Energy and Environmental Engineering
CEME 102

Dr. Kamlesh
Assistant Professor, MED
SVNIT Surat

GLOBAL AND NATIONAL ENERGY SCENARIO. **(1 hours)**

INTRODUCTION TO ENERGY SOURCES **(2 hours)**

Classification of Energy Sources in terms of Primary and Secondary Sources, Commercial and Non Commercial Sources of Energy; Renewable and Fossil based Sources of Energy;

INTRODUCTION TO FUELS AND ITS PROPERTIES **(1 hours)**

INTRODUCTION TO VARIOUS ENERGY CONVERSION SYSTEMS **(6 hours)**

like Power Plant, Pump, Refrigerator, Air Conditioner, Internal Combustion Engine, Solar PV Cell, Solar Water Heating System, Biogas Plant, Wind Turbine System general functioning including their normal rating specifications.

ASPECTS OF ENERGY CONSERVATION AND MANAGEMENT **(4 hours)**

Energy Conservation Act, Energy Policy of Company; Need for Energy Standards and Labelling; Energy Building Codes.

ENERGY STORAGE IN BATTERIES **(2 hours)**

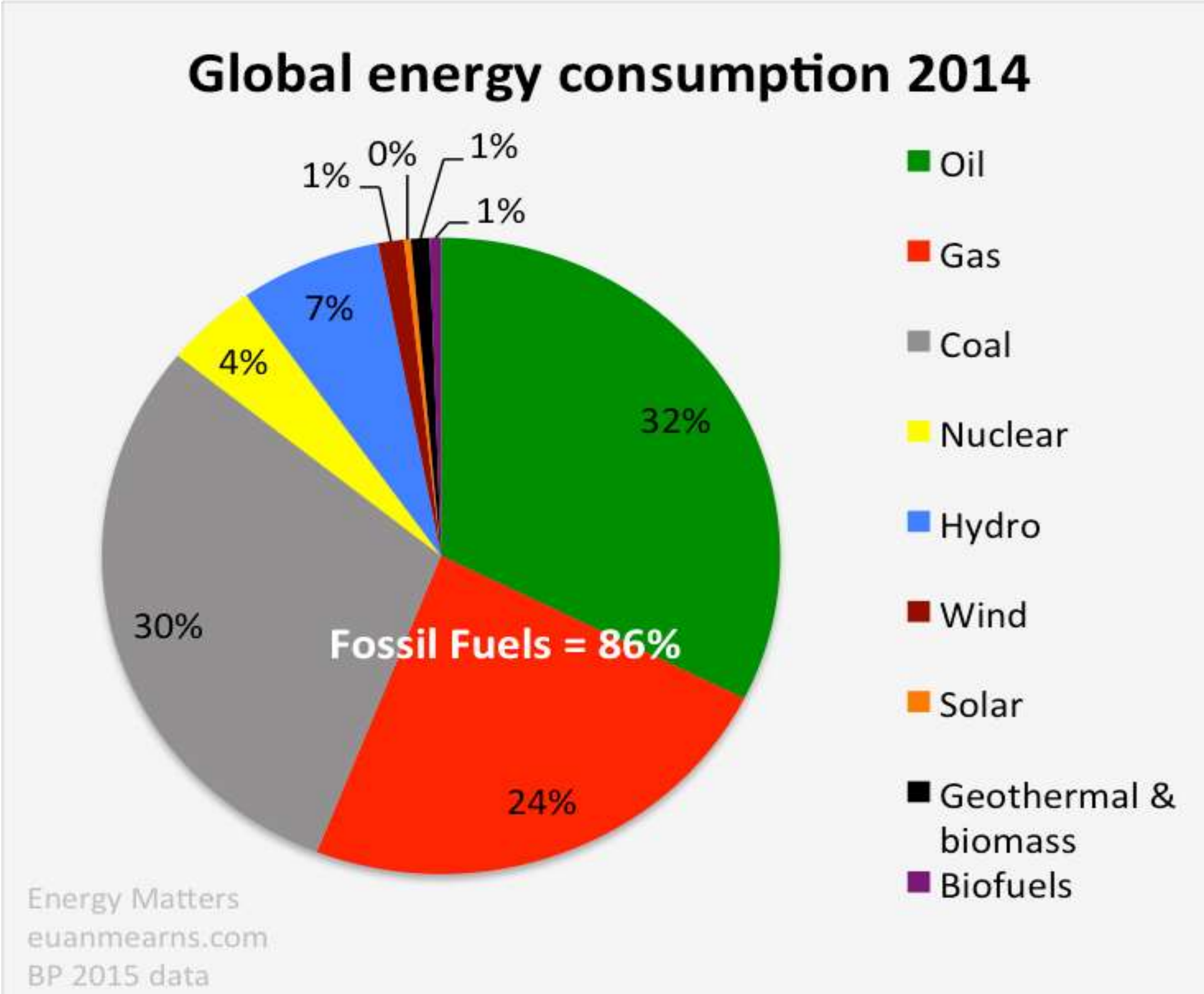
Type of batteries; Electric Vehicles

Content

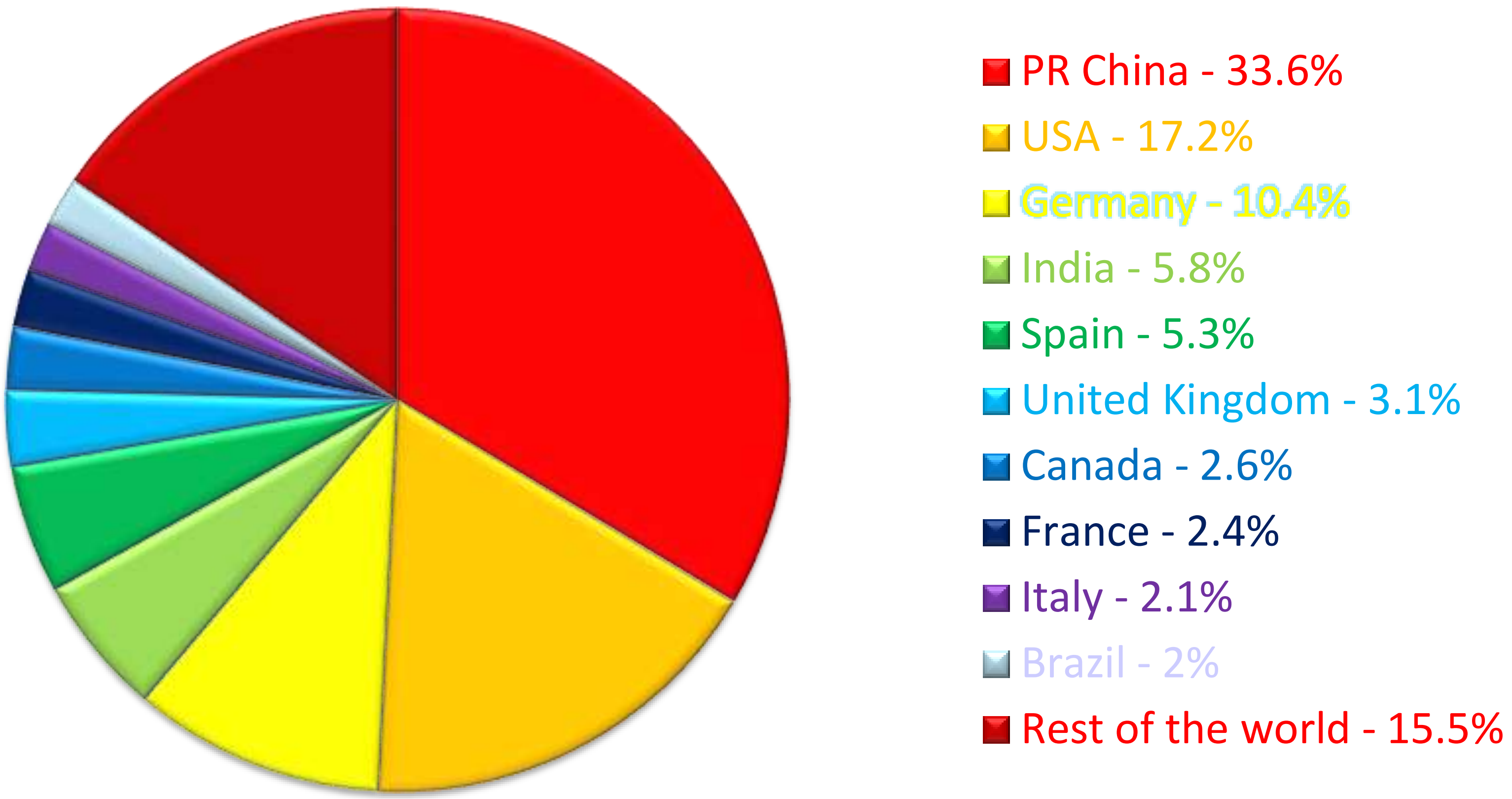
- General Introduction to Wind Turbines
- Components involved
- Types of Wind Turbines
- Types of Blades
- Performance of Wind Turbines
- Application
- Failures

