

Tuning Test Item Bank

Mechanical Engineering

Constructive Response Task (Sample) : Wind Power Generation

Wind power generation is the conversion of wind kinetic energy into electrical energy or electricity, through the use of wind turbines. In recent years, there has been much interest in wind power generation as one of the measures against global warming, mainly for two reasons. Firstly, compared to other forms of small-scale power plants, it can generate electricity inexpensively. Secondly, its emission of carbon dioxide per unit power generation is relatively low.

Figure 1 shows the total amount of electricity supplied by wind power generation, worldwide, between 1997 and 2014. According to this figure, the capacity of wind power generation has grown by more than 10 percent each year, amounting to more than fifty times factor increase during the past 17 years. In order to improve the overall cost effectiveness of wind power generation e.g. in wind farms, a number of design parameters need to be taken into account including the location, wind turbine structure and design, safety systems, etc.

Respond to the following questions which focus on the wind turbines used for wind power generation from a mechanical engineering point of view.

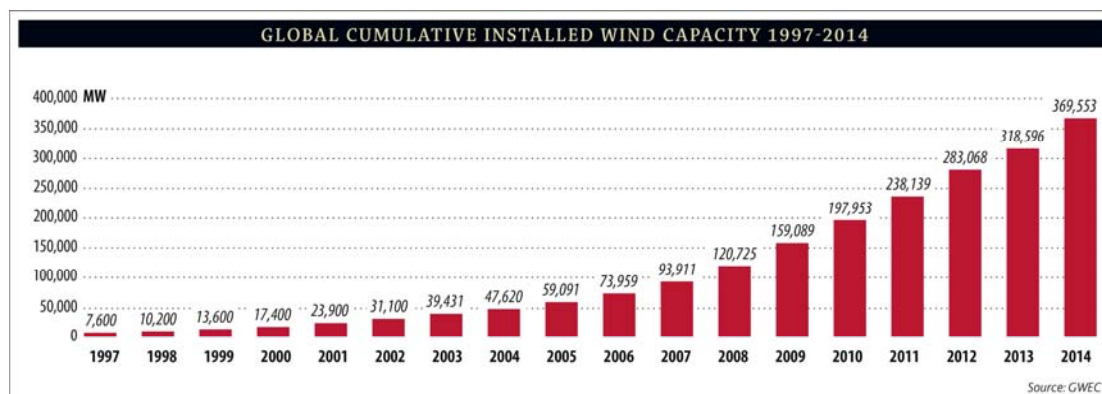


Figure1. Growth in electricity supplied by wind power generation worldwide

Source : The Global Wind Energy Council , *Global Wind Statistics 2014*.

http://www.gwec.net/wp-content/uploads/2015/02/3_global_cumulative_installed_wind_capacity_1997-2014.jpg

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Question 1. Examine the locational condition or site of a wind farm for wind power generation.

Figure 2 shows a wind farm for wind power generation. List and explain two reasons below why this is a good site for wind power generation.



Figure 2: An example of a wind farm

Photograph of Otonrui Wind Farm, provided by Horonobe City

Reason 1:

Reason 2:

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Question 2. Examine the “shape of the blades” of wind turbines used for wind power generation.

Compare the shapes of the blades for a traditional windmill and a wind turbine shown in Figures 3a and 3b, respectively. Explain from a mechanical engineering point of view two features of blades that characterise wind turbines for wind power generation.



Figure 3a Traditional windmills.

Martijn Roos. www.mroosfotografie.nl

<http://free-photos.gatag.net/2014/11/07/040000.html>



Figure 3b Wind turbines used for wind power generation.

<http://sozai-free.com/sozai/01541.html>

Design Feature 1:

Design Feature 2:

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Question 3. Examine the “Number of blades” of a wind turbine for wind power generation.

From a mechanical engineering point of view, identify three advantages of having many blades or few blades, and provide possible explanation why large-scale wind turbines used for wind power generation often have three propeller type blades.

Reason 1:
Reason 2:
Reason 3:
Possible explanation from above:

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Question 4. What are the “responsibilities of a mechanical or power engineer” in designing wind turbines for wind power generation?

Only one year after the wind turbine was constructed, it became apparent that the wind velocity could be larger than assumed in the initial design. In order to prevent the collapse of wind turbine column due to strong wind, identify three potential countermeasures that are technically possible for different levels of risk. For each countermeasure, evaluate their advantages and/or disadvantages from a broad perspective, including the non-technical aspects.

Countermeasure 1:
Countermeasure 2:
Countermeasure 3: