

9. Introduction to Wind Energy



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Lecture 9

Wind power

Wind is the result of the Sun heating the Earth and creating convection currents in the Earth's atmosphere.

Using the wind as a source of energy is **not** a new idea.

- Sailing ships, powered by the wind, have been around for thousands of years.
- Windmills which used the wind's power to grind corn were once a common landmark across Britain.



http://bioblocks.weebly.com/uploads/8/7/0/6/8706802/notes_-_renewable_energy.pdf

2

Introduction

- The best places for wind farms are in coastal areas, at the tops of rounded hills, open plains and gaps in mountains - places where the wind is strong and reliable.
- To be worthwhile, you need an average wind speed of around 25 km/h.
- Isolated places such as farms may have their own wind generators.

3

Introduction

- The propellers are large, to extract energy from the largest possible volume of air. The **blades can be angled** to "fine" or "coarse" pitch, to cope with varying wind speeds.
- The generator and propeller can **turn to face the wind** wherever it comes from. Some designs use vertical turbines, which do not need to be turned to face the wind.
- The towers are tall, to get the propellers as high as possible, up to where the wind is stronger. This means that the **land beneath** can still be used for farming.

4

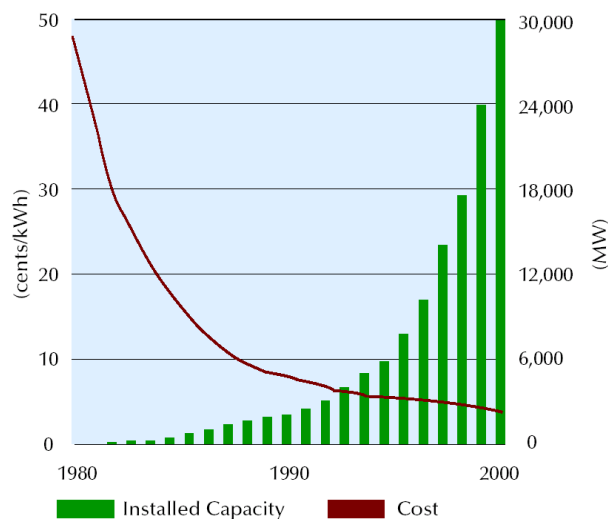
Introduction

■ WHAT IS WIND?

- Wind is simply air in motion. It is caused by the uneven heating of the earth's surface by radiant energy from the sun
- Wind power is the conversion of wind energy into a useful form of energy, such as using: wind turbines to make electricity, wind mills for mechanical power, wind pumps for water pumping.
- Wind speed can be measured using an instrument called a **wind gauge** or **anemometer**

5

Wind Power Generation



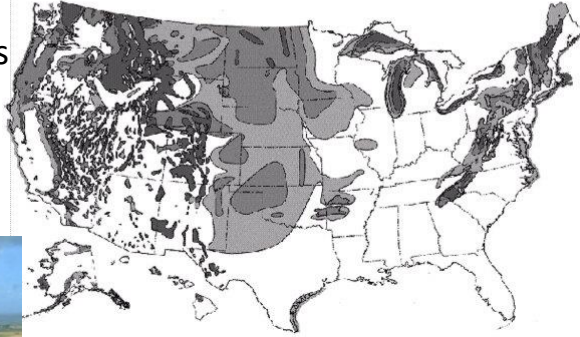
Source: Renewable Energy Sources PPT by Dragica Vasileska

6

Best wind locations in the States

- Midwest mountains
- Coastal areas

Wind Power Class	Wind Energy Resource Potential	Wind Power Density at 30 m [W/m ²]
3	Moderate	240-320
4	Good	320-400
5-7	Excellent	400+



Netherlands

Source: Renewable Energy Sources PPT by Dragica Vasileska

Source: Renewable Energy Sources PPT by Dragica Vasileska



England = off shore

Netherlands = off shore



Offshore Wind Cluster Features

- Larger average wind speed than onshore.
- Easier planning consent.
- Technical expertise exists from oil rig experience.
- Suitable location.

