup.com or contact us for a printed copy.

Resin distribution options: ensuring wet-out

Perforations (PFC)

To avoid having air trapped between the core and the laminate, small perforations or grooves are often added symmetrically to the core. This technique is commonly used when doing hand lay-up, vacuum bagging or when using core bedding adhesives. In an infusion process, the perforations will transfer resin from one side to the other, ensuring both sides are wetted out and avoiding trapped air as well. Many different kinds of perforated sheets are available to fit both size and orientation.

Grooved and perforated materials (GRC, GRV, GPC)

In the vacuum infusion process, the core itself, if grooved and perforated properly, act as an infusion medium. There are a variety of options to choose from, allowing the user to pick which is most suitable for the process/application. They can also successfully be combined with formable options such as grid-scored material.



Single-cut sheets (SCC)

Single-cut sheets (SCC) are scored longitudinally on one side and transversely on the opposite side, creating a perforation that enables air and resin to flow.



Double-cut configuration (DCC)

The double-cut configuration (DCC) introduces curvatures into panels without applying a scrim. The core is cut in a 0-90 grid pattern on both sides. The cuts overlap, allowing air and resin to easily flow through the core.



Kits to boost your production performance

All of our materials can be delivered in kits, tailored to your specific process. A kit consists of pre-cut parts that are shaped as necessary and then numbered to fit exactly into their designated places in the mold.

Save time, labor and cost

By eliminating the on-site shaping and cutting of flat sheets, you can reduce build times and save labor and material cost. In addition, with the easy assembly and exact fit, you can achieve a consistently high quality in less time.

Getting your material delivered in a kit helps you:

- Boost performance in terms of weight, cost and quality
- Shorten lay-up time of the core in the mold
- Improve surface quality and decrease weight
- Minimize the amount of waste handling
- Reduce material stocks

The kit can consist of everything from sheets only to 3D shapes made with CNC routing.

In order to meet our customers' various needs, we offer four levels within our kit offering, each taking into account individual requirements for various wind applications.

For more information, please see the Diab Kits guide at diabgroup.com or contact us for a printed copy.





Diab core infusion

When manufacturing a wind application part, the end result is highly dependent on the process you use.

We have developed Diab Core infusion to ensure our customers reach optimal results.

With the DIAB core infusion a perfect wet-out of the laminates is achieved by using grooves, cuts and perforations in the core.

Improved efficiency and lower total cost

Our core infusion process can cut mold cycle times by up to 50% and labor costs by 30%. It can be readily introduced using existing molds and without the need for heavy capital investment or sophisticated flow modeling software. With the Diab system the specially grooved core not only enhances the structural performance of the composite component, but also acts as the resin transfer medium.

