Benha University

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Renewable Energy Systems

By

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Lecture (11)

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Renewable Energy Systems Efficiency

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Factors that Affecting Wind Energy System Efficiency

- Wind energy is one of the cleanest form of producing power form a renewable source.

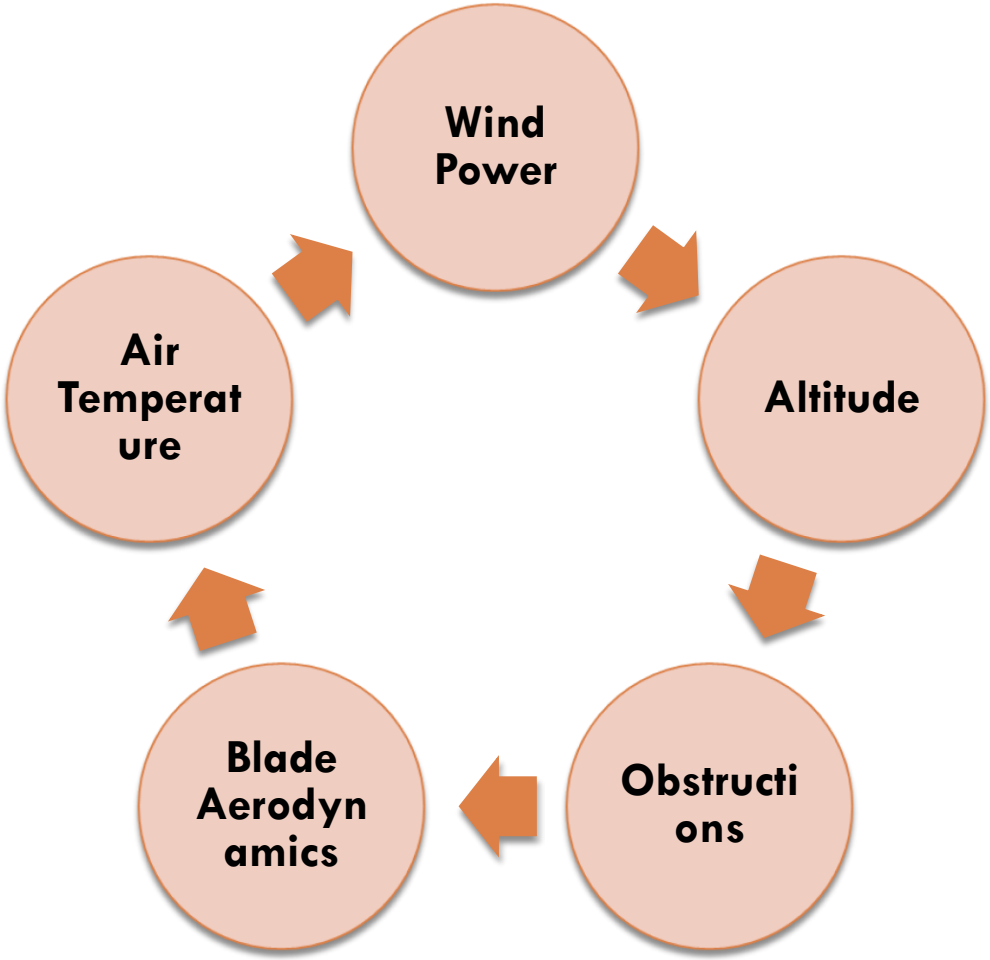
BUT !!!!!!!!!!

BUT !!!!!!!!!

BUT !!!!!!!!!

But are you aware that wind turbines are not that easy to set up ????