9

Sun energy converted to wind energy

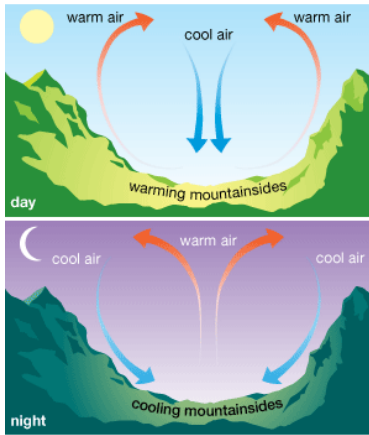
About (1 to 3%) of solar energy reaching the Earth is converted into wind energy



10

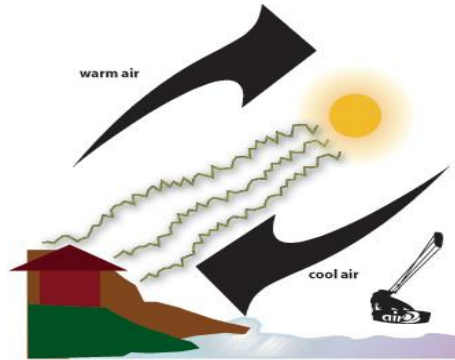
Sources of wind

Valley and mountain breezes



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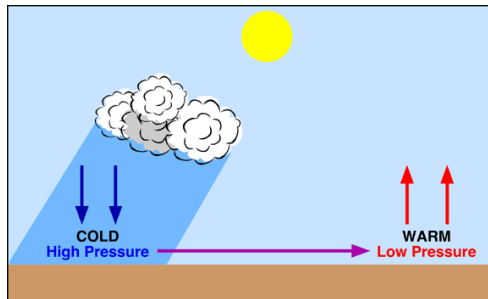
1- Difference between mountain & valley



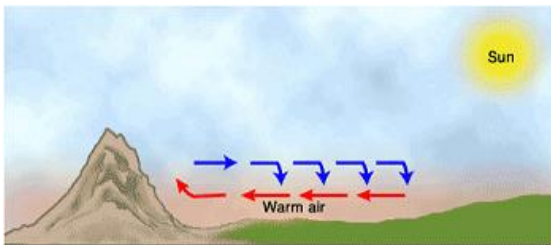
2- Difference between land & sea

11

3- Difference in weather



4- Most wind energy occurs at **High Altitudes**, Here wind speeds are continuous of more than 160 km per hour



Valley Wind



Advantages and Disadvantages

- Wind is free, wind farms **need no fuel**.
- Wind energy is **friendly** to the surrounding **environment** because it produces no waste or greenhouse gases.
- The **land beneath** can usually still be used for farming.
- Wind farms can be **tourist attractions**.
- A good method of supplying energy to **remote** areas.
- One of the greatest advantages of wind energy is that it is **available**.

13

Advantages and Disadvantages

- Wind energy is **renewable**.
- And also helps in reducing toxic gas **emissions**.
- Some other advantages of wind energy are that it is **widely distributed**.
- It is **cheap**.
- Wind Energy is also advantageous over traditional methods of creating energy, in the sense that it is **getting cheaper** to produce wind energy. Wind energy may soon be **the cheapest** way to produce energy on a large-scale

14

Advantages and Disadvantages

- The wind is **not** always **predictable** - some days have no wind (**intermittent supply**).
- Some people feel that covering the landscape with these towers is **unsightly**.
- Can **kill birds** and cause bird migration.
- Can affect **television reception** if you live nearby.

