

WIND ENERGY EBOOK

## **PERFORMANCE, SERVICE LIFE AND LOWERING THE COST OF ENERGY**

A guide to the benefits of PEEK  
polymers in wind turbines



# WINDS OF CHANGE

Renewable energy is here to stay. With the UN 2030 Sustainable Development Goals (SDGs) front and center<sup>1</sup> and the Global Wind Energy Council forecasting 469 GW of new wind power capacity installed over the next five years<sup>2</sup>, the wind turbine industry is striving for:

- Increased efficiency and performance through larger turbines and more remote locations
- Reducing the high initial investment for turbine fields
- Reduced operation cost and maintenance

OEMs are increasingly faced with critical challenges that are pushing the limits of existing materials in demanding turbine applications:

- Larger turbines could benefit from new designs and lighter weight materials
- Remote locations could benefit from new manufacturing methods and more durable materials
- CAPEX AND OPEX reductions could be improved by materials with increased lifetime reliability

1. <https://www.un.org/sustainabledevelopment/energy/>

2. <https://gwec.net/global-wind-power-growth-must-triple-over-next-decade-to-achieve-net-zero/>



# WIND TURBINES, A NEW APPROACH

With these challenges, a new approach to wind turbine construction is essential. Given our decades of experience in delivering innovative PEEK thermoplastic and composite solutions for the energy industry, Victrex understands the need for reliability, efficiency and performance in harsh environments.

Victrex polymer solutions have been known to deliver:



## WEIGHT SAVINGS

Up to 80% weight savings vs. metal help to reduce mechanical stresses



## WEAR RESISTANCE

Excellent wear resistance helps improve reliability and service life



## TOLERANCE OF EXTREME ENVIRONMENTS

Excellent resistance to moisture, lubricants, greases, salt water and other causes of chemical attack and corrosion



## NVH REDUCTION

Up to 50% reduction in noise, vibration and harshness (NVH) for a quieter operating environment, reduced fatigue, and higher power output.<sup>1</sup>

1. <https://royalsocietypublishing.org/doi/10.1098/rsta.2014.0069>

# A CLOSER PEEK AT PEEK

One of the easiest ways to understand this complex topic is to view polymers as a pyramid. This identifies three major categories of polymers:

03 / High-performance polymers

02 / Engineering polymers

01 / Commodity polymers



High Performance  
Polymers Explained

READ THE BLOG

01

02

03

PE PVC PP PS ABS PMMA PVA PVDC PET etc.

PA POM PC PPE PBT

PEI  
PI  
PAI  
PES  
PSU

LCP  
PPS  
PPA  
PTFE

VICTREX PEEK

POLYMER PERFORMANCE

## PROVEN METAL REPLACEMENT SOLUTION

Polyetheretherketones such as VICTREX PEEK are well suited to demanding environments. While alternative materials can meet specific needs, PEEK, a member of the PAEK (Poly Aryl Ether Ketones) family of polymers, can support multiple requirements. For example, the light weight and high strength PEEK polymer and its composites provide high resistance to wear, temperature, fatigue and aggressive fluids/chemicals and can contribute to:

- ✓ INCREASED RELIABILITY
- ✓ IMPROVED OPERATIONAL EFFICIENCY
- ✓ EXTENDED SERVICE LIFE
- ✓ COST SAVINGS
- ✓ MORE DESIGN FREEDOM



# WHY CHOOSE PEEK POLYMERS FOR WIND TURBINES?

- **WEIGHT REDUCTION AT AN EQUIVALENT STIFFNESS:**

Using these high performance polymers (HPPs) can result in up to 70-85% lower weight, but at an equivalent stiffness when compared to some metals

- **TRIBOLOGICAL PERFORMANCE:**

These HPPs have the ability to perform in hydrodynamic and mixed frictional environments, where there may be only boundary lubrication and even dry conditions

- **STABLE PROPERTIES:**

PEEK polymers retain their properties in corrosive, contaminated, and high-temperature service conditions

