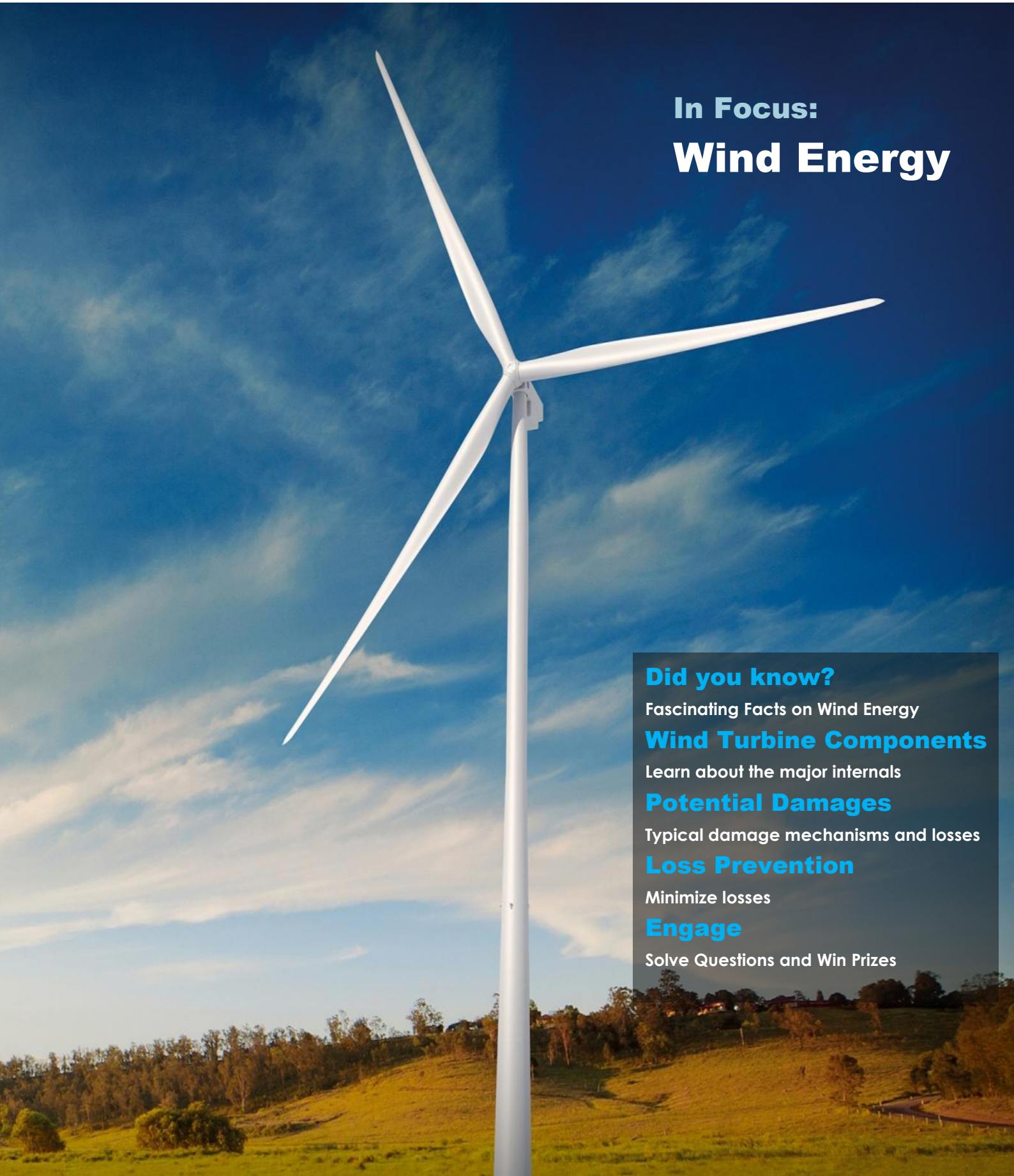
TATA AIG INSURANCE
WITH YOU ALWAYS

RE-Konnect

Risk Engineering Bulletin

June 2018 Vol. 2 | Issue 5



In Focus:
Wind Energy

Did you know?
Fascinating Facts on Wind Energy

Wind Turbine Components
Learn about the major internals

Potential Damages
Typical damage mechanisms and losses

Loss Prevention
Minimize losses

Engage
Solve Questions and Win Prizes

Preface

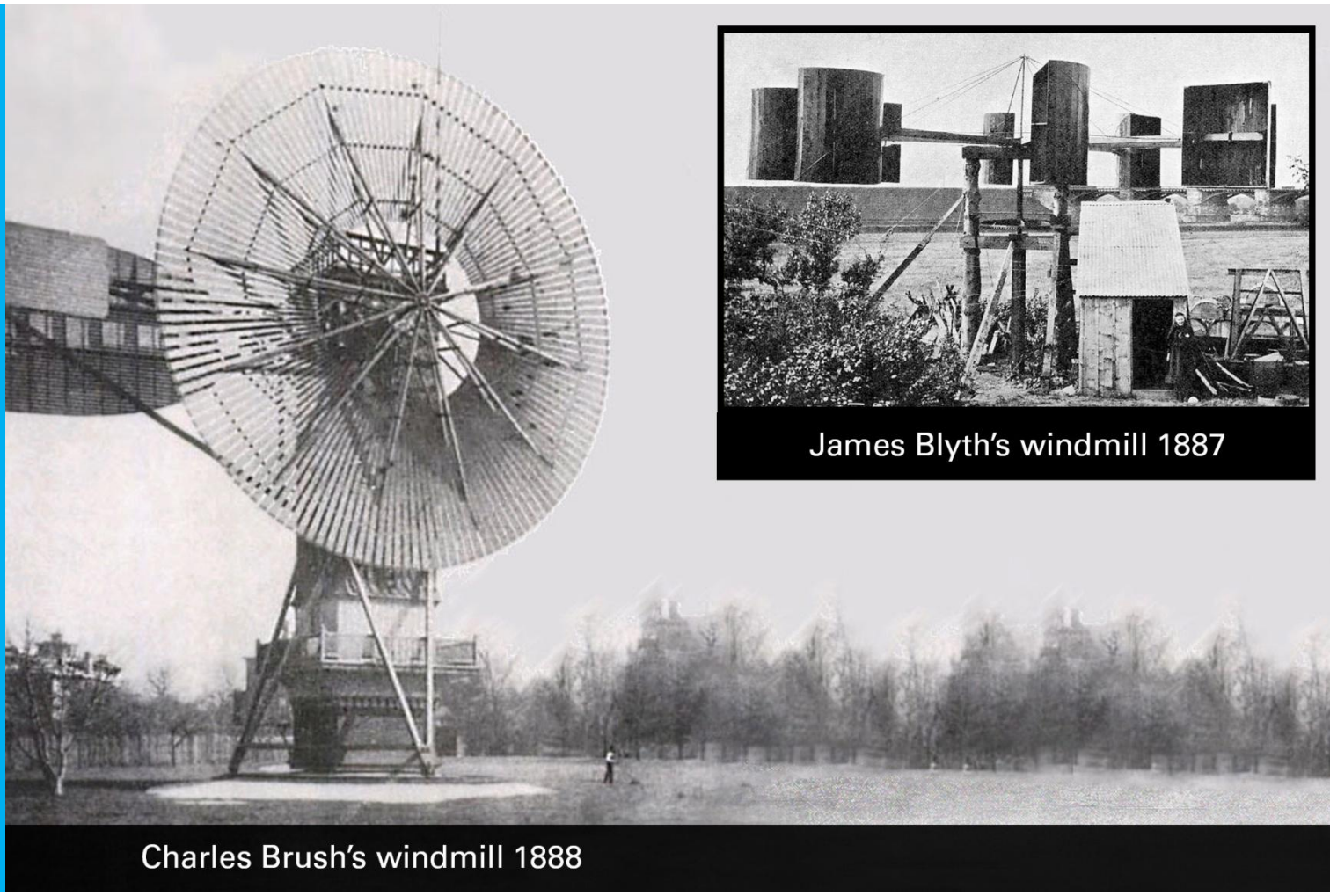
Man has been harnessing energy from wind since ages. Reports about installations utilizing the wind energy and intended for irrigation systems date from as early as 1700 BC. Systems with a horizontal rotating axis have been known since the 12th century and frequently served for direct use of wind energy within milling units. Renewable forms of power generation are more and more in the focus of investments in the energy sector. In this process, energy production by wind turbines has developed into an important power generation source.