15

Advantages and Disadvantages

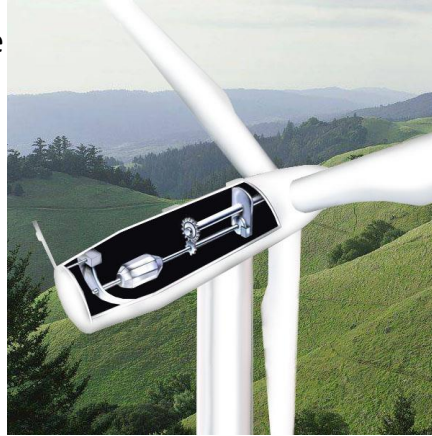
- The wind power technology requires a **higher** initial **investment**.
- Wind energy **cannot be stored**.
- Good wind sites are often located **far** from cities where the electricity is needed.
- Wind towers make **noise**.

16

Wind Turbines

Wind turbines (or aero-generators) use large blades to capture the kinetic energy of the wind. This **kinetic energy** is used to directly turn a turbine and produce **electricity**.

Wind turbines do not produce any **polluting waste**, however, some people consider them to be a **noisy** and an **eyesore**. There is also concern that, if poorly located, they could kill migrating birds.

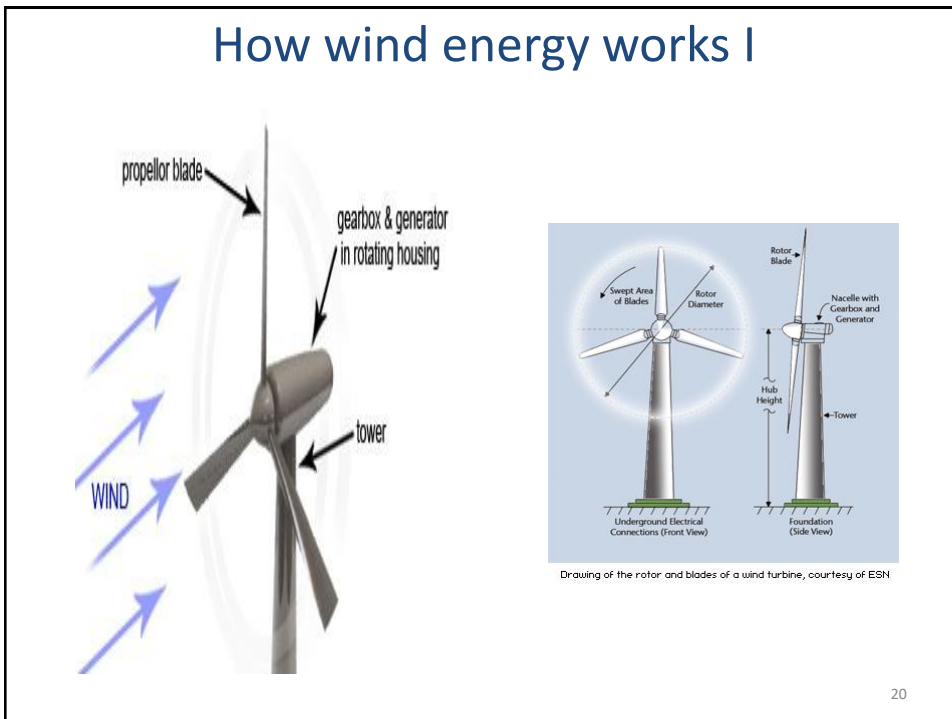
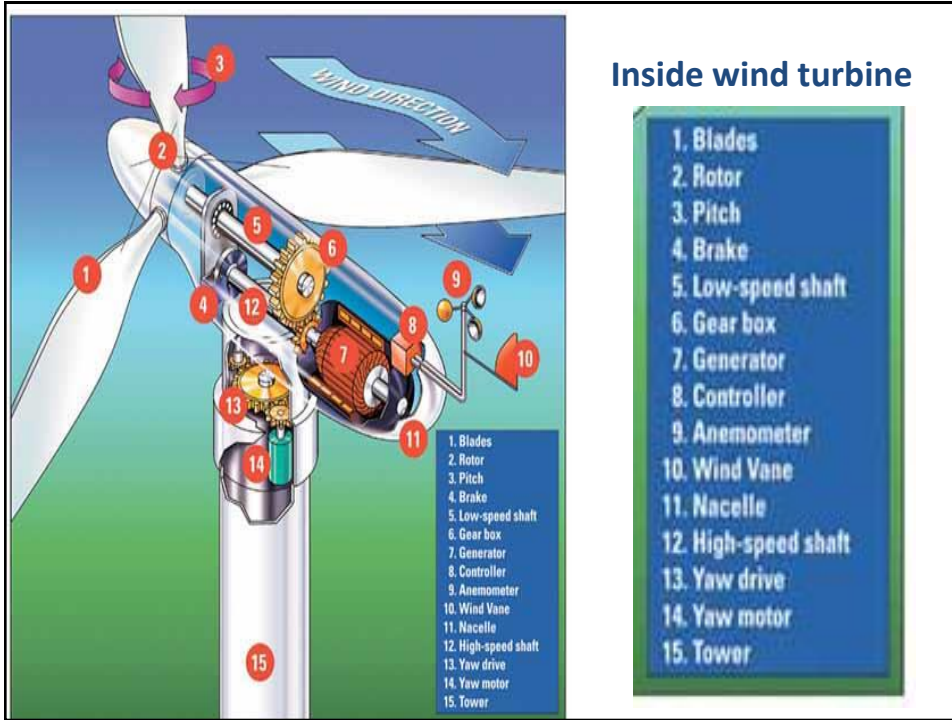