The efficiency of wind turbines depend on 5 major factors



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1. Wind Power

- **Let:**
  - * P= wind power
  - * V= wind speed
  - * F= wind force

- **Then:**

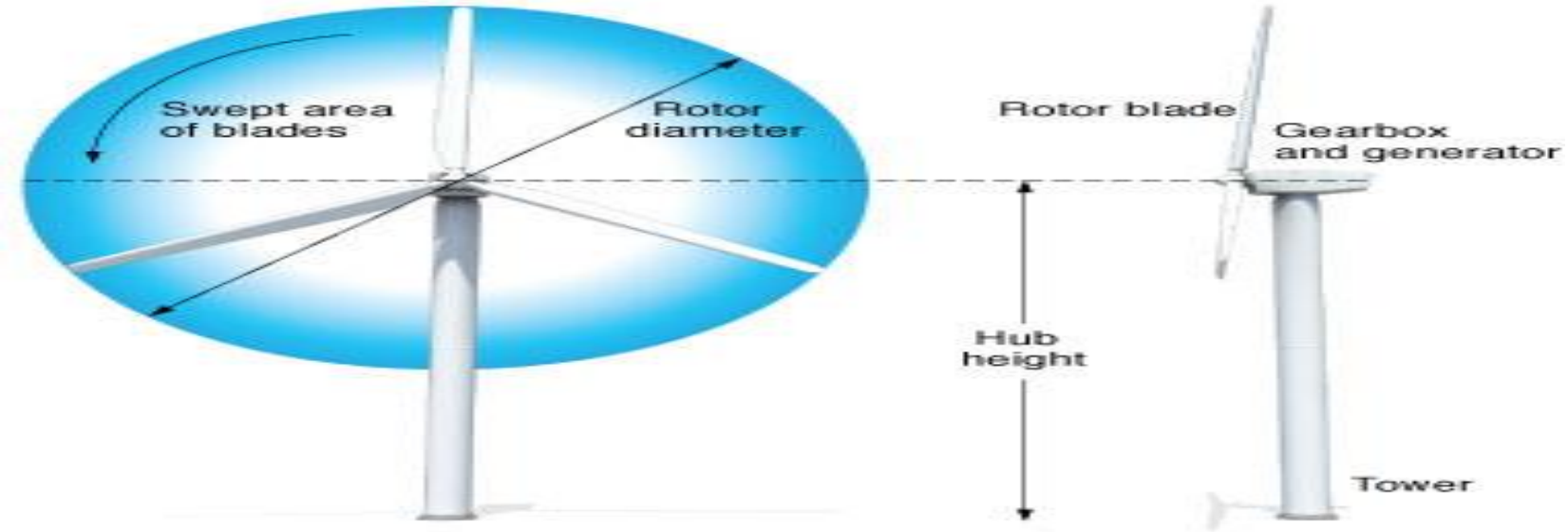
$$P = kVF$$

- **Where (k) is a constant.**

- The faster the wind speed and the stronger the wind force, the greater the amount of power generated by a wind turbine.
- Different regions have different wind speeds. Therefore its vital to understand the relation ship between wind speeds with power production.