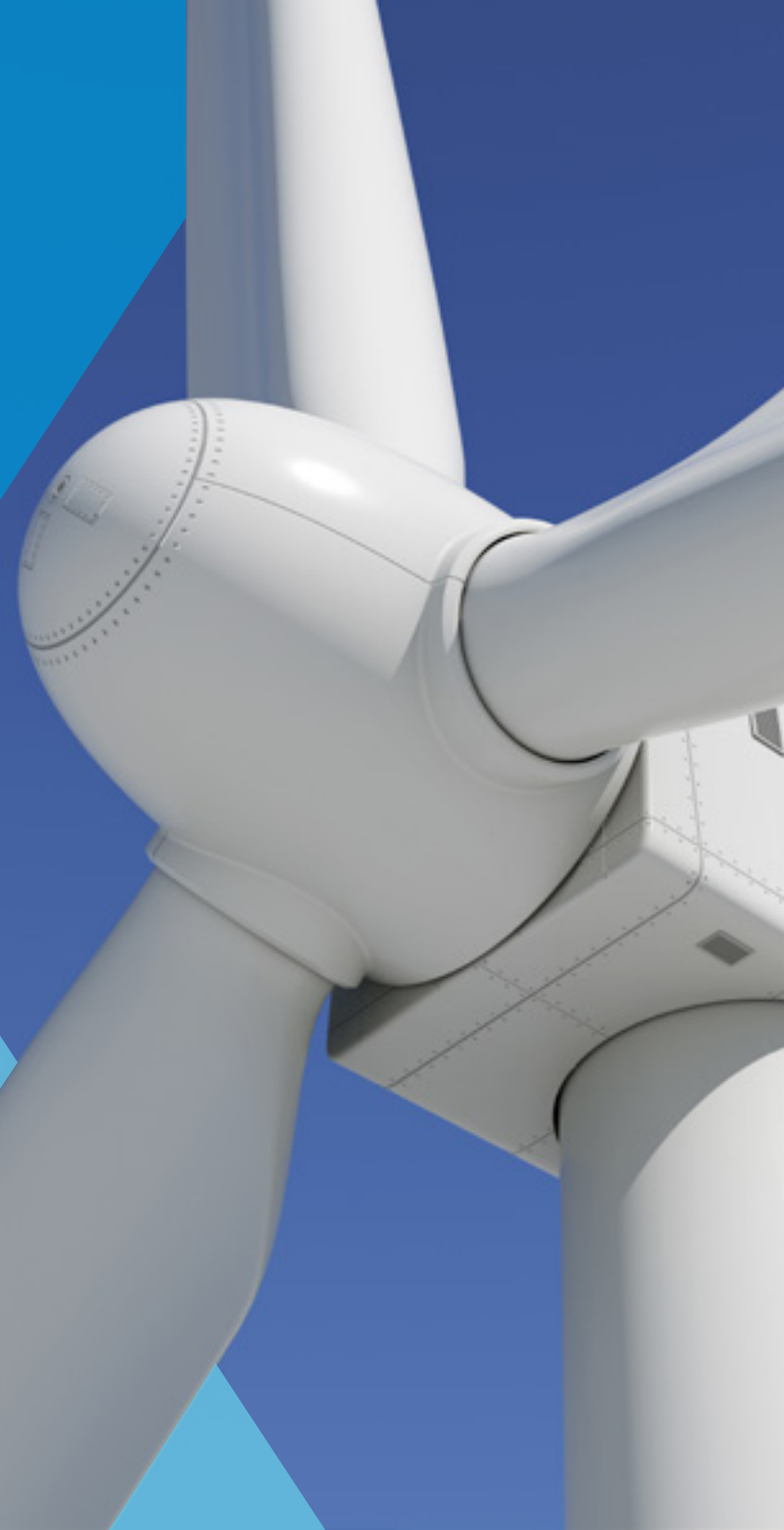
- **TUNABLE PROPERTIES:**

PEEK polymers are thermoplastic and consequently can be formulated with additives to enable design of properties for purpose

