Unconventional Types of Horizontal Axis Wind Turbines

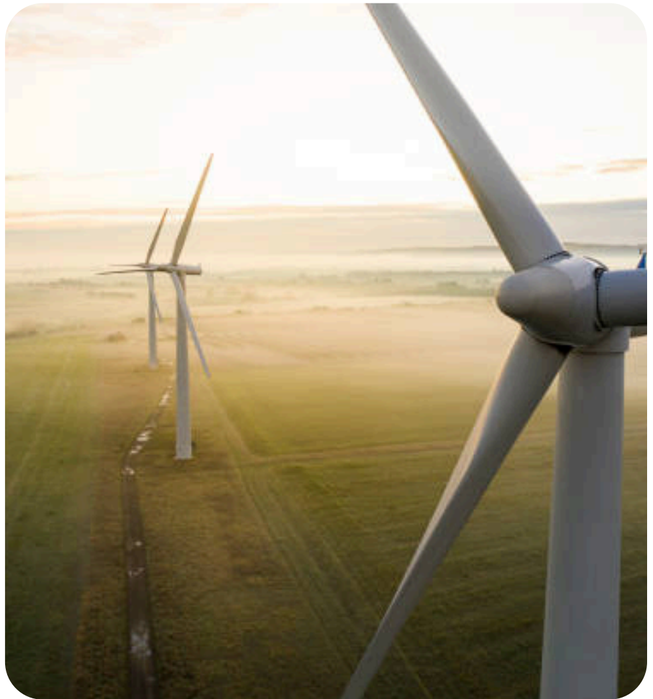
SULTAN IBRAHIM SULIMAN
AHMED BADR AHMED
FAHD ABDULLAH AL-ZAHRANI

The difference between horizontal and vertical turbines

	VAWT	HAWT
Axis of Rotation	Perpendicular to the ground	Parallel to the ground
Efficiency	Lower practical efficiency due to aerodynamic drag, higher under ideal conditions	Generally higher efficiency, capturing 40-50% of wind energy
Design and Installation	Simpler, less costly, easier installation	More complex, costly due to need for precise alignment and substantial structural support
Location Suitability	Suitable for urban/residential areas with variable wind directions	Optimal for large-scale wind farms with higher altitude winds
Power Output	Lower, limited by proximity to ground wind speeds	High, sufficient to power thousands of homes
Noise Levels	Lower, more compatible with urban settings	Higher, potential environmental impact
Tip speed ratio	Vertical axis wind turbine has considerably low tip speed ratio.	Horizontal axis wind turbine has high tip speed ratio.
Cost	less expensive because their design and installation is quite simple	more expensive due their complex design and installation.

Why Horizontal Axis Wind Turbines (HAWT)?

We chose Horizontal Axis Wind Turbines (HAWT) because they are the most widely used and researched type in large-scale wind energy production. They offer higher efficiency, better aerodynamic performance, and are suitable for high wind speed areas. Additionally, studying unconventional HAWT designs helps improve performance and reduce costs in future wind power systems.



Unconventional Horizontal Axis Wind Turbines

1. Contra-Rotating Double Rotor HAWT

Description:
This turbine uses two sets of blades rotating in opposite directions on the same axis. It captures more wind energy by extracting additional power from the airflow after it passes the first rotor.

Advantages:

Higher energy efficiency

Reduces wake energy loss

Improved power output without a larger rotor

Disadvantages:

Complex mechanical design

Difficult to balance and control

Higher manufacturing and maintenance costs

2. Flettner Wind Turbine

Description:
This turbine uses rotating cylinders (instead of blades) based on the Magnus effect, where spinning objects in wind generate lift. It's a unique design that converts wind flow into rotational energy.

Advantages:

Innovative design with potential for high torque

Can operate at lower wind speeds

Reduced noise compared to traditional blades

Disadvantages:

Lower efficiency in high-speed winds

Requires external power to spin the cylinders initially

Mechanically complex and less proven in large-scale applications

3. Towing Rotors HAWT

Description:
This design features two or more rotors placed along the same horizontal axis, often spaced apart on a single structure or tower. The idea is to capture more energy by using multiple smaller rotors instead of one large one.

