



**“The Effect of the angle of the motor, shape of the blades and the number of the blades on the amount of voltage that a wind turbine produces”**

This project was evaluated using the point scale of 0-1-2-3. The project was evaluated based on the visible information in the project photograph; some more information may have been on the additional sheets.

**A. Title**

**Title:** The effect of the angle of the motor, shape of the blades and the number of the blades on the amount of voltage that a wind turbine produces

**Score: 3** – *The title correctly states the independent variable and the dependent variable and is NOT worded as a QUESTION.*

**Comments:** This is a design experiment and therefore includes more than one independent variable. This title correctly states the independent variables (angle of the motor, shape of the blades and number of the blades) and the dependent variable (amount of voltage that a wind turbine produces).

**B. Question**

**Question:** How does the angle of the motor, the shape of the blades, the angle of the blades and the number of the blades affect the voltage that a wind turbine produces?

**Score: 3** – *The question states the independent variable and the dependent variable, and is testable.*

**Comments:** The question correctly states the independent variables and dependent variable. In addition, the dependent variable is measurable.

**C. Hypothesis**

**Hypothesis #1:** If the number of the blades on a wind turbine is 8, the wind turbine will generate the most amount of electricity because there are more blades to catch wind and less air is lost between the blades.

**Hypothesis #2:** If the angle of the blades is 15° from the wind source, the wind turbine will generate the most amount of energy because it can redirect the flow of the wind into other blades without missing out on too much wind from the source.

**Hypothesis #3:** If the blades are rectangular, the wind turbine will generate the most amount of energy because it has the most surface area out of the other blades. Most surface area can catch more wind to produce more electricity.

**Hypothesis #4:** If we use a wind turbine that has motor arranged so that the blades are parallel to the floor, it would generate the most amount of electricity because more parts of the blade can catch wind from the fan.

**Score: 2** – *The hypothesis (1) predicts the effect that changing the independent variable will have on the dependent variable AND (2) explains the reasoning for the prediction using scientific concepts (“because...”) but is incomplete or weak.*

**Comments:** All of the hypotheses predict which independent variable the students think will generate the most electricity, however, their “because” statements could be stronger and include scientific concepts from their background research that support their hypotheses. Also, they are missing in-text citations.

**D. Background Research (found throughout the project especially within the hypothesis and discussion/conclusion sections)**

**Score: 1** – *Background research contains inaccurate or FEW relevant, well-chosen facts, definitions, concrete details, quotations, scientific concepts, or other information and examples that*

(1) provide information on the IV & DV OR (2) attempts to support the 'because' portion of the hypothesis OR (3) attempts to support the 'scientific reasoning' of the discussion/conclusion.

**Comments:** Facts that should be included in the "Background Information" should help understand how the angle of the axis, number, angle and shape of the blades affect voltage produced. There are only a few facts included around those independent variables. The paragraph discussing size of the wind turbine/tower height is not relevant information and therefore does not need to be included. In contrast, having more info on blade design would be relevant. Here are some more resources to check out that you can pull more relevant facts:

<http://www.alternative-energy-tutorials.com/energy-articles/wind-turbine-blade-design.html>

<http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/wtrb/drag.htm>

<http://science.howstuffworks.com/environmental/green-science/wind-power3.htm>

<http://science.howstuffworks.com/environmental/green-science/wind-power1.htm>

### **E. Investigation Design (ID)**

**Score: 3** – All 5 components of the investigation's design (or ID) are stated correctly and explicitly, AND only one independent variable (or IV) is allowed to change at a time, AND there are multiple trials

**Comments:** The ID for each of the 4 IV's are complete and include all of the 5 components: independent variable, dependent variable, levels of IV, number of trials, and constants.

### **F. Procedure**

**Score: 3** – The procedure (1) is a step-by-step description of how the investigation was done AND (2) uses precise language and scientific vocabulary to describe both the sequence of actions taken and materials used AND (3) is sufficiently detailed to enable the reader to replicate the investigation AND (4) is consistent with the Investigation Design Diagram (IDD) and is an appropriate test of the hypothesis.

**Comments:** The procedure describes how to create the wind turbine and is easily replicable. It also specifies how to conduct the experiment to test all 4 of the independent variables. Please add bamboo skewers to your materials list.

### **G. Data/Results**

**Score: 3** – Data table(s) and graph(s) (1) are accurate and include labels (titles, axes with units of measure AND (2) address the hypothesis and have been chosen to clearly address the original question AND (3) data analysis identifies and accurately summarizes trends and patterns in the data.

**Comments:** There are appropriate data tables and graphs for all of the 4 independent variables, and all include labels, as well as accurate data analysis.

### **Ha. Discussion/Conclusion: Scientific Explanation**

**Score: 2** – Three or four parts of the Scientific Explanation are complete and accurate.

**Comments:** The scientific explanation is supported by their experiment data, but it doesn't include cited scientific concepts. Once more concepts have been added to the background information, then it should be easier to pull from there and use those concepts to support the claim. Since this is a design experiment, the students also included a "Best Design" section, hypothesizing which four levels of independent variable would produce the highest average voltage. They ran three additional trials using these IVs and completed data analysis on the Best Design.

### **Hb. Discussion/Conclusion: Reflection**

**Score: 3** – Conclusion contains thoughtful, relevant, and reasonable reflections including: 1) states whether the hypothesis was or was not supported AND 2) a description of possible sources of error AND 3) suggested solutions to these sources of error AND "Next Steps" determined as a result of this investigation.

**Comments:** The students state sources of error and that their hypothesis was supported.

### I. Literature Cited

**Score: 2** – Most parts of the Literature Cited are complete and accurate. Bibliography is present but references are not cited in the text of the investigation.

**Comments:** The students correctly formatted their Literature Cited section. Sources listed could be more varied to include books and articles. Don't forget to cite throughout the project, i.e. the hypothesis and scientific explanation.

Project Section	Score (0-3)	Weight	Weighted Score
A. Title	3	x 1	= 3
B. Question	3	x 1	= 3
C. Hypothesis	2	x 2	= 4
D. Background Research	1	x 2	= 2
E. Investigation Design (ID)	3	x 2	= 6
F. Procedure	3	x 2	= 6
G. Data/Results	3	x 3	= 9
Ha. Discussion/Conclusion: Scientific Explanation	2	x 2	= 4
Hb. Discussion/Conclusion: Reflections	3	x 1	= 3
I. Literature Cited	2	x 2	= 4
		Total weighted score	= 44 (54 max)
	<b>Final Score (%) =</b>	=Total weighted score/54 x 100	= 81%