Key Insights for respective Dashboards**:**

**Insights based on the Wind Turbine Failure Dashboard 01:**

* **Wind turbine failure rate:** The overall wind turbine failure rate in January is 20.45%. This is a relatively high failure rate, and it is important to investigate the underlying causes.
* **Wind turbine failure rate over time:** The dashboard shows that the wind turbine failure rate has been increasing over time. This is a concerning trend, and it is important to identify and address the factors that are contributing to it.
* **Gearbox inlet temperature:** The gearbox inlet temperature is a key indicator of gearbox health. The dashboard shows that the gearbox inlet temperature has been increasing over time. This could be a sign of gearbox problems, and it is important to monitor this metric closely.
* **Generator bearing temperature over time:** The generator bearing temperature is another key indicator of generator health. The dashboard shows that the generator bearing temperature has been fluctuating over time. This could be a sign of generator problems, and it is important to monitor this metric closely.
* **Failure status based on wind speed**: The dashboard shows that the wind turbine failure rate is higher at higher wind speeds. This is likely due to the increased stress on the wind turbine components at high wind speeds.
* **Power generation over time:** The dashboard shows that the power generation has been decreasing over time. This could be due to a number of factors, including wind turbine failures, reduced wind speeds, and component degradation.
* **Correlation between power and wind speed:** The dashboard shows a strong correlation between power generation and wind speed. This is as expected, as wind turbines generate more power at higher wind speeds.
* **Comparison of generator and nacelle ambient temperature over time:** The dashboard shows that the generator temperature is typically higher than the nacelle ambient temperature. This is because the generator generates heat as it operates.

**Recommendations:**

* Investigate the causes of the high wind turbine failure rate.
* Monitor the gearbox inlet temperature and generator bearing temperature closely.
* Develop a wind turbine maintenance plan that takes into account the higher failure rate at higher wind speeds.

**Insights based on the Wind Turbine Failure Dashboard 02:**

* **Sum of wind speed and power over time:** The sum of wind speed and power has been increasing over time. This could be due to a number of factors, including increased wind speeds, increased power generation capacity, or a combination of both.
* **Failure status depending on ambient temperature:** The failure rate of wind turbines is higher at higher ambient temperatures. This is likely due to the increased stress on the wind turbine components at high temperatures.
* **Performance of rotor speed over time:** The rotor speed of wind turbines has been fluctuating over time. This could be due to a number of factors, including changing wind speeds, wind turbine component degradation, or a combination of both.
* **Temperature of gear oil over time:** The temperature of gear oil has been increasing over time. This could be a sign of gearbox problems, and it is important to monitor this metric closely.
* **Failure status based on generator speed over time:** The failure rate of wind turbines is higher at higher generator speeds. This is likely due to the increased stress on the wind turbine components at high generator speeds.

**Recommendations:**

* Develop a wind turbine maintenance plan that takes into account the higher failure rate at high ambient temperatures and high generator speeds. This may involve more frequent inspections and maintenance at high temperatures and high generator speeds.
* Monitor the temperature of gear oil closely. If the temperature of gear oil increases significantly, it may be a sign of a problem. In this case, preventive maintenance should be performed to avoid a failure.
* Investigate the reasons for the fluctuating rotor speed. This may involve gathering additional data, such as wind speed data and maintenance records. Once the reasons have been identified, corrective action can be taken.

**Insights based on the Wind Turbine Failure Dashboard 03:**

* **Average Gear Box Inlet Temperature:** The average gear box inlet temperature has been increasing over the past year. This could be a sign of wear and tear on the gear box, which could lead to failure.
* **Wind direction by Month:** The most common wind direction is from the west. There are also more failures in the winter months, when the wind is stronger.
* **Failure Status based on Wind Direction:** The highest percentage of failures occurs when the wind is blowing from the west. This could be because the wind turbines are more stressed when the wind is blowing from this direction.
* **Average of Nacelle temperature:** The average nacelle temperature has been decreasing over the past year. This could be a sign of problems with the cooling system, which could lead to failure.
* **Sum of Gear oil temp and Generator bearing Temp over Month:** The sum of gear oil temperature and generator bearing temperature has been increasing over the past year. This could be a sign of wear and tear on the gear box and generator bearing, which could lead to failure.
* **Sum of Wind speed, Power, and Generator speed by Month:** The sum of wind speed, power, and generator speed has been increasing over the past year. This is likely due to the increasing number of wind turbines in operation.

**Recommendations:**

* Investigate the cause of the increasing gear box inlet temperature. This could be due to a number of factors, such as wear and tear on the gear box, problems with the cooling system, or excessive dust build-up. Once the cause is identified, corrective action can be taken, such as repairing or replacing the gear box, cleaning the cooling system, or installing dust filters.
* Monitor the wind turbine failures by wind direction. The higher percentage of failures in the winter months could be due to the stronger winds. It is important to monitor the wind turbines closely during this time and to take preventive measures, such as reducing the turbine's power output or shutting it down completely in high winds.
* Investigate the cause of the decreasing nacelle temperature. This could be due to problems with the cooling system, such as a leak or a blockage. It is important to identify and fix the problem quickly to prevent the nacelle from overheating.
* Monitor the sum of gear oil temperature and generator bearing temperature. The increasing temperature could be a sign of wear and tear on the gear box and generator bearing. It is important to monitor this closely and to take corrective action as needed, such as replacing the gear box or generator bearing.