Advantages:

Higher total power output

Easier transportation and assembly (smaller individual rotors)

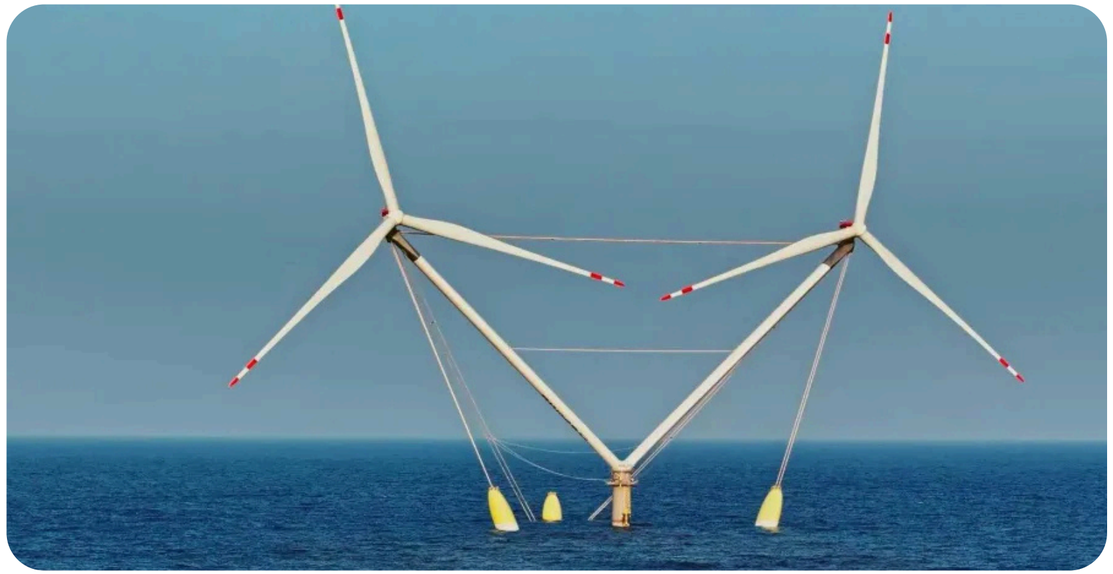
Modular design allows for flexible scaling

Disadvantages:

Increased aerodynamic interference between rotors

More structural stress on the tower

Complex control system needed for coordination



4. Multirotor HAWT

Description:
A multirotor wind turbine consists of several small rotors mounted on a single structure. Instead of one large rotor, it uses multiple rotors to capture wind energy more efficiently over a wider area.

Advantages:

Improved energy capture with multiple rotors

Lower manufacturing cost for small rotors

Better structural redundancy (one rotor failure doesn't stop operation)

Disadvantages:

Aerodynamic interaction between rotors reduces efficiency

Larger footprint and visual impact

More complex maintenance and control

5.High speed single/double/three-bladed

:

These turbines use one, two, or three blades designed for high rotational speeds. Fewer blades mean less drag, allowing the turbine to spin faster .and generate more power per unit of swept area

:Advantages

Higher rotational speed = higher power generation

Lightweight and cost-effective design

Easier to manufacture and maintain (especially single-blade)

:Disadvantages

Single- and two-blade types suffer from balance and stability issues

Higher noise levels

Less efficient at low wind speeds compared to multi-blade systems

6. Sail Wing HAWT

Description:
This turbine uses rigid or flexible sail-like blades, inspired by sailboat technology. The blades capture wind similarly to how sails generate lift, and are often lightweight and adjustable.

Advantages:

Lightweight and simple blade structure

Can start at low wind speeds

Easy to fabricate and transport

Disadvantages:

Less durable in extreme weather

Lower aerodynamic efficiency compared to airfoil blades

May require frequent adjustment or tensioning

HAWT designs offer innovative solutions to improve wind energy efficiency.

Each design has unique advantages and trade-offs depending on the application.

Future development may rely on combining traditional principles with modern engineering ideas to achieve better performance and sustainability.

Conclusion

Thank You

Any Questions?