17

Wind Turbine

- Is a rotating machine which converts the **kinetic energy** of wind into **mechanical** energy.
 1. If the **mechanical** energy is used directly by **machinery**, such as a pump or grinding stones, the machine is usually called a **windmill**.
 2. If the **mechanical** energy is instead converted to **electricity**, the machine is called a **wind generator**, wind turbine, wind power unit (WPU), wind energy converter (WEC).

18



How wind energy works II

- The terms "wind energy" or "wind power" describe the process by which the wind is used to generate **mechanical power** or **electricity**. Wind turbines convert the kinetic energy in the wind into mechanical power.
- The **Sun** heats our atmosphere unevenly, so some places become warmer than others.

21

How wind energy works III

- These warm places make the air to rise, other air blows in to replace them - and we feel a wind blowing.
- We can use the energy in the wind by building a tall tower, with a large propeller on the top.
- The wind blows the propeller round, which turns a generator to produce electricity.

22

How wind energy works IV

- We tend to build many of these towers together, to make a "**wind farm**" and produce more electricity.
- The more towers, the more wind, and the larger the propellers, the more electricity we can make.

Question to discuss:

How many towers could supply the city of Bal'aa (بلعا), Tulkarm?

Note that **Bal'aa** is one of the highest places in the district.

23

Wind farms

One problem with wind turbines is that **individually** they do not generate a lot of electricity. They are usually **needed in large numbers** to have an impact on electricity production. A group of wind turbines is called a **wind farm**.



© Robert Thresher/NREL

Wind farms require **large amounts of space** in open areas, but the land can also be used for farming at the same time.

Offshore wind farms are located at sea. This wind farm is located 10 kilometres from the shore

24

Wind Energy Applications

- **Wind Energy Applications**



25

Wind Energy Applications

- 1. Electricity Production**
- 2. Wind Energy for Water Applications**
 - ✓ Water Pumping
- 3. Industrial Applications**
 - ✓ Telecommunications
 - ✓ weather stations
- 4. Windmill**

26

Sizes and Applications



- Small (≤ 10 kW)**
- Homes
 - Farms
 - Remote Application



- Intermediate (10-250 kW)**
- Village Power
 - Distributed Power



- Large (250kW - 2+MW)**
- Central Station Wind Farms
 - Distributed Power
 - Community Wind

27

How has the use of wind power changed over time?



28