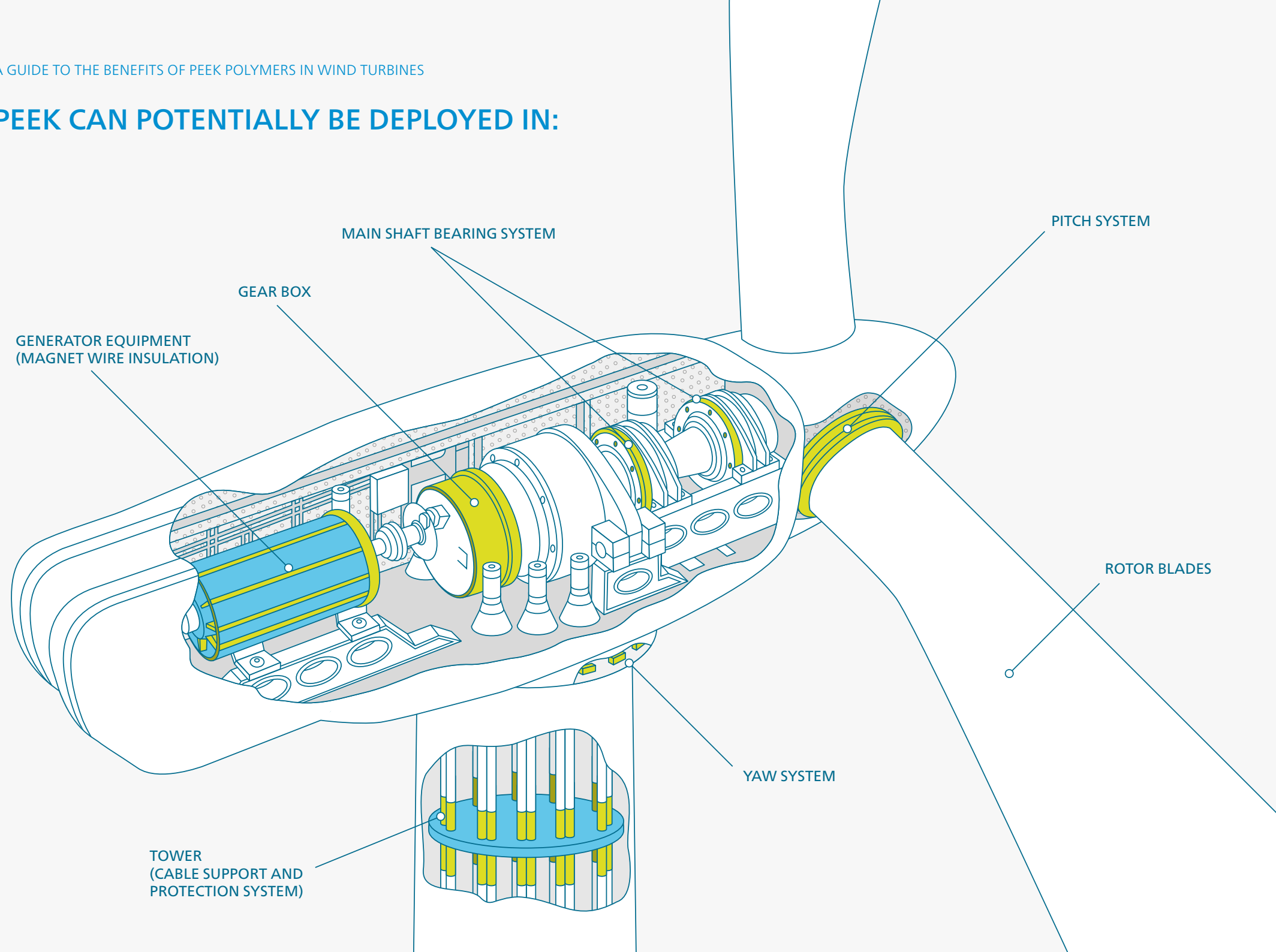


A GUIDE TO THE BENEFITS OF PEEK POLYMERS IN WIND TURBINES

# WHERE CAN PEEK BE USED IN WIND TURBINES?



PEEK CAN POTENTIALLY BE DEPLOYED IN:



## AN EXCELLENT MATERIAL SOLUTION FOR BEARING CAGES

VICTREX PEEK-based solutions can provide stable performance in temperatures ranging from  $-196^{\circ}\text{C}$  ( $-321^{\circ}\text{F}$ ) to  $260^{\circ}\text{C}$  ( $500^{\circ}\text{F}$ ) with the added capability of withstanding differential pressures up to about 360 MPa (52,200 psi). These properties may enable wind turbine bearings to survive high operational loads.

PEEK offers a combination of strength and flexibility, high operating temperature range, high chemical, moisture and wear resistance which could make it an excellent alternative for conventional alloy-based components.





## A PROVEN TRACK RECORD IN BEARINGS

In thrust washers, bushings and bearing cages, VICTREX PEEK has a proven track record in delivering:

- Stable coefficient of friction (CoF) as low as 0.05 in dry conditions
- Excellent wear performance across a range of pressure and velocity scenarios
- High compressive strength over a wide temperature range to support component miniaturisation at increased loads
- High reliability due to excellent emergency running properties
- Improved noise, vibration, and harshness (NVH) in plain bearings

# HIGH PERFORMANCE POLYMERS FOR BRAKES

PEEK polymers have mechanical & tribological properties that can translate to robust brake performance at a variety of service conditions. If implemented in a yaw brake, a PEEK-based brake could have the ability to impart higher braking pressures with less slippage.

More reliable brakes could increase energy production, help to prevent shut downs, and potentially avoid structural damage in more extreme situations.