Introduction

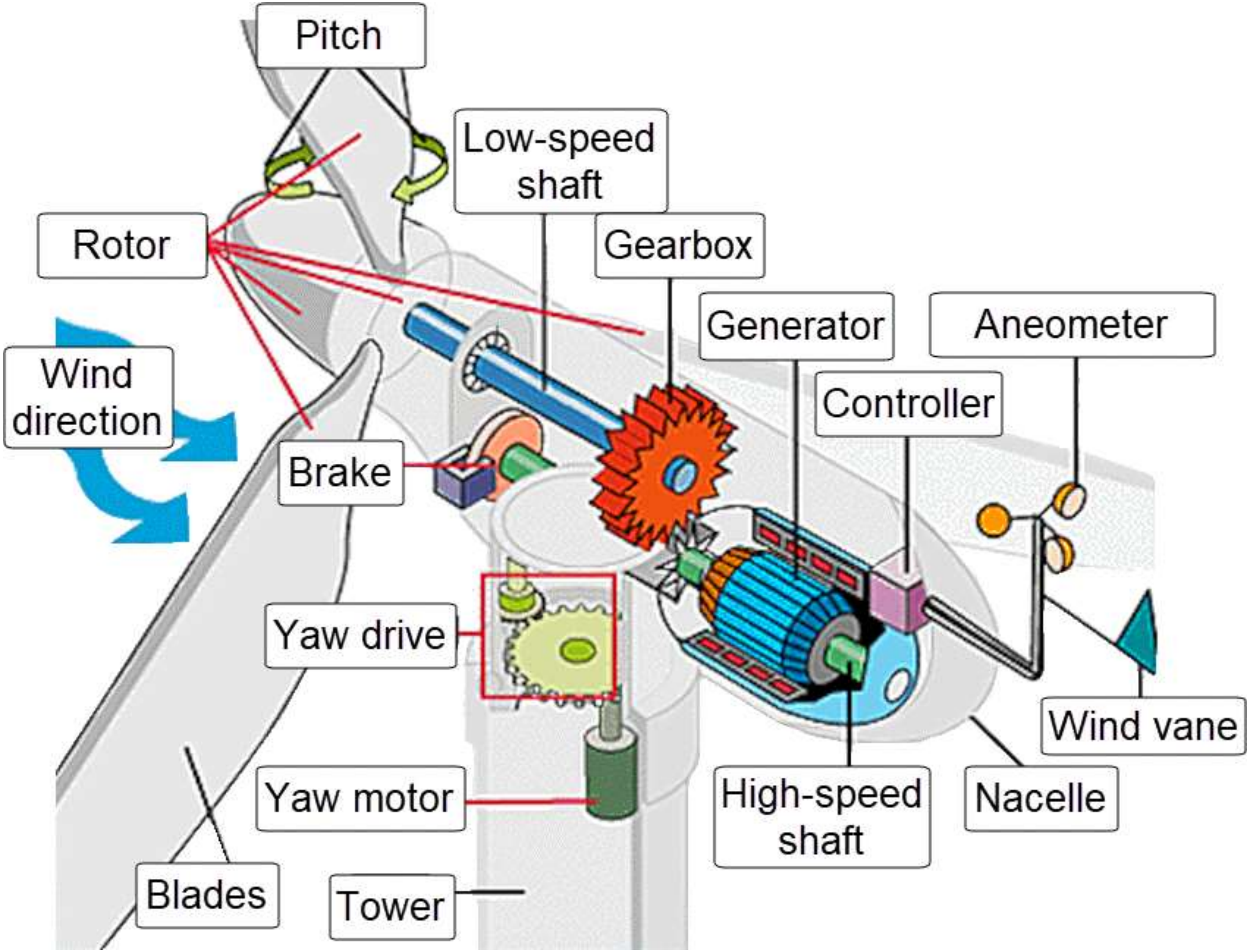
- A wind turbine is a device that converts the wind's kinetic energy into electrical energy.
- Wind turbines work on a simple principle: instead of using **electricity to make wind**—like a fan—wind turbines use wind to make electricity. Wind turns the propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity.


Global energy consumption 2014
1%
0%
1%
1%
7%
4%
32%
30%
Fossil Fuels = 86%
24%
Oil
Gas
Coal
Nuclear
Hydro
Wind
Solar
Geothermal & biomass
Biofuels
Energy Matters
euanmearns.com
BP 2015 data

WORLD WIND POWER CAPACITY



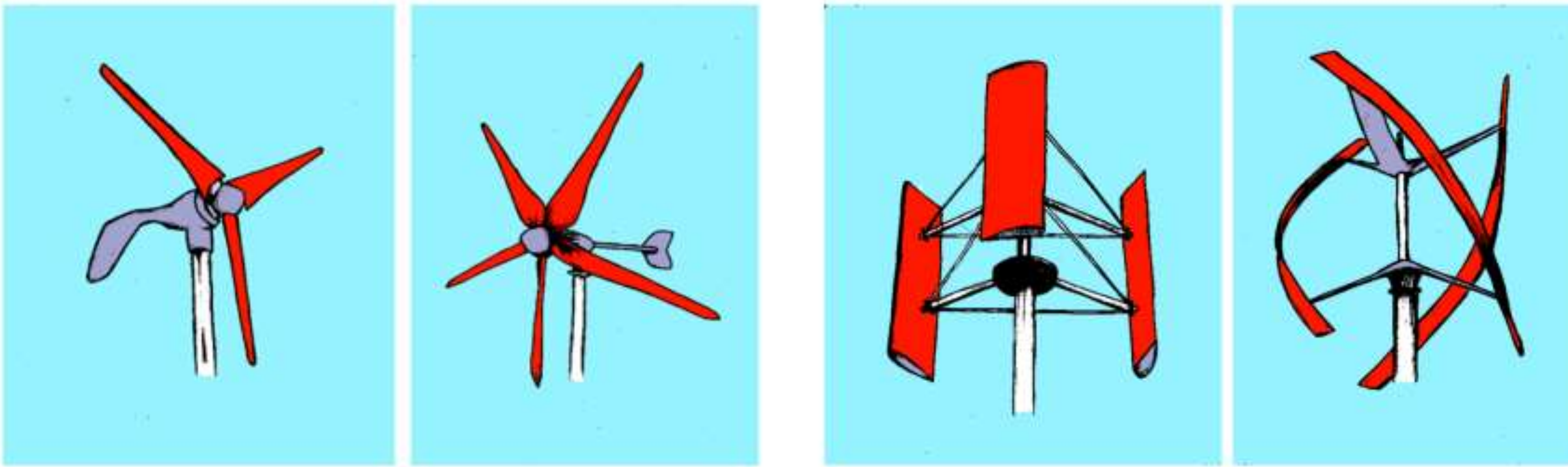
Components



Pitch
Low-speed shaft
Rotor
Gearbox
Generator
Aneometer
Wind direction
Controller
Brake
Yaw drive
Wind vane
Yaw motor
High-speed shaft
Nacelle
Blades
Tower