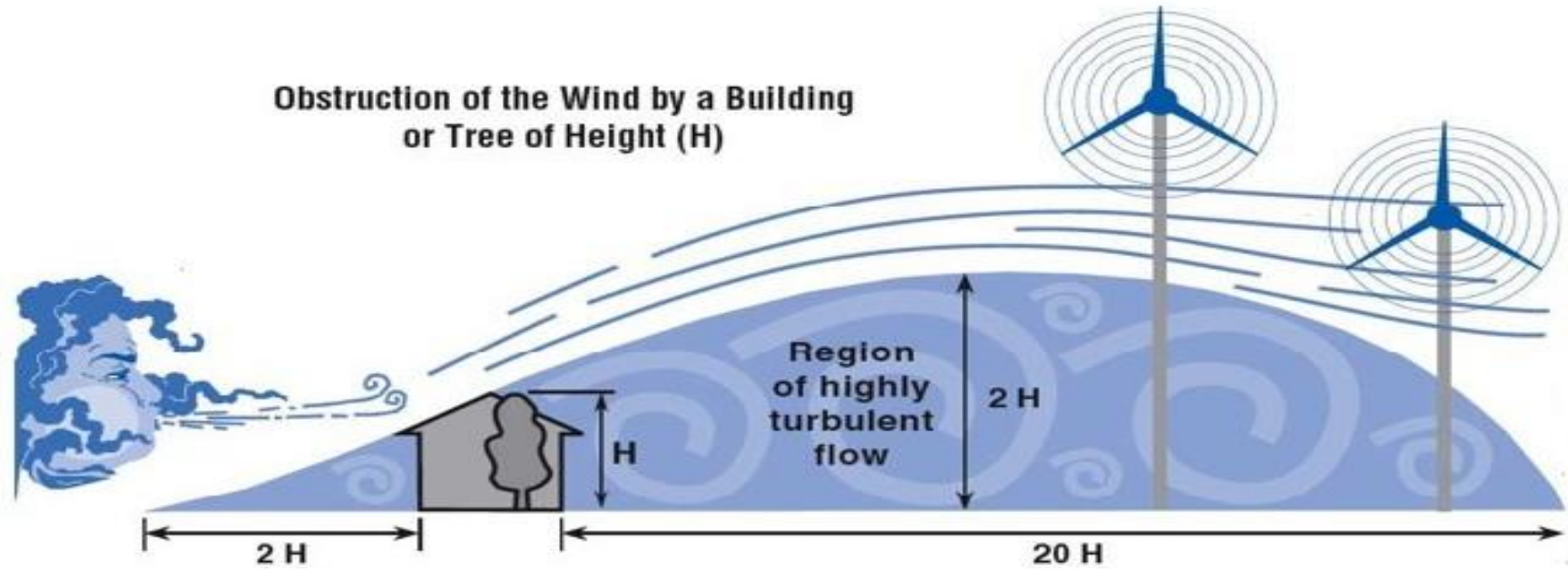
2. Altitude

- Place of higher altitudes have faster wind speeds due to various atmospheric factors.
- Higher places also have lesser obstructions from the surrounding hills, trees, and buildings.
- Wind speed increases by 12% as the distance between the turbine and ground is doubled.



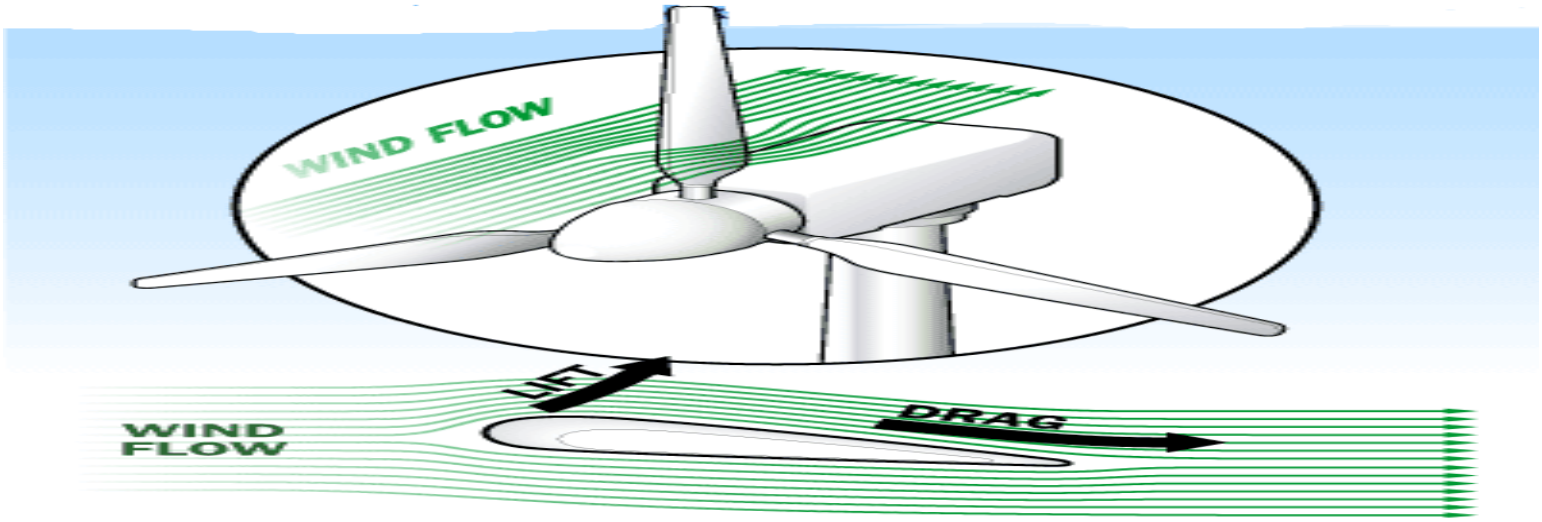
3. Obstructions

- Wind is slowed by trees, buildings, hills, and mountains which all create some form of friction that restrict free airflow.
- Its wise to measure the wind speed at a proposed site for at least one year to determine project viability.



4. Blade Aerodynamics

- The shape of blades should be accurately selected for getting maximum efficiency.
- The amount for a given airfoil depends heavily on the angle that it makes with the direction of the relative wind, known as the angle of attack.
- When the angle of attack gets too large, turbulence develops and drag increases significantly, while lift is lost.



5. Air Temperature

- The power from a wind turbine will increase almost 16% as the temperature drops from $+20^0$ C to -20^0 C for any given wind speed.
- Colder air is denser and increases power output.

