Designing the Most Energy Efficient Wind Turbine Blades

Lesson Plan By Shay Motalebi

Primary Subject – Earth Science

Secondary Subjects – Physical Science, Social Studies, Technology, Math, Art

Grade levels – 8th grade, can be modified to use in 6-12 grades

Prep Time – 2 hours for assembling the turbine towers and set up

Suggested Class Time – 4 Periods (48 Minutes) And One Block Hour (90 Minutes)

WIND ENERGY

People have used windmills to harvest wind energy for centuries, but modern technology allows us to convert a windmill's kinetic energy into electricity that can be stored in batteries or pumped directly into the grid to power homes and businesses.

Energy 101 – Wind Turbine

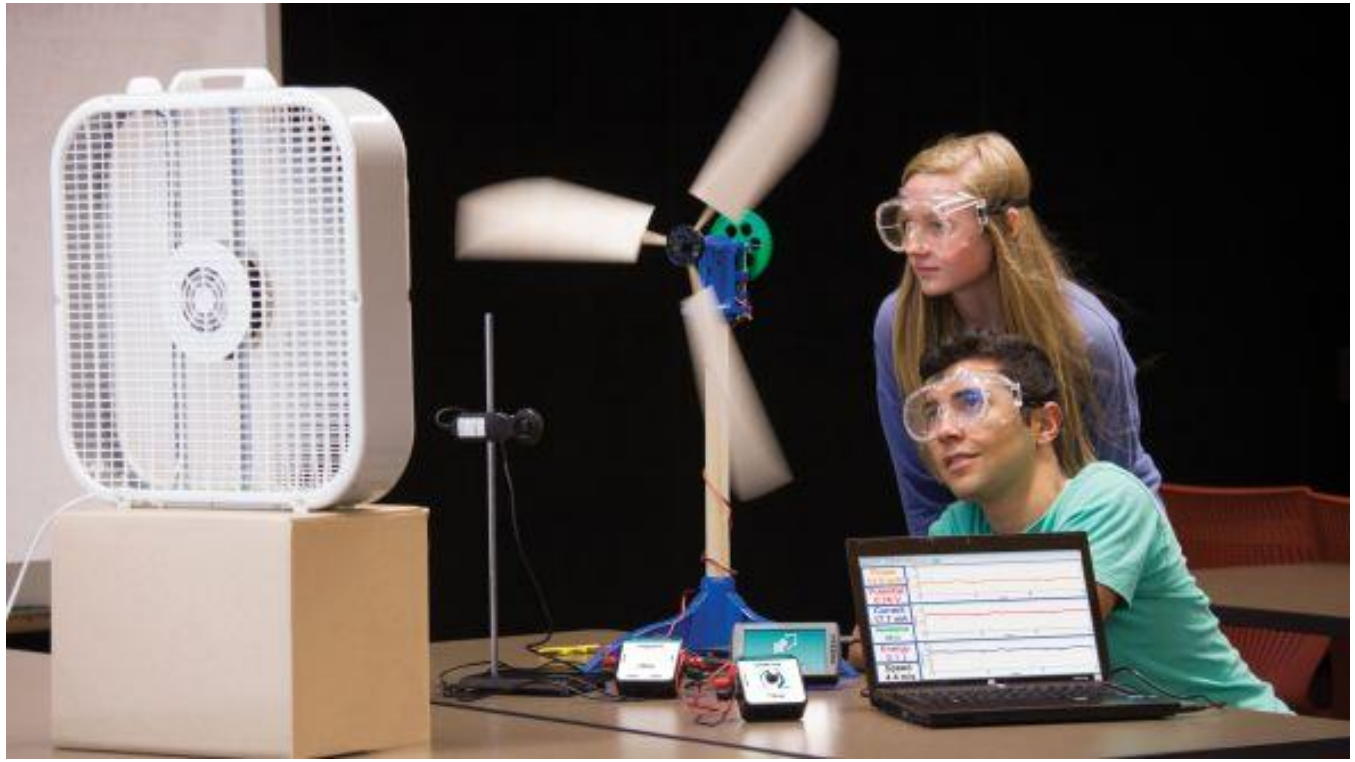
https://youtu.be/tsZITSeQFR0

US Department of Energy

An introduction to energy production from wind and the way wind turbines work

Modern Wind Turbines

KidWind - Vernier



Challenge :