In this issue of RE-Konnect, we present you a brief overview on wind turbines, focussing on various hazards faced by the industry and loss prevention.

Did You Know?

- Sail boating is the earliest known use of wind power for mankind. Wind energy propelled boats along the Nile River as early as 5000 B.C.
- In 200 B.C., simple windmills in China were pumping water, while vertical-axis windmills with woven reed sails were grinding grain in Persia and the Middle East. Returning merchants and crusaders carried this idea back to Europe. The Dutch refined the windmill and adapted it for draining lakes and marshes in the Rhine River Delta.
- The first known wind turbine used to produce electricity was built in Scotland in 1887.
- The first modern wind turbine was built in 1940's in Vermont. During World War II, the largest wind turbine known in the 1940s, a 1.25-megawatt turbine that sat on a Vermont hilltop known as Grandpa's Knob, fed electric power to the local utility network.
- Wind farms can be constructed in off shore locations. Winds are steadier and stronger in offshore locations but setting up infrastructure is costlier.
- Wind is caused by the uneven heating of the atmosphere by the sun, variations in the earth's surface, and rotation of the earth. Mountains, bodies of water, and vegetation all influence wind flow patterns and hence the amount of wind energy that can be harnessed.
- According to National Renewable Energy Laboratory, 1MW of wind energy can offset approximately 2,600 tons of carbon dioxide (CO_2).

First known wind turbine designs used in the production of electricity



James Blyth's windmill 1887

Charles Brush's windmill 1888

Jaisalmer Wind Park, India's largest wind farm with a capacity of 1064 MW

Wind Turbine Components

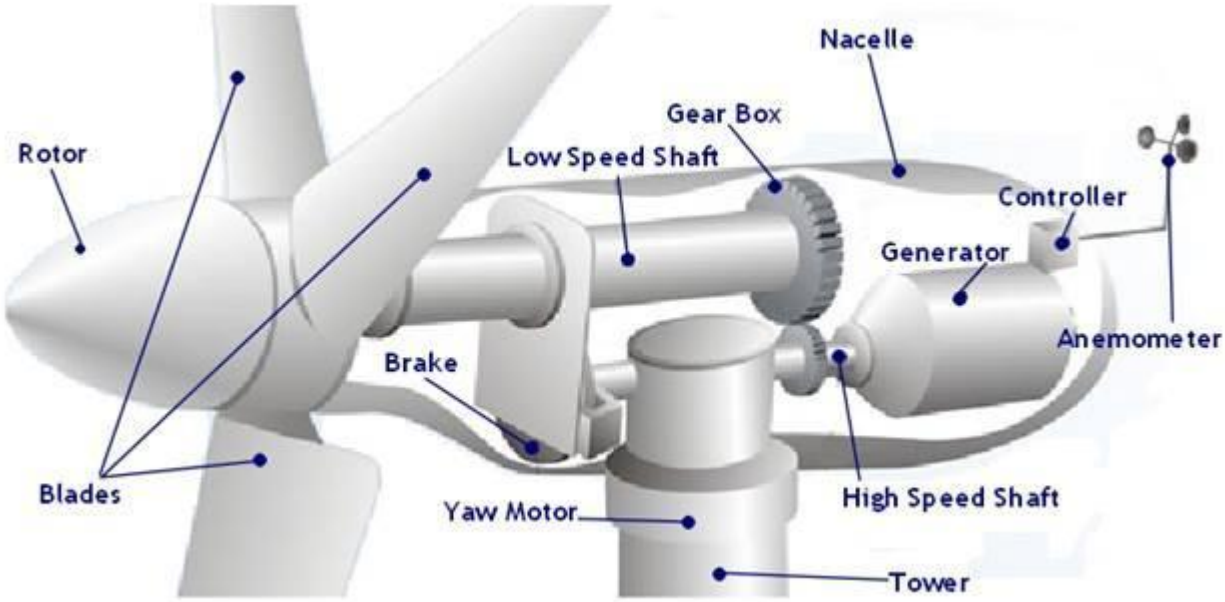
There are different concepts and designs of wind turbines that have been and are being developed and tested since their first invention. The three-blade rotor with a horizontal rotating axis and aerodynamically optimized profiles is the only design that has gained wide acceptance today and is found in most stations.