Renewable Energy Systems Maintenance (Wind Systems)

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Wind Turbine Maintenance

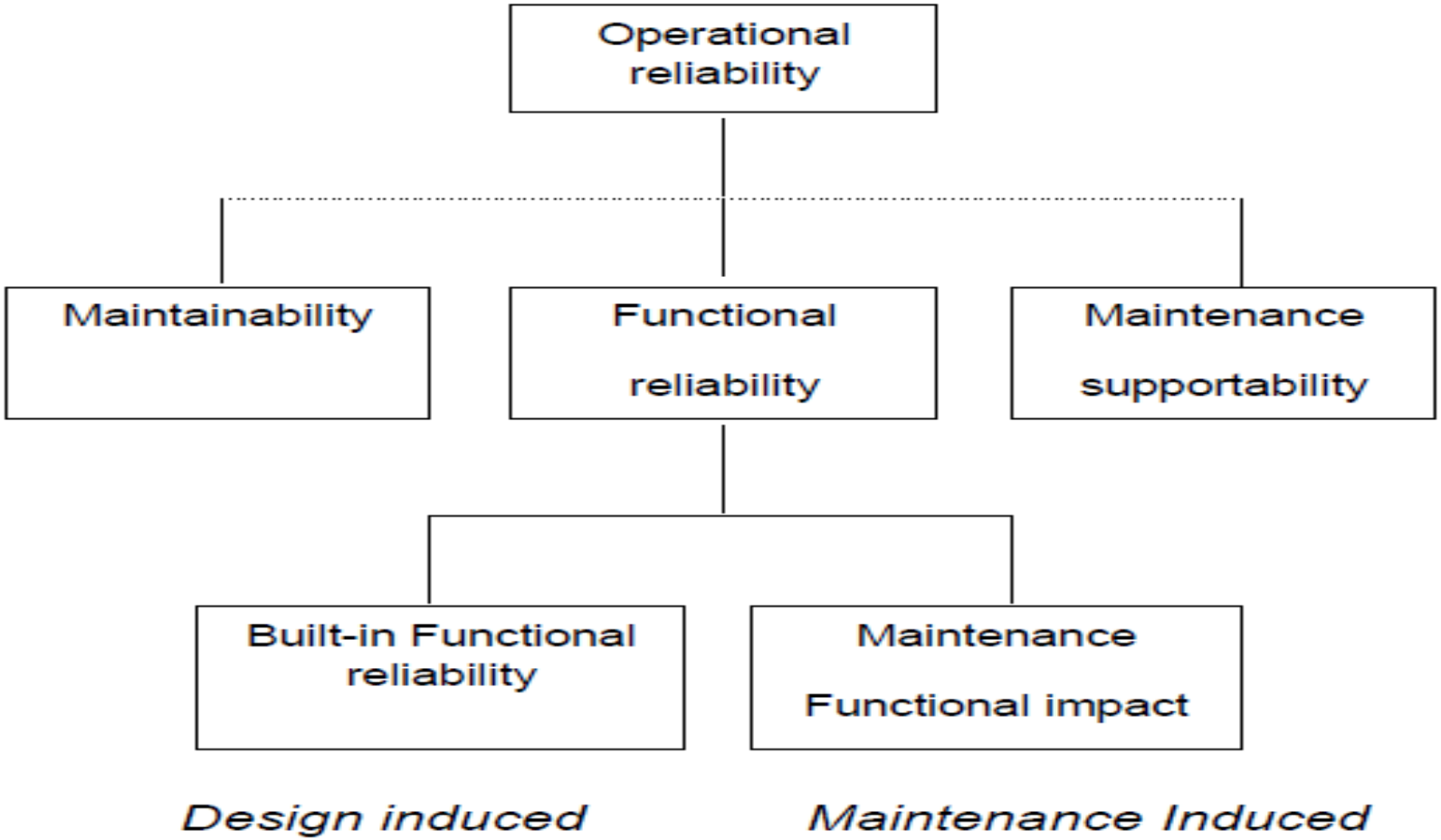
- Many of the failures may originate from handling errors or incorrectly applied maintenance methods.
- It is therefore important that the machine is run and maintained properly at determined intervals to avoid serious and costly breakdowns.
- We can then define the main objectives for maintenance activities as:

a) **Personal safety.**

b) **Environmental safety.**

c) **Operational reliability.**

The concept of operational reliability



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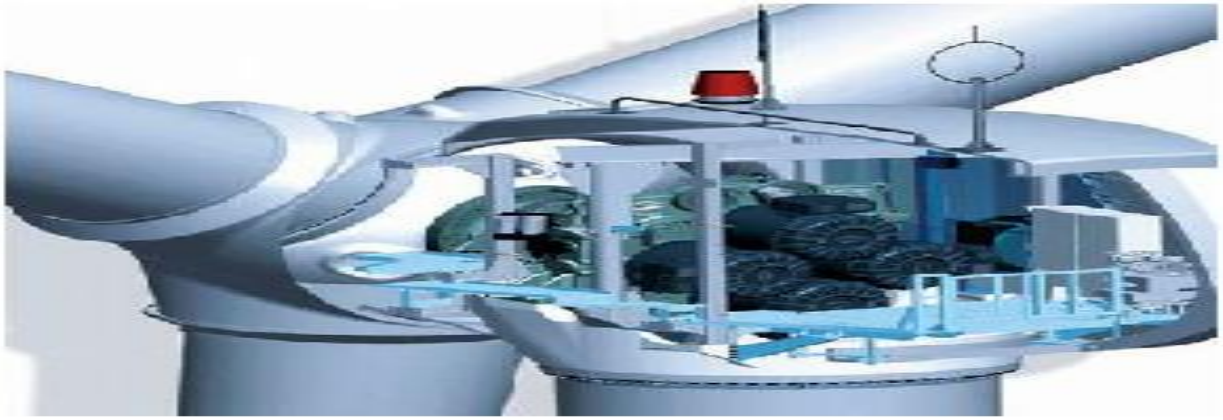
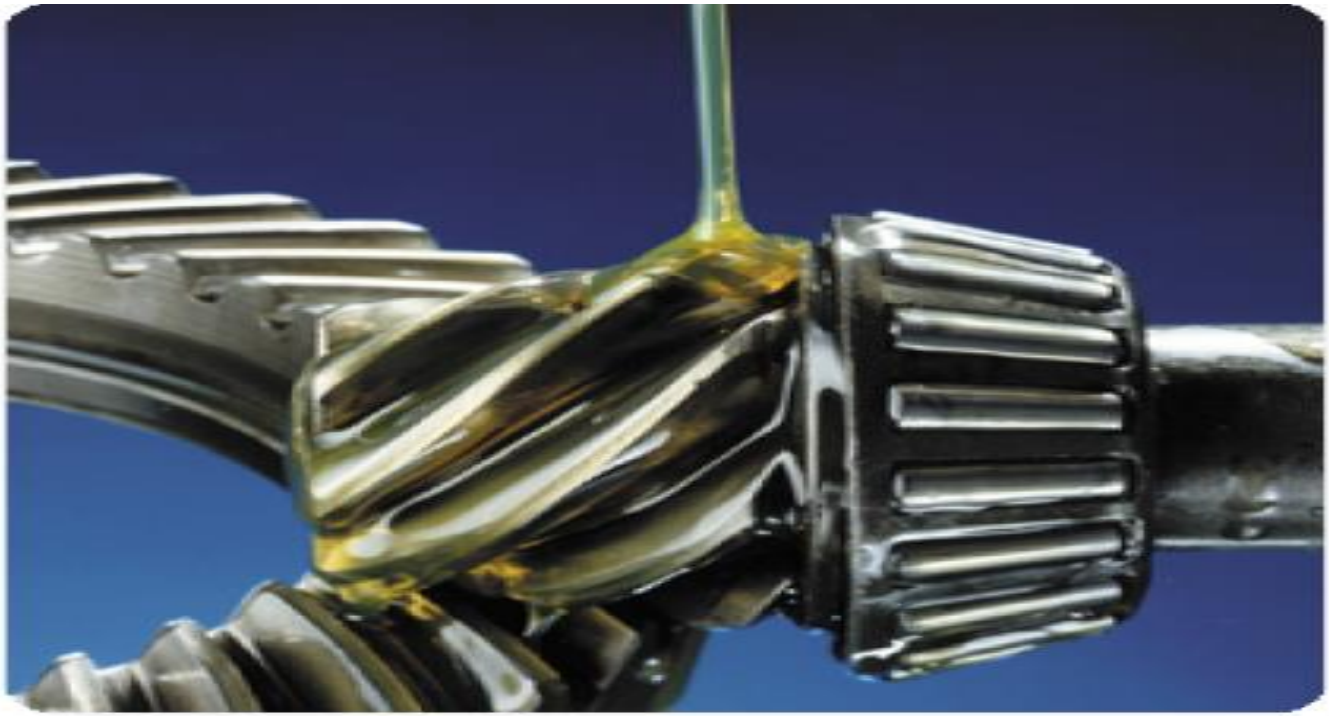
1. Maintainability

- This is a factor that indicates how equipment or a machine is adapted to facilitate maintenance and service.
- It will include physical location, resource requirements, need for
- lifting equipment, special tools requirement or selection of standard components.
- Maintainability must start on the drawing board and during the design period.