Design a turbine that produces the highest voltage and lifts the most weight, by adjusting different variables that affect the speed of rotation

Introduction

Rationale

- STEAM Education and project based learning at NLA
- Fits in the unit of Atmosphere and Weather
- Awareness towards the current trends in using clean energy
- Fulfills the Engineering Practices required by Mn Science standards and NGSS
- Engaging, inquiry, critical thinking
- Collaborative learning and problem solving opportunity
- Competitive – Students remain interested

Relationship to the Subject, Unit or Theme

- Wind is a part of the unit of Atmosphere, One of the 4 major systems of the Earth.
- The energy produced by wind is a renewable source that benefits the environment by reducing emission of greenhouse gases, fits in the Earth's Natural Resources standards.

Curriculum

Earth Science Standards

8.3.2.1.3 - The role of the Sun's energy in formation of Wind and changes in ocean currents

8.3.4.1.1 – Human Interactions with Earth's Systems (Use of Land, water, fuel resources)

The Nature of Science and Engineering Standards

8.1.3.3.1 – Engineering principals, economic, political, social, ethical expectations

8.1.3.3.2 – New technologies lead to new scientific knowledge and enhanced data

8.1.3.3.3 – The Impact of advanced technology on how people live, work, interact

8.1.3.2.1 – The role of individuals and cultures throughout history in Engineering practices

Goal/Purpose

- Integrating engineering design into the Atmosphere and Natural Resources units
- Give students the opportunity to problem solve and work in teams
- Emphasize the importance of using renewable energy sources

Science Learning Objectives – Students will be able to:

-Describe the factors that cause wind

-Compare renewable and non-renewable energy impact on peoples lives and the environment

-Explain how a wind turbine converts kinetic wind energy and is carried by electric currents

Engineering Learning Objectives - Students will be able to:

-Identify variables that can affect the efficiency of a wind turbine

- Observe cause and effect relationship (changes in the blade design affect the output of the turbine)

-Collaborate and create the wind turbine blades that produce the most mass lift and electricity

Student Prerequisites:

-Knowledge of the states of energy (potential, kinetic) and the law of conservation of energy

-Familiar with the processes of engineering design and scientific inquiry

-be able to collect data and create bar graphs

Accommodations/Modifications/Adjustments

-Students are grouped based on skills and expertise. (Manager, Artist, Builder)
Each contribute to the team at their best ability. Everyone is expected to assist and clean up.

- Options of personalized lab notebook write up, *Schoology* portfolio, or fill out worksheets and cut/paste in notebooks.

Suggested Activities and Assessments

A. Pre-assessment: True/False
- Students discuss their answers in small groups, followed by whole class discussion
- Formative grade

B. Research Project: ”What type of energy is best for us and the environment?”
- Individual or Partner options, Format options (digital, poster, brochure, etc.)
- Teacher assigns the type of energy, presentations due one week, peer review
- Summative grade

D. Power Point lecture: Wind Energy and Engineering Design
- Students take notes
- Post-assessment: Exit Slip

C. Wind Turbine Blades Engineering Lab
- Groups of 3-4, differentiated based on skills and interests
- Teacher gives a review of engineering design process
- Students design and perform the activity
- Follow up discussion, Kahoot or Quizlet.live
- Summative grade – lab reports in notebooks

Wind Turbine Blades Engineering Lab

Materials:

2 KidWind Wind Experiment Kit

2 Floor Fans

2 Multimeters

Cardboard

Paper plates

Styrofoam cups

Lab notebooks

Procedure:

- Brainstorm and choose one variable in your group.
- Make a list of all variables kept constant.
- make a sketch of the blades
- Build and assemble the blades on the hub
- Test the output by reading the voltage and by measuring the weight lifted by a pulley
- Redesign or adjust to increase the output power of your blades
- Retest and record the results in the data table
- Repeat 3 times.

