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Wind Power

Achievements and Competencies

Learning Outcomes

Grades 10-12
Force, motion, and work
Energy and momentum
Fields

Achievements and Competencies are based on the Common Framework of Science Learning Outcomes (K-12) set by the Canadian Council of Ministers of Education (1997).

Specific Expectations

Grades 11-12

PHYSICS

Force, motion, and work

> 116-4 Analyze and describe examples where technologies were developed based on scientific understanding (e.g., analyze examples such as rocket launchers and seat belts).

Students describe how a wind mill converts the kinetic energy from the wind into mechanical energy when it turns the blades and consequently the generator finally produces electrical energy.

> 116-6 Describe and evaluate the design of technological solutions and the way they function, using scientific principles (e.g., evaluate technologies such as airbags to reduce injury, and rotating space stations to create artificial gravity).

Students are asked to analyze how the wind mill works and the advantages and disadvantages of this type of renewable resource and ways which the design of the wind mill can be altered to increase its efficiency.

> 215-6 Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (e.g., work cooperatively when determining the power output of a group-constructed machine).

Students work in groups of six to eight. They must determine as a group where they would build a wind farm in their own town. As a group, students must also determine how to make their wind mill as efficient as possible.

325-9 Analyze quantitatively the relationships among force, distance, and work.

The students compare the larger and smaller wind mills and determine that the larger wind mill needs more wind force to operate but the blades move further (as they are larger) creating more work. The smaller wind mills need less wind force to operate but the blades do not move as far therefore more wind force is needed to create the same amount of work.

325-10 Analyze quantitatively the relationships among work, time, and power.

Both wind mills can be shown to create more power the longer they operate and the stronger the winds are.

PHYSICS

Energy and momentum

114-4 Identify various constraints that result in trade-offs during the development and improvement of technologies (e.g., identify issues such as design, cost, and availability of injury prevention devices in sports).

Materials for blades for efficient power generation storing of electricity produced. Larger windmills can generate more power per wind mill but require stronger winds. Smaller, lighter blades work with softer winds but more are needed to generate the same amount of power.

118-10 Propose courses of action on social issues related to science and technology, taking into account an array of perspectives, including that of sustainability (e.g., propose a course of action that addresses the issue of eliminating speed limits on four-lane highways)

This project allows the students to discuss the social issues with commercial wind farms, eg. the noise pollution of the wind farm

212-1 Identify questions to investigate that arise from practical problems and issues (e.g., identify questions such as "How can we increase the efficiency of energy transformations?").

Students identify questions to investigate such as "How can we store the electricity generated for peak time usage?" and "How can we increase the efficiency of the individual wind mill and wind farm?'

116-6 Describe and evaluate the design of technological solutions and the way they function, using scientific principles (e.g., describe technologies such as climbing ropes, airbags, and helmets).

Students must determine where the optimal place is to put the wind mills. They must also analyze the location chosen and give reasons as to why this location is optimal.

PHYSICS

Fields

212-2 Define and delimit problems to facilitate investigation (e.g., study the relationship between electrical force and charge using only two charges).

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Wind Power - Achievements and Competencies

Students compare the large and small windmills to both identify and solve various problems that arise when discussing wind power. They must determine when one large windmill would be the most efficient solution and identify other times when many small windmills would be the most efficient alternative.

> 213-4 Estimate quantities (e.g., estimate quantities when measuring electrical and magnetic fields).

Upon completion of their windmills students measure the voltage of many small windmills, either connected in parallel or series, as well as the one large windmill. They first estimate which combination will produce the highest voltage and then measure the actual voltages produced.

> 328-3 Describe electric fields in terms of like and unlike charges, and magnetic fields in terms of poles.

As the kinetic wind energy is converted to electrical energy by the windmill an electromagnetic field is produced. Electricity is carried from these windmills through cables which carry this electromagnetic field.

> 328-5 Analyze, qualitatively and quantitatively, the forces acting on a moving charge and on an electric current in a uniform magnetic field.

A moving charge experiences many forces. The motion of the charges in an electric field produce current and as a result of the current a magnetic field is produced. This magnetic field exerts force on the charged particles inside the field.

> 328-6 Describe the magnetic field produced by current in both a solenoid and a long, straight conductor.

Students analyze how the generator in the windmill (a solenoid) works. They determine that in a solenoid a large field is produced parallel to the axis of the solenoid. Components of the magnetic field in other directions are cancelled by opposing fields from neighboring coils. Outside the solenoid the field is also very weak due to this cancellation effect and for a solenoid which is long in comparison to its diameter, the field is very close to zero. Inside the solenoid the fields from individual coils add together to form a very strong field along the center of the solenoid.

> 328-8 Develop and compare expressions used when measuring gravitational, electric, and magnetic fields and forces.

Student must accurately define and understand various terms such as current, voltage, and electromagnetic induction.

> 328-9 Compare the way a motor and a generator function, using the principles of electromagnetism.

Students will determine that a generator is attached to a device like a hand crank or water wheel to turn its armature, causing the coil to generate electricity while a motor uses a battery to cause the coil to turn the armature and axle, rotating whatever is attached to it. The wind mill the students create is a generator as the blades are turning the shaft which is connected to the generator. Mechanical energy is then converted into electrical energy.