2. Functional reliability

- This factor is the ability of equipment or component to operate as intended under the given operating conditions (environmental, raw material) for the specified time.



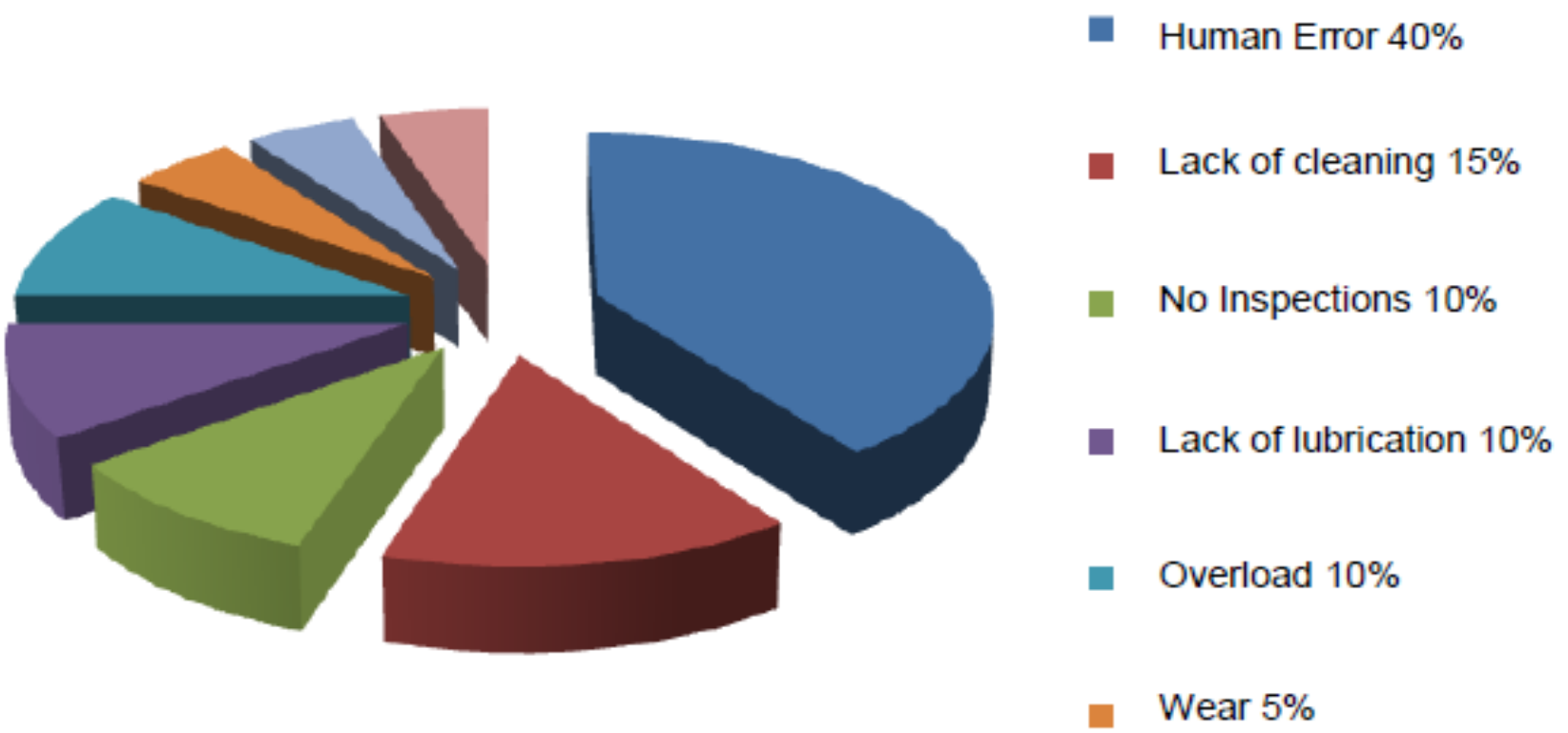
3. Maintenance supportability

- This factor specifies in a quantitative manner the possibility of utilizing spare parts, tools, aids and resources for a maintenance operation at the right time and at the right cost.