In this configuration, the rotor blades run on the windward tower side. Although system details may vary considerably between manufacturers, the basic design is mostly the one shown in figure.

The essential components of a wind turbine include:

- The supporting structure (foundations and tower),
- The nacelle on top if it, with an azimuth controls system,
- The energy conversion section comprising the generator and possibly a gearbox inside the nacelle,
- The rotor that is connected with the energy conversion section and supported by the main bearing

Typical major components inside a Nacelle are shown in the figure below:



Potential Damages – Typical Loses

Wind turbines have been hailed as one of the greatest advancements in the age of renewable energy, but often the potential negative impacts and occasionally downright deadly disasters involving these green energy darlings are ignored. Losses may occur in any part of the turbine. High losses occur due to the total fire/destruction of the unit. Total losses of wind turbines frequently occur due to fires following a lightning strike or due to damage to mechanical or electric wind turbine components.

Lightening Damage

Considering the height, wind turbines are vulnerable to lightning strikes. The rotor blades are usually equipped with lightning receivers that are intended to divert lightning in a controlled way in combination with metal conductors, slip rings and/or spark gaps. However, any inadequacy on these components can occur due to faulty installation and maintenance of the lightning protection system. In these cases, loss occurs on rotor blades, electronic switchgear etc. Lightning strikes are one of the major causes of fires in wind farms.

Damage to central electrical panels and equipment

Damage to the transformer substation, especially damage to transformers is possible and will put an entire wind farm out of operation if it occurs. The number of damaged cables in wind farms has increased recently and this occurrence will have the same effect, i.e. a temporary downtime of the entire wind farm.

If the substation transformers are not owned by the wind farm owner, the downtime increases as multiple parties are involved in the restoration of the same.

Converters and other electric equipment

Damage to electric components of a wind turbine usually is not different in terms of features from damage occurring in electrical systems used in other areas of application. Electronic semiconductor components, especially insulated-Gate Bipolar Transistors (IGBTs) constitute an exception to this rule. These components are used in the power electronics section of wind turbines in order to make constant and mains-compatible electric power available for feeding into the mains grid from wind-oriented units with variable generator frequency and voltage through a converter. Failure of these semiconductor components results in a wide range of damage which rarely reaches the loss amounts mentioned above.

Burglary

The number of damaged cables in wind farms has increased recently, putting the entire wind farm out of operation temporarily. Stolen cables are frequently the origin of such cases. In other cases, damage to cables occurs, for example excavators often cut cables during excavation works in the vicinity of these wind farms.

Gearbox damage or Rotor Damage in turn leading to Fire Loss

Gearbox damages and rotor damage counts among the most expensive losses that can occur on a wind turbine. Variations in load occur due to gusts of wind, turbulences, and braking processes as well as periodic loads due to tower oscillations etc. Premature material fatigue on gears, gearbox parts and on shaft and gearbox bearings cannot be excluded under these conditions. During these conditions, the overstressed brakes, hot bearings and also lightning strikes may lead to fire. Mechanical or mechano-hydraulic brakes may reach high temperatures if the aerodynamic brakes fail during operation, and thus constitute another hazard that can cause ignition of combustible materials.

Fires cause almost total losses of wind turbines. The avoidable fire loads that occur often include oil and grease escaping through leaks in lubrication systems. In addition, there are numerous components of a wind turbine which represent high fire loads due to their operational use, e. g. cable harnesses, control cabinets as well as plastic coverings and GRP rotor blades. Fires of electronic equipment/control systems/compensation units are also possible.