Data Analysis:

- The manipulated variable, Voltage and lift capacity are recorded on a data table at each trial.

- Make a graph of voltage vs. variable and/or weight vs. variable tested.

Conclusion:

Option 1 - If you were a lead design engineer, what would you recommend your company do to their turbine blades based on your results and the class data? Why?

Option 2 – A worksheet with a list of questions to respond.

Class result is listed on the board and the group who designed the highest output receives a reward.

Sources

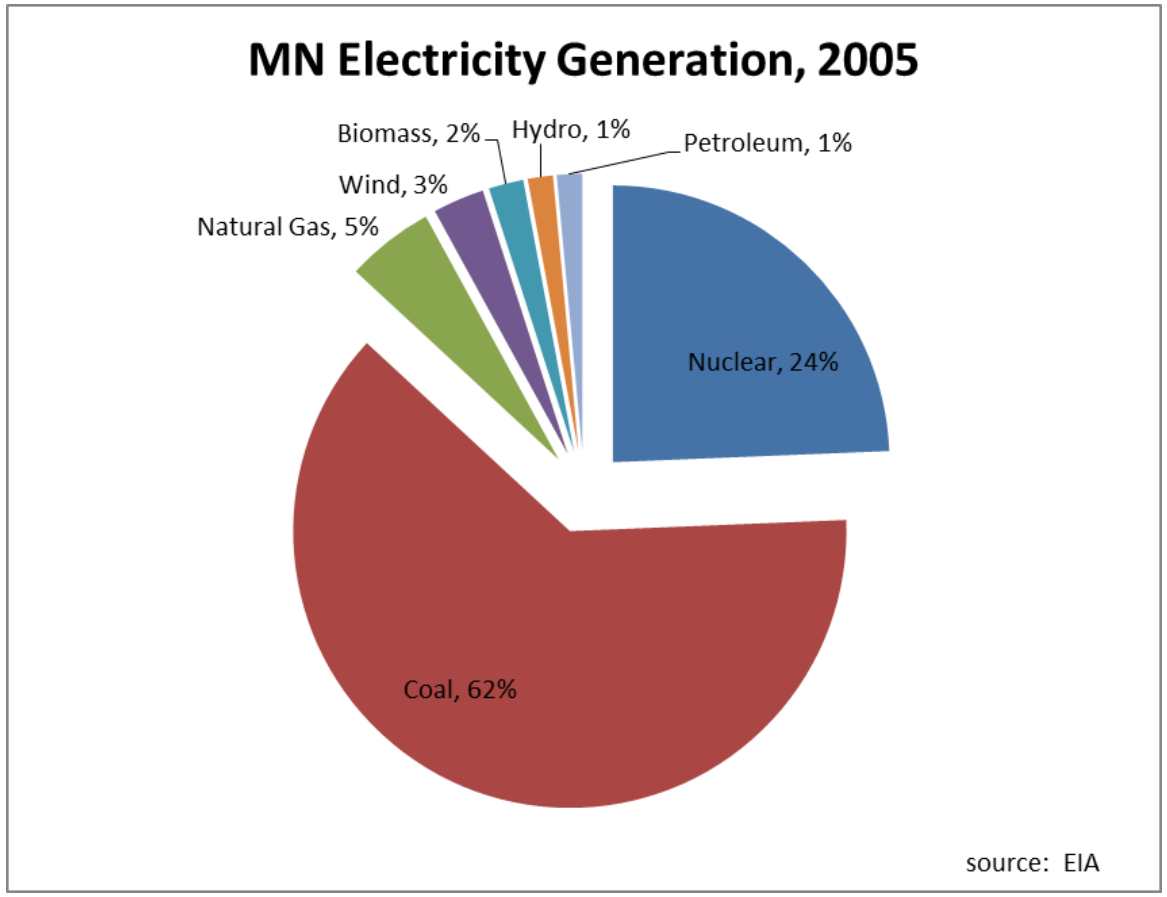
Wind Turbine 101 Video - https://www.youtube.com/watch?v=tsZITSeQFR0

