

8b.7 Applying Systems Thinking: Wind Turbine

Story Extension for This Lesson:

As Sam and Alex continue their journey, they see a wind turbine on the shores of one of the Great Lakes. "What a great idea!" Sam says. "There is always wind blowing off of the lake."

Alex thinks about it, and says "I have a great idea! Why don't they put some turbines right in the middle of the lake! There is always wind blowing, and it's far enough away from people that it won't bug them!"

Grade: 8

Strand: Systems in Action

Big Ideas:

- Systems are designed to accomplish tasks. (Overall expectations 1, 2, and 3)
- All systems include an input and an output. (Overall expectations 2 and 3)
- Systems are designed to optimize human and natural resources. (Overall expectations 1 and 3)

Overall Expectations:

1. assess the personal, social, and/or environmental impacts of a system, and evaluate improvements to a system and/or alternative ways of meeting the same needs
2. investigate a working system and the ways in which components of the system contribute to its desired function
3. demonstrate an understanding of different types of systems and the factors that contribute to their safe and efficient operation

Specific Expectations:

- 1.2** assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration
- 2.1** follow established safety procedures for working with apparatus, tools, materials, and electrical systems
- 2.3** use scientific inquiry/experimentation skills (see page 12) to investigate mechanical advantage in a variety of mechanisms and simple machines
- 2.4** use technological problem-solving skills (see page 16) to investigate a system (e.g., an optical system, a mechanical system, an electrical system) that performs a function or meets a need
- 2.6** use appropriate science and technology vocabulary, including mechanical advantage, input, output,

friction, gravity, forces, and efficiency, in oral and written communication

3.2 identify the purpose, inputs, and outputs of various systems

3.4 compare, using examples, the scientific definition with the everyday use of the terms work, force, energy, and efficiency

3.5 understand and use formulas to establish the relationship between work,

force, and distance moved parallel to the force in simple systems

Inquiry Skills:

Calibrating, Designing, Constructing, Evaluating

Other 21st Century Skills

Technological Problem Solving skills

Instructions:

Part 1:

Show the class the picture (attached) of the wind turbine. Currently in Ontario (and Canada), wind turbines are on land, but in many parts of the world, they are found in large offshore farms (show the class a picture of a German wind farm).

Although wind turbines might seem like a non-controversial form of clean energy, they are anything but. Both on land and offshore, there are opposing views as to the environmental and fiscal cost of wind energy as a source of electricity.

Part 2:

Have students research how a wind turbine works, and create a systems flowchart (input, processes, output). This should be fairly easy for students at this stage, since they already did this for hydroelectric or nuclear systems.

Part 3:

Have students create their own wind turbine. There are many ways to do this. Students can build their own structure to support a turbine shaft, or you can secure a turbine to a table using a straw as the shaft housing or even a water bottle.

A string can then be tied around the turbine shaft, and a small load can be attached to the bottom. As the turbine and shaft spin, the string will wrap around the shaft and raise the load. If the load and distance lifted are known, students can calculate the work done by the turbine in a given time!

Part 4:

The Province of Ontario had a plan to put wind turbines on the Great Lakes, where wind is often plentiful. However, the plan met with community resistance, and some have challenged whether or not wind power is necessary or economically viable.

- Resource: <http://www.windontario.ca/>

Have students research wind power, and then have them defend whether or not they think wind power on the Great Lakes (or on land) is a good idea. Students must use three habits of Systems Thinkers to act as "lenses" with which to analyze the information and draw their conclusion.

Materials List:

- card stock
- tin plates, paper plates and/or other materials to make turbine blades
- wooden dowel to act as turbine shaft
- tape
- scissors
- wooden or plastic wheels or other housing to attach blades and shaft to (see pic, attached)
- string
- (optional) straws to act as turbine shaft housing (straw can be attached to table with tape; end of shaft and blades hang off the table)
- (optional) small motor onto which the blades could be attached. If using a motor, a multimeter can be connected to measure how many volts the turbine is producing (see attached pic)