Loss Prevention

The overall property and liability risk for wind turbines is almost common. The level of protection needed should be based on an individual risk analysis. The following are the basic loss prevention methods used to reduce the risk in the turbines:

1. Lightning protection of wind turbines/wind farms

Apart from lightening, over voltage is one reason which can destroy certain electrical and electronic equipment. In order to safeguard the critical electrical equipment and sensitive control system of wind turbine, an over voltage protection is recommended. The manufacturers consider this in an early stage and design it as per the maximum hazard category according to IEC 62305. The continuous functionality of the same depends on the regular maintenance of the system with regular inspection and immediate removal of any faults that have been detected without any delay.

Regular testing of the earth resistance is therefore required to ensure the function of the lightning protection system along the entire distance from the blade tips to the earthing.

2. Fire alarms and fire protection systems

Considering the entire turbine as single equipment, there is no structural fire compartmentalization, a fire can spread and cause total destruction of the plant. In case of fire in the nacelle, the probability of a large-scale loss due to a fire is increased by the fact that the fire brigade cannot fight a fire at such heights.

It is recommended to protect large turbines with a cost-effective 'clean agent' micro-system that only targets the specific fire hazard. There are devices on the market that are safe for release in case of fire and safe even while technicians are inside a turbine. There are also multiple options for extinguishing fire in the substation transformers like N_2 flooding system and High Velocity water spray system.

3. Remote Condition Monitoring System

Breakdowns that attribute to fires and large repairs can be reduced provided they are continuously monitored. Monitoring and analysis of bearings, gearbox (of the generator), rotor blades and other components are essential for enabling detection of developing damage (to overheating and vibrations of bearings, electrical faults) at an early stage and can allow avoidance or limitation of potential damage with little effort.

As a supplement, it is recommended to evaluate the recorded data using trend analyses as well in order to detect potential future failures that may lead to losses as early as possible.

4. Inspection and Maintenance Programs

Regular inspection of turbines helps out in identifying the faults in systems. Each and every manufacturer provides recommendations on the inspection schedules. This includes regular visual inspections, trending unit performance and analyzing lube oil in the gearbox. Also all the interlocks and protections are to be tested (for wind cut-off/cut-in, vibrations, temperatures) post overhaul of the machine or annually.

Guidelines

Following codes and standards can be referred for further reading:

- **NFPA 850:** Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
- **IEC 61400:** Class of international standards published by IEC (International Electrotechnical Commission) regarding wind turbines
- **NFPA 70:** National Electrical Code

Engage

Answer the following question and win Amazon coupons worth Rs 500 each. Send the answer to *editor.bulletin@tataaig.com* . Five winners for this quiz will be announced in the next issue.

Q1. When was the first known wind turbine used to produce electricity:-

a) 5000BC
b) 1887
c) 1945
d) 1200BC

Q2. Which of the following scenarios requires remote monitoring to avoid a loss?

a) Heating up of Gear box
b) Detecting Vibrations in the rotor
c) Electrical Faults
d) All of the above

Q3. Which of the following equipment does lighting harm?

a) Rotor Blades
b)Transformers
b) Control Panels
d) All of the Above

Winners of the previous issue are as follows:

- **Pradeep Jaiswal** – HMEL, Bhatinda
- **Alok Patel** – GIC of India, Mumbai
- **Pradeep Jain** – Petronet LNG
- **Amit George** – Unison Insurance Broking Services, Vadodara
- **Tarun Parashar** – HEML, Bhatinda

Answers to previous questions: 1. Avoid & look for alternatives 2. All of the above 3.Permit Issuer is an own employee at Supervisory Level

Abhimanyu Mannepalli
Risk Engineering, Energy (PowerGen)
abhimanyu.mannepalli@tataaig.com

For feedback or comment related to the bulletin please contact: *editor.bulletin@tataaig.com*

World's first hybrid wind-hydro energy generator in Germany's Swabian-Franconian Forest

To download previous issues of the bulletin, please visit the following link:
https://www.tataaig.com/PropertyEnergyLossPrevention

Tata-AIG General Insurance Company Limited
Peninsula Business Park, Tower A, 15th Floor
G. K. Marg, Lower Parel, Mumbai 400013
www.tataaig.com