Wind Energy

Slide 2: ***Wind Energy: What is Wind?***

- Winds are caused by the sun heating the earth's surface unevenly.
- Air above hot land rises.
- It is replaced by air from cooler areas.
- This movement of air is called wind.
- Winds are influenced by the rotation of the earth and by the surface type, called 'roughness'.
- There are large- and small-scale winds.
- They are also influenced by differences in temperature between land and sea.

Slide 3: ***Wind Energy: Wind Power***

- Winds travel at different speeds above the ground; winds are slowed down by friction/roughness of the earth.
- Roughness is very low for ice, water and desserts, but very high in cities and forests.
- Between 10 and 15 km above the earth they form strong jet streams, which can blow up to 140 km/h.
- Some jet streams reach speeds of 450 km/h.
- Wind changes from day to day, depending on the weather and the seasons.
- However, all over the world there are patterns of wind direction and wind speeds that can be utilized for generating electricity.
- Some sites are better suited for wind farms than others.

Slide 4: ***Wind energy: Small-scale Wind Power***

- Wind energy was one of the first sources of energy to be used by early civilizations.
- Wind power was first utilised by sailing boats.
- Sailing ships move forward using the kinetic energy of the wind.
- The first machines to use wind were windmills.
- Windmills use the wind's kinetic energy to turn machinery.
- Early windmills were used to grind grain. The heavy sails of the windmill turned heavy millstones – that's where the name 'windmill' came from.
- The use of wind mills evolved to wind turbines generating electricity.

Slide 5 & 6: *Wind energy: Small-scale Wind Turbines*

- There are a number of applications for small-scale wind turbines:
  - Residential (off-grid and grid-tied)
  - Telecommunication towers
  - Commercial (small businesses)
  - Farms
  - Rural communities
- Small-scale wind turbines, Vertical Axis Wind Turbines (VAWT) and Horizontal Axis Wind Turbines (HAWT), have capacities ranging from 50 W to 300 kW.
- They are typically installed in conjunction with battery storage systems.
- Due to wind energy resources being highly inconsistent in areas, batteries allow energy to be stored for when resources are unavailable and for a constant energy supply.
- The installation location is not as sensitive to performance as large-scale wind turbines and can therefore be installed in urban and rural areas, on and around building structures.
- VAWTs are more commonly used as small-scale technology in urban areas and cities, where the effect of surrounding obstructions and tall-standing buildings has a significant impact on wind behaviour.

Small wind turbines generally have a much lower energy output than large commercial wind turbines, but their size can differ significantly:

- So-called micro wind turbines may be as small as a 50-W generator and generate only about 300 kWh per year. They are used for boats, caravans and miniature refrigeration units, but also for fence-charging and other low-power uses.
- In comparison, household-size turbines reach diameters of 9 m, can have a rated power of 20 kW and produce about 20 000 kWh per year for homes, farms, ranches and small businesses.
- The biggest turbines described as small-scale wind turbines have a rated power of
  50 kW. Small-scale wind turbines have been used to provide electricity to houses in remote areas that do not have access to electricity.

Slide 7&8: *Large Wind Turbines: Using Wind to Generate Electricity*

- Since the 1980s to late 2000s there was rapid growth in wind turbine technology.
- Together with this increase in capacity came a cost reduction, which makes wind turbines one of the most cost-effective methods of electricity generation.
- Wind turbines turn generators to make electricity.
- They use two or three thin blades that look like aeroplane propellers.
- These blades can be up to 50 m long, or even longer.
- The larger the blades, the more energy from the wind are transformed into electricity.
- The wind turbines are fixed on top of tall towers.
- The blades are joined by a series of gears to a generator in the top of the tower.

- If the wind is blowing, the generator will turn and produce electricity.

- Wind speed increases with height above the earth's surface due to surface drag or roughness.
- It is therefore better to build taller wind turbines to utilise the higher-speed winds above the earth's surface.

Annual energy production is determined by:
- Topography, the wake effect and other obstacles, such as trees.
- To avoid the wake effect, wind turbines are not placed behind one another, because turbulences are formed behind each turbine.

Slide 9&10: *Wind Farms: Benefits and Concerns*
A wind farm consists of wind-powered devices using the kinetic energy of the wind to generate electricity.

Benefits:
- Wind turbines of all designs do not need any fuel to run them.
- They do not produce any pollution.
- Once the wind turbines have been built, their running costs are low.
- Turbines last up to 25 years before they get worn out and need replacing.
- The scrap metal value of these turbines pays for the decommissioning cost.
- Wind energy is a cheaper form of electricity.
- The wind is always blowing somewhere.

Concerns:
- Wind turbines only work on windy days.
- They have to be shut down if the wind is blowing too strong.
- Only some parts of the country are windy enough for wind farms.
- Wind farms have to be built near the existing electricity grid (otherwise expensive power lines have to be built).
- Some people do not like wind farms because they can spoil the view and they can be noisy.

Slide 11: *Wind Farms in South Africa: REIPPPP*
- The first bidding round of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) started in 2011.
- To date, four bidding rounds have been completed.
- In bid window 1–4 (2011–2015) more than 3 000 MW of wind energy was installed.
- New bid windows are ongoing.
- The following website is a map that provides the details of each REIPPPP project in South Africa.

http://www.eskom.co.za/Whatweredoing/Pages/RE_IPP_Procurement_Programme.aspx

The following details can be viewed on the website:

- **Name** of the project

- Type of **technology** being built
- The **capacity** of the power plant
- Current **status** of the project

Bidding rounds	Capacity allocated (MW)	Number of projects
Window 1	651.59	8
Window 2	571.26	7
Window 3	787	7
Window 4	676.42	5
Window 4b	686.3	7
Total	**3372.57**	**34**

Slide 12: *Main aspects of a suitable windfarm*

Main aspects of a suitable wind farm:

1. Wind resource:
    - Wind speed throughout the year
    - Consistency and regularity of the wind
    - Dominant wind direction in the year; each site has a main wind direction and the wind turbines are placed according to the dominant wind on the site
2. Grid connection:
    - The distance to the existing grid and whether the grid is able to absorb the energy produced by the wind farm
3. Environmental aspects:
    - Noise
    - Electromagnetic interference
    - Aviation-related issues
    - Wildlife
    - Public attitudes and planning (visual impact)
4. Accessibility:
    - The accessibility of the site during construction must be taken into consideration.
    - Will the trucks transporting the turbines be able to reach the site and what is the distance that the turbines will have to travel?

Slide 13: Some wind farms in the country

- Cookhouse Wind farm is located 7km outside Cookhouse in the Eastern Cape and is one of the biggest wind farms in SA with a capacity of 135MW.
- Jeffrey's Bay Wind farm is located in the Jeffrey's Bay in the Eastern Cape with an installed capacity of 138MW.

- Hopefield wind farm is a 66MW wind farm in located in the Western Cape. The farm can power up 70 000 low cost houses or 29 000 medium cost houses.