Condition based maintenance

- Condition based maintenance makes it possible to schedule maintenance more effectively, and identify the deviations and failures before the deviation/failure affects production or becomes so great that a costly breakdown occurs.
- Condition monitoring is divided into three groups:-
  - Subjective inspection.
  - Objective inspection.
  - Condition monitoring using continuous monitoring.

Implemented failures



Maintenance Challenges and opportunities

- Improving reliability.
- Turbine supplier monopoly during warranty period.
- Potential future scope for third-party service providers at projects which have come out of warranty.
- Strong skills and training demand

(Solar Photovoltaic Systems)

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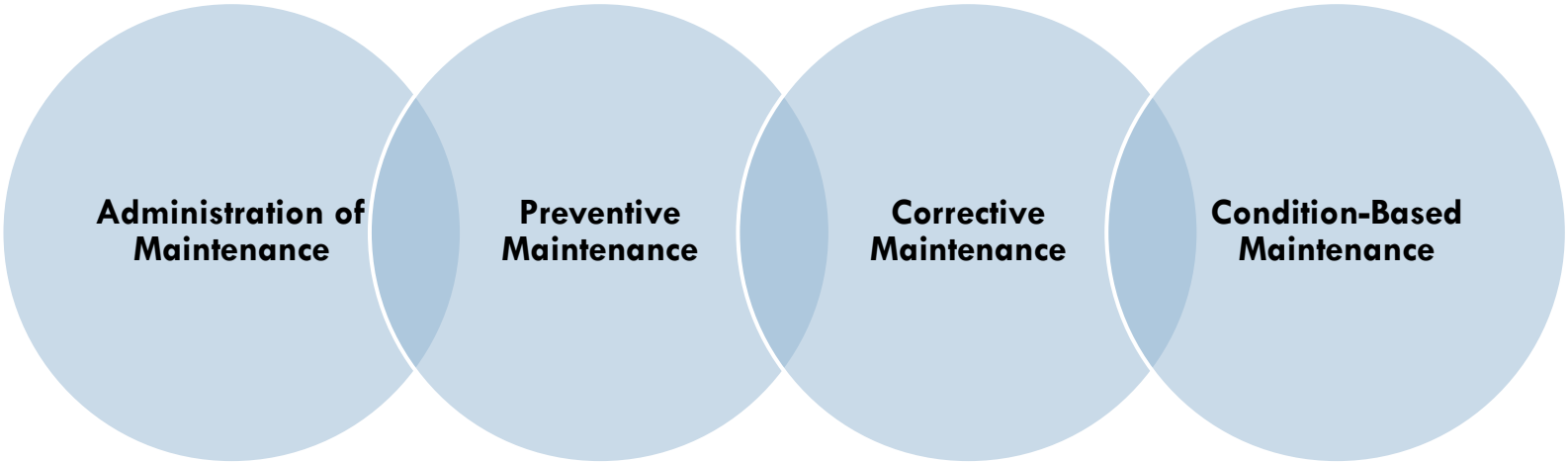
PV Maintenance

- **PV Maintenance** includes the following four types of maintenance procedures:



1. Administration of Maintenance

- Administration includes: establishing budgets and securing funds for preventive maintenance, establishing reserves or lines of credit for corrective maintenance.
- planning services to avoid conflict with system operation or operations at the customer site, correspondence with customers, selection and contracting with service suppliers and equipment manufacturers, record keeping, enforcement of warranties.

2. Preventive Maintenance

- Scheduling and frequency of preventive maintenance is set by the operations function and is influenced by a number of factors, such as equipment type, environmental conditions at the site (snow, pollen, humidity, dust, wildlife), and warranty terms.
- Scheduled maintenance is often carried out at intervals to conform to the manufacturer recommendations as required by the equipment warranties.

3. Corrective Maintenance

- Required to repair damage or replace failed components.
- It is possible to perform some corrective maintenance such as inverter resets or communications resets remotely.
- Also, less urgent corrective maintenance tasks can be combined with scheduled, preventive maintenance tasks.

4. Condition-Based Maintenance

- Condition-based maintenance is the practice of using real-time information from data loggers to schedule preventive measures.
- Because the measures triggered by condition are the same as preventive and corrective measures, they are not listed separately.
- Rather, condition-based maintenance affects when these measures occur, with the promise of lowering the frequency of preventive measures and reducing the impacts and costs of corrective measures.

Preventive/Scheduled Maintenance

- Preventive maintenance maximizes system output, prevents more expensive failures from occurring, and maximizes the life of a PV system.
- Preventive maintenance must be balanced by financial cost to the project.
- Preventive maintenance depend on system size, design, complexity, and environment.