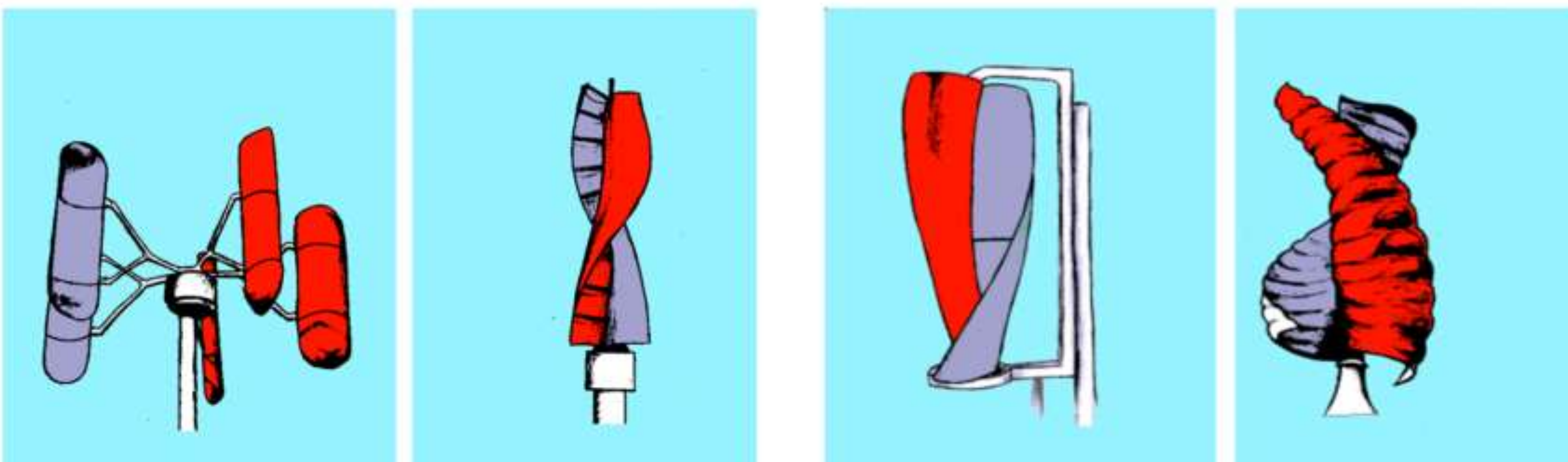
Onshore wind turbines

Offshore wind turbines



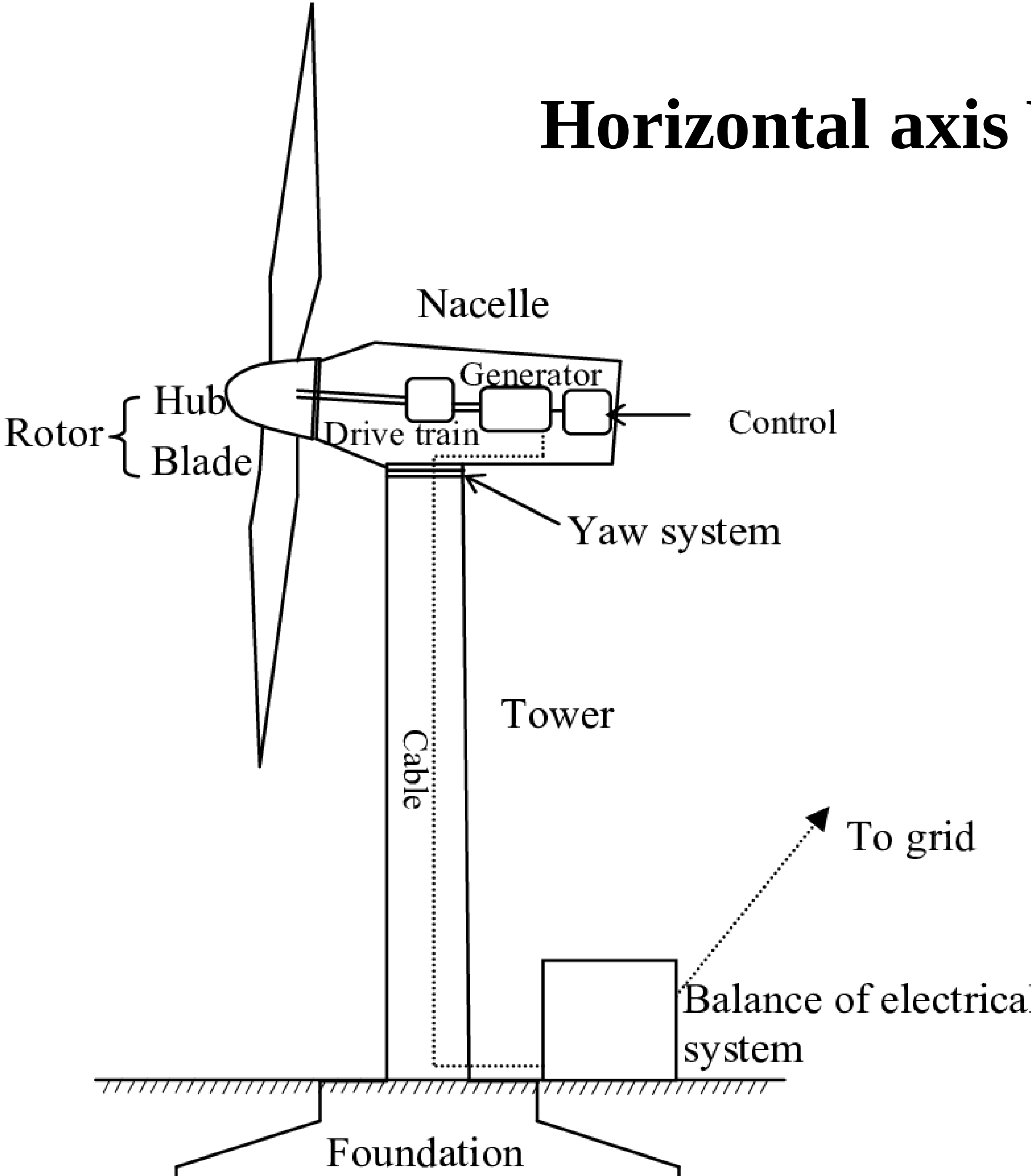
Horizontal axis wind turbines Darrieus type – vertical axis

(a) wind turbines using lift force



(b) wind turbines using drag force

Horizontal axis WT



Vertical-axis turbines.

Videos of Wind Turbines

- https://www.youtube.com/watch?v=qSWm_nprfqE