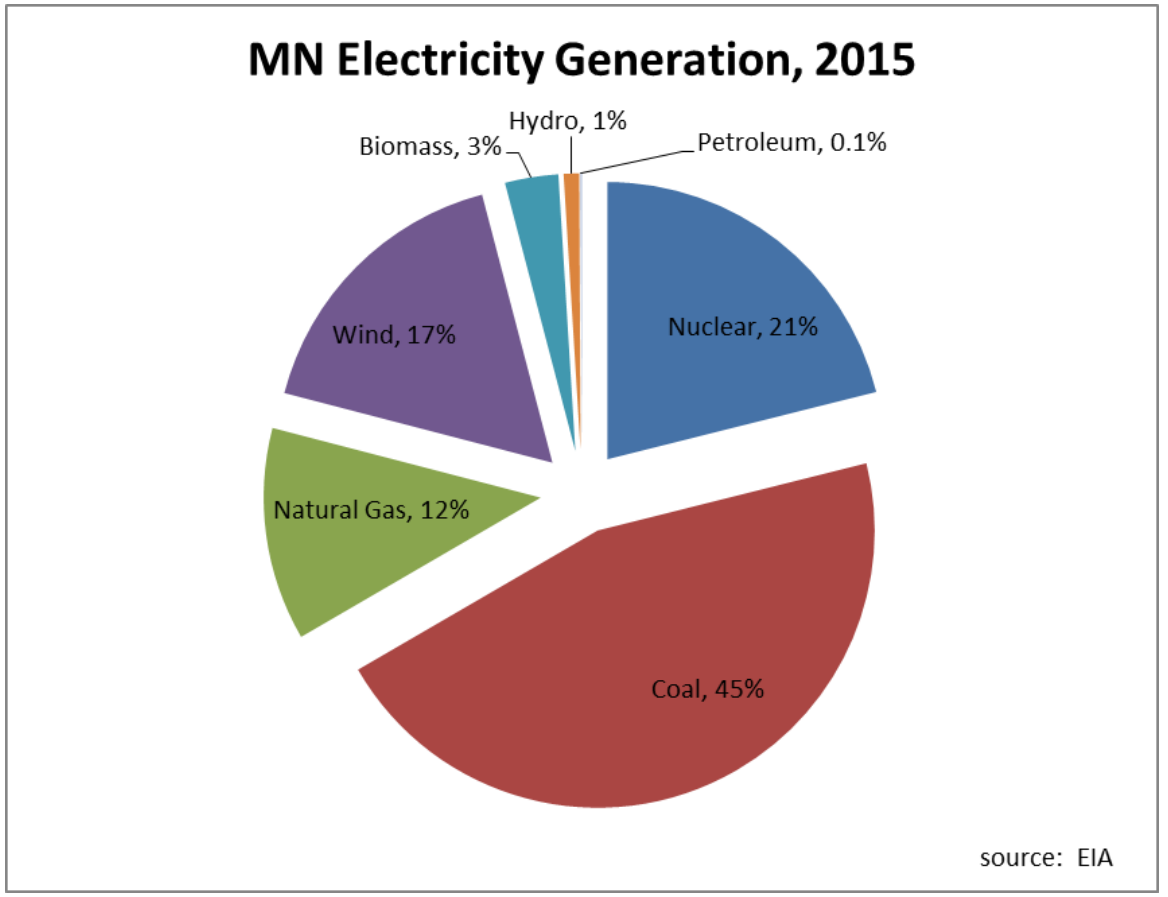
Vernier http://www.vernier.com/products/kidwind/wind-energy/kw-awx/

Experience Energy, Grades 3-8. http://www.climategen.org/what-we-do/education/climate-change-and-energy-curricula/curriculum-guides/experience-energy-for-grades-3-8/worksheets/

KidWind www.kidwind.org

Good to know…





https://mn.gov/commerce/media/news/?id=17-156648