Failure in materials and workmanship, such as encapsulate of this module, are often covered by "product warranty."

Snail trails in encapsulate are attributed to cracks in cells caused by flexure of the panel at the factory, shipping, or installation. The module would be covered by the "performance warranty" only if the cracks isolate fragments of the cell and reduce the output over time.

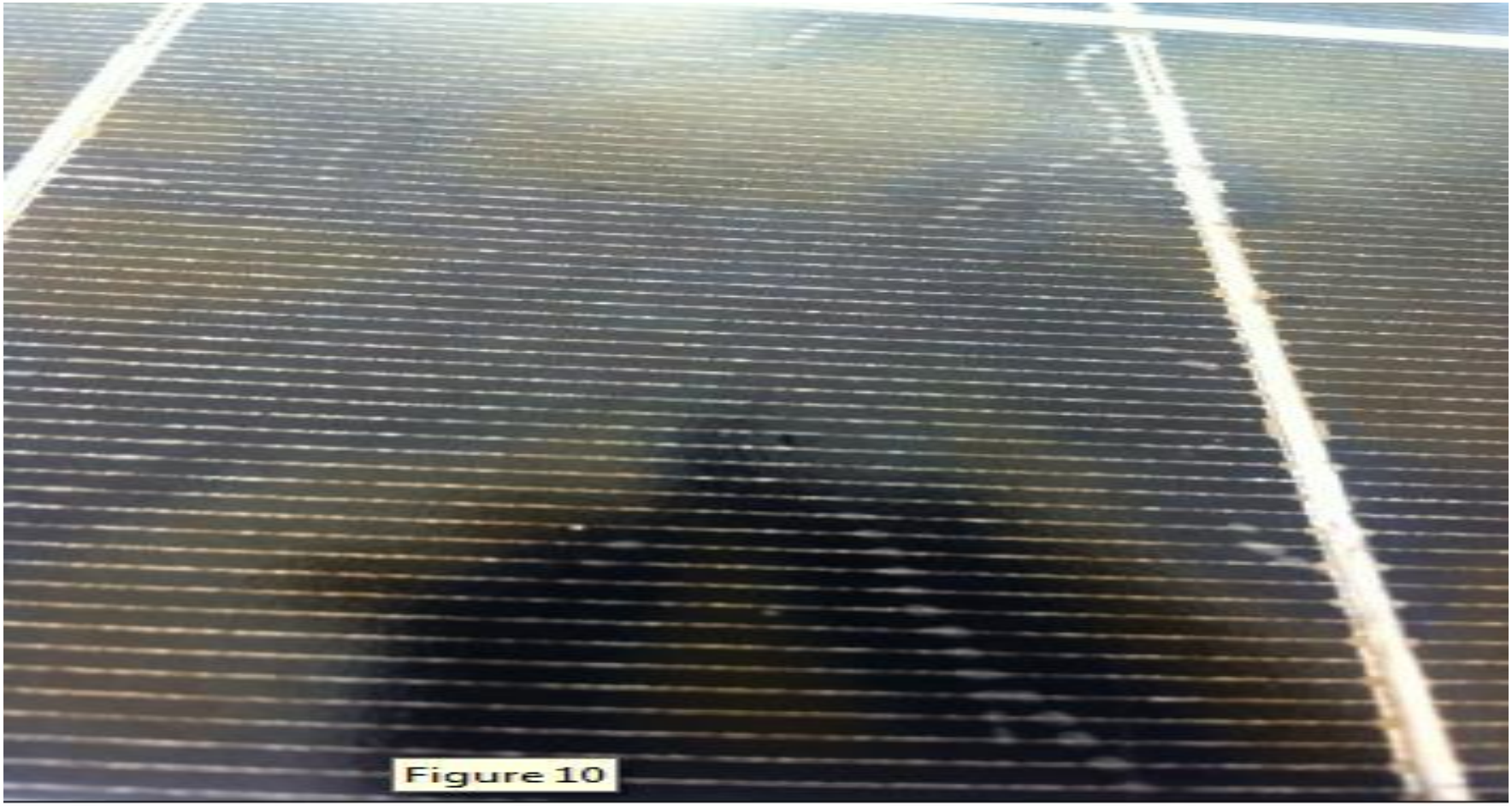


Figure 10

Failure to follow product box handling and storage requirements can cause damage when moved and void a warranty. The umbrella symbol on this box indicates it should be kept dry and the box might fail when picked up with a forklift

Figure 11