- https://www.youtube.com/watch?v=gd7dESilkWc

Applications of Wind Turbine

Home wind turbine

Agriculture wind turbine

Application Based Wind Turbine

Commercial wind turbine

Floating wind turbine

Portable wind turbine


Dutch Windmill


US Farm Windmill

WIND TURBINE TREE

Performance analysis

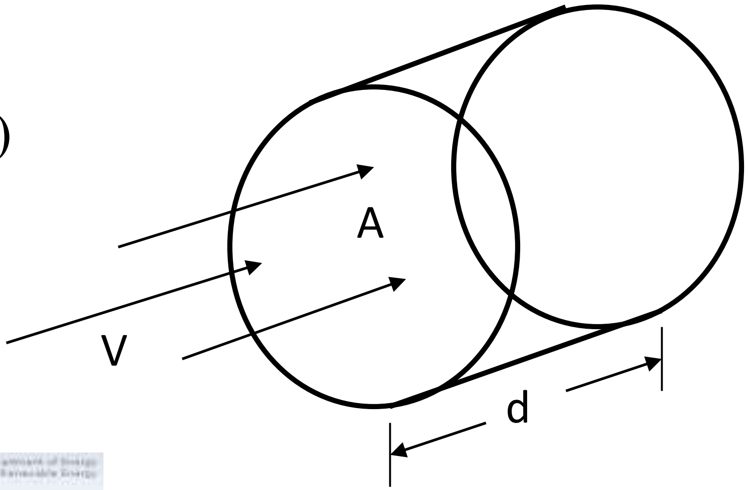
How much Power does a Wind Turbine Generate?

Kinetic Energy = Work = $\frac{1}{2}mV^2$

Where:
M= mass of moving object
V = velocity of moving object

What is the mass of moving air?

= density (ρ) x volume (Area x distance)
= ρ x A x d
= $(kg/m^3)\ (m^2)\ (m)$
= kg



How much Power does a Wind Turbine Generate?

$$\text{Power} = \text{Work} / t$$
$$= \text{Kinetic Energy} / t$$
$$= \tfrac{1}{2} m V^2 / t$$
$$= \tfrac{1}{2}(\rho A d)V^2/t$$
$$= \tfrac{1}{2}\rho A V^2 (d/t)$$
$$= \tfrac{1}{2}\rho A V^3$$

$d/t = V$

Power in the Wind $= \tfrac{1}{2}\rho A V^3$

NREL National Renewable Energy Laboratory

Innovation for Our Energy Future

A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Example – Calculating Power in the Wind

Power in the Wind = $\frac{1}{2}\rho AV^3$

$V = 5$ meters (m) per second (s) m/s
$\rho = 1.0$ kg/m^3
$R = .2$ m >>>> $A = .125$ m^2
Power in the Wind = $\frac{1}{2}\rho AV^3$

$= (.5)(1.0)(.125)(5)^3$

$=$ <u>7.85 Watts</u>

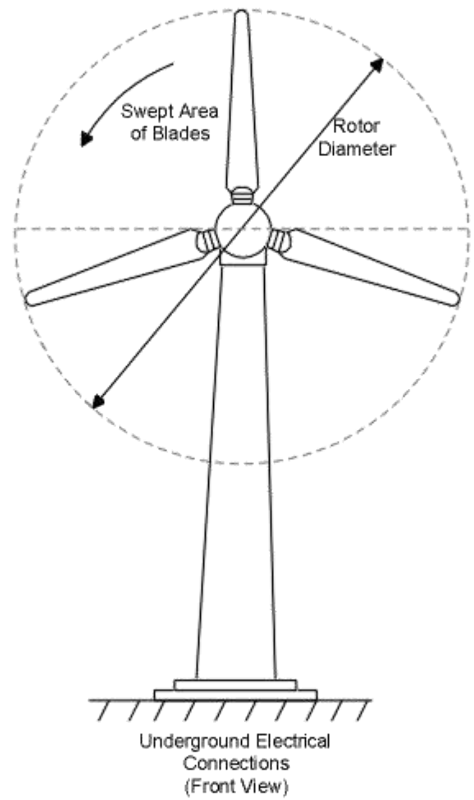
Units $= (kg/m^3) x (m^2) x (m^3/s^3)$
$= (kg\text{-}m)/s^2$ x m/s
$=$ N-m/s $=$ <u>Watt</u>

A couple things to remember…

Power in the Wind = $\frac{1}{2}\rho A V^3$

Swept Area – $A = \pi R^2$ (m^2)
Area of the circle swept by the rotor.

ρ = air density ,1-kg/m^3



Issues/Failures

- Unpredictable. Perhaps the biggest disadvantage to wind energy is that it cannot be produced consistently.
- Threat to wildlife. Wind energy does not cause environmental problems through greenhouse gas emissions, however, turbines can have an impact on wildlife.
- Noise.
- Looks.
- Location limitations

Too much wind speed

Mechanical failures

Noise problem

Wind turbine failures