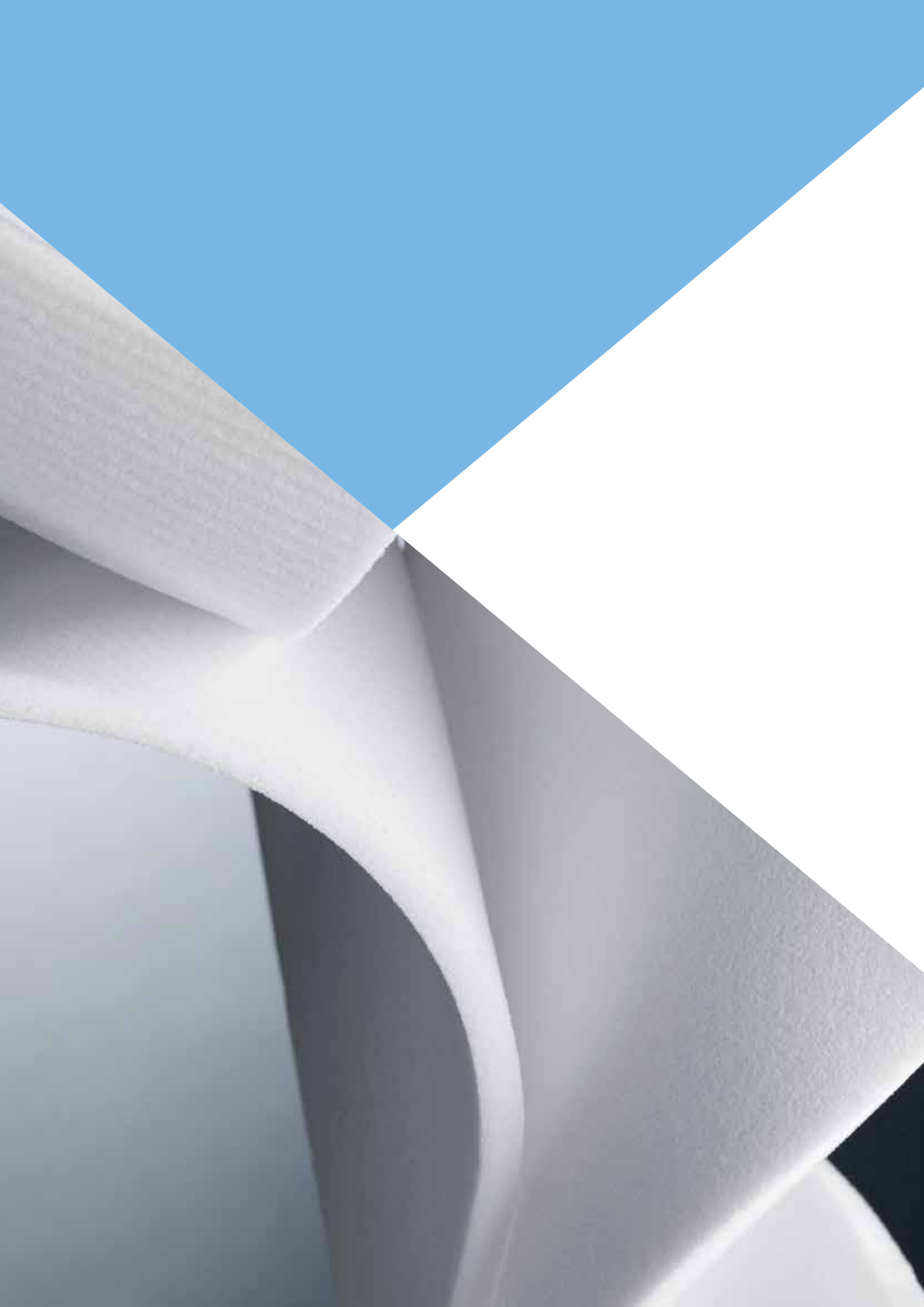
By eliminating the requirement for sacrificial distribution mats or nets, the cost of consumables, waste and labor time is significantly reduced.

World-leading in core infusion

Diab were pioneers in developing core infusion. Since then countless composite component producers around the world have adopted our core infusion as their process of choice for both large and small moldings. We continue to develop and refine the process, and the effort to optimize the technique keeps us in the forefront of core infusion.







Complete composite engineering services

Diab's integrated range of solutions and services can serve you in every part of the composite design and manufacturing process. Many of our customers take advantage of our engineering expertise to ensure each element fits together for optimal performance.

Technical services

Diab Technical services partner up with you to help you maximize the benefits provided by the Diab sandwich concept. We have a deep knowledge about sandwich design, finishing and kits and our skills cover everything from hand lay-up to resin infusion. We help you choose the most appropriate design procedure for each specific case and when necessary validate the findings with in-house testing. Strategically located around the world we provide advice and support wherever you are.

We can also provide both theoretical and practical training of personnel and then directly assist your team with prototyping and infusion trials.

Composites Consulting Group (CCG)

Composites Consulting Group (CCG) is an independent Diab Group company providing specialty composite technology services. With a broad competence including everything from design and engineering to testing, tooling, process optimization and training, we ensure that you can realize the full value of composite designs.

CCG consists of mechanical and process engineers, material scientists, naval architects and composite technicians with many years of experience from a wide range of industries. Our process consultants routinely work with applications using contact molding, vacuum infusion, RTM and RTM Light, prepregs, pultrusion and filament winding among others.

Extensive competence in wind

Our Technical Service team and the Composites Consulting Group (CCG) have a unique combination of practical and theoretical experience ensuring that solutions are valuable from both a design and a manufacturing perspective.

Our competence in wind includes:

- Structural calculations
- Core material selection
- Finishing selection
- Kit optimization
- Set up and training of manufacturing processes



To learn more about CCG services, please visit cgg-composites.com