# THE VICTREX™ PEEK ADVANTAGE

VICTREX PEEK materials have the potential to increase strength, wear performance, and corrosion resistance of sliding bearings, bearing cages, and brakes. Potential outcomes could include:

- **GREATER RELIABILITY AT SIMILAR SPECIFICATIONS:**

Weight reduction, more compact designs, wear resistance, and corrosion resistance could reduce damage to components and supporting structures over time. Their combined effect could result in longer intervals between repair/maintenance and ultimately extended service life.

- **INCREASED POWER GENERATION:**

Turbine components that can support higher torque density could enable greater power generation.

- **INCREASED EFFICIENCY WITH LIGHT WEIGHTING AND THERMOPLASTIC DESIGN FLEXIBILITY**



# 10 FACTORS TO CONSIDER WHEN CONSIDERING A MATERIAL CHANGE

Now it's time to assess how high performance polymers can benefit your application. Ask yourself these questions to kick-start the process:

- 
1. Are there alternative materials that could better meet wind turbine needs? ☐
  2. Which material can effectively and economically replace my incumbent material? ☐
  3. Does this material have a proven record of service in other demanding environments and conditions? ☐
  4. Does the material provide the combination of mechanical properties, friction and wear performance that are needed for my application? ☐
  5. Can strength to weight ratio be improved by considering this material? ☐
  6. Will the material survive moisture, lubricants, greases, salt water and other causes of chemical attack and corrosion? ☐
  7. Has the material been used in wind applications? ☐
  8. Will a polymer solution contribute to improved reliability and service life? ☐
  9. Does the material manufacturer have proven success in the same or similar applications? ☐
  10. Will the material supplier be able to support me from concept to commercialisation? ☐

# PARTNER WITH VICTREX FOR SUCCESS

VICTREX PAEK and PEEK polymers may enable greater competitiveness along the value chain from suppliers to OEMs to wind asset developers and operators. Immediate opportunities for improvement include brakes, roller bearing cages, and sliding bearings.

With over 40 years of experience and test data, Victrex can support the development of the next generation of components needed for more efficient and reliable wind turbines.

LET'S TALK



Aligned to global megatrends and fuelled by our product leadership strategy we strive to bring innovative solutions to our focus markets, shaping new materials, forms and parts.



#### ENERGY SOLUTIONS

## 75+ MILLION

VICTREX™ PEEK seals in use today.

[LEARN MORE >](#)



#### INDUSTRIAL SOLUTIONS

## 100+ MILLION

Machines operate using Victrex solutions.

[LEARN MORE >](#)



#### AUTOMOTIVE SOLUTIONS

## 500+ MILLION

VICTREX™ PEEK based parts in automotive applications.

[LEARN MORE >](#)



#### AEROSPACE SOLUTIONS

## 20,000+

Aircraft rely on Victrex solutions.

[LEARN MORE >](#)



#### ELECTRONICS SOLUTIONS

## 4+ BILLION

Mobile devices use APTIV™ acoustic film.

[LEARN MORE >](#)



#### MEDICAL SOLUTIONS

## 13+ MILLION

Implanted devices worldwide use Invibio PEEK-OPTIMA™ polymers.

[LEARN MORE >](#)



Victrex support the Sustainable Development Goals



# SUSTAINABILITY

Aligning our new sustainability vision with UN Sustainable Development Goals (SDGs)

## HIGHLIGHTS

- Achieve carbon net zero
- Increase the use of our sustainable and recyclable products which support CO2 removal
- Minimise resources used in our operations



## 2030 VICTREX GOALS



SUSTAINABLE  
SOLUTIONS



RESOURCE  
EFFICIENCY



SOCIAL  
RESPONSIBILITY



12 RESPONSIBLE  
CONSUMPTION  
AND PRODUCTION



13 CLIMATE  
ACTION



17 PARTNERSHIPS  
FOR THE GOALS

- Achieve net zero carbon emissions by 2030 in our own operations
- Increase recycling rates of PEEK/PAEK in the supply chain
- Increase revenue from our sustainable products **with positive environmental & social benefits** (currently c40%)
- Sustained reduction in resources per unit tonne by 2030



3 GOOD HEALTH  
AND WELL-BEING



4 QUALITY  
EDUCATION



5 GENDER  
EQUALITY



8 DECENT WORK AND  
ECONOMIC GROWTH

- Deliver a zero accident and incident culture
- Grow global STEM programme
- Increase community activity across our global locations
- Focus on supporting gender equality, diversity and inclusion

# WHAT NEXT?

Take a deep dive into PEEK  
for wind energy applications



**VICTREX PEEK polymers and composites  
for wind turbine wear components**

[READ MORE >](#)



**VICTREX PEEK polymers and composites  
for wind turbine sliding bearings**

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**A Closer Peek at PEEK – HPP explained**

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