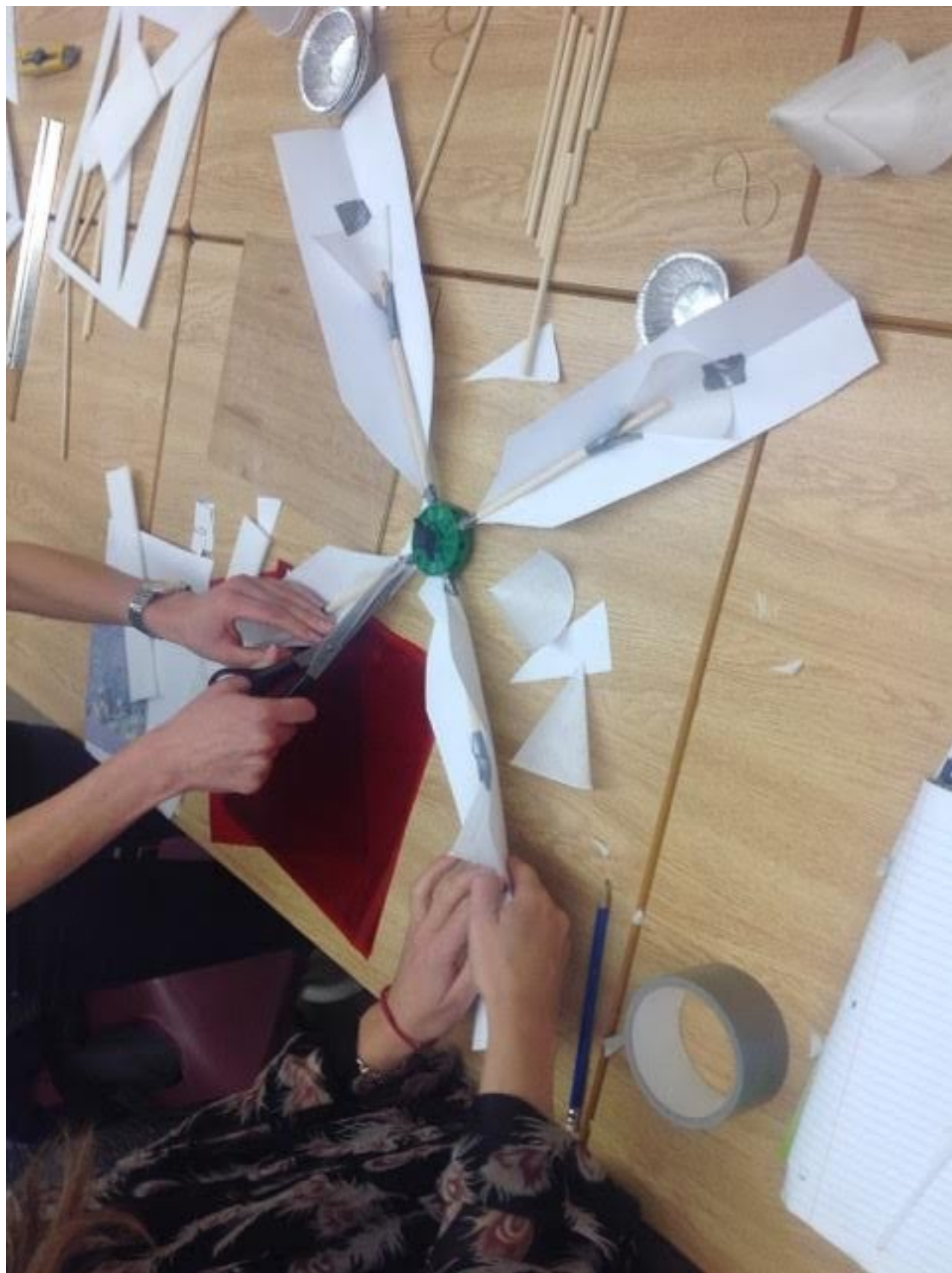
Assessment Strategy:

This series of activities with wind turbines is a very rich task and can be used for both formative and summative assessment (assessment for learning and assessment as learning).

Use the Technological Problem Solving Continuum from the Ontario Curriculum, Science & Technology, Grades 1 - 8, (pages 17-18) to guide you and your students in co-creating success criteria for this activity.

Handouts:

- Turbine1
- Turbine2
- Turbine3
- Bluffs only option for wind farm Toronto Star







Bluffs ‘only option’ for wind farm

Toronto Hydro says no other offshore sites in GTA are financially feasible locale

Abstracted from an article by Iain Marlow, staff reporter, from the Oct. 29 2008, Toronto Star

The proposed site of a wind farm off the Scarborough Bluffs in Lake Ontario is the only place in the GTA where wind power might be feasible, Toronto Hydro said yesterday. “Within the City of Toronto borders, it is pretty much the only option,” said Joan McLean, spokesperson for the project.

WIND POWER ON THE LAKE

Number of turbines proposed: 60
Approximate height (m) of a turbine: 98
Length (km) of reef to host turbines: 25
Distance (km) turbines would be from shore: 2-4
Power (MW) from each turbine: 1.5-2
Total power (MW): 100-200
homes powered by farm: 50,000

Noting they had already investigated the west end, McLean added: “The reality is that the construction of offshore wind turbines is not financially feasible (in) over 20 meters of water depth,” which excludes much of the GTA's shoreline.

Toronto Hydro Energy Services has proposed placing up to 60 turbines on a swath of shallow reef from Ajax to the Leslie Spit. The project has prompted intense interest from locals concerned about its impact on the view, the shore, and residents. Some 400 people showed up to an information session Monday – twice as many as could fit in the hall. It was postponed and will be rescheduled. “The noise concerns me,” said resident Jeanne Gagné. “This would be one of the first to be so close to a residential area. Everybody is pointing at us as being not-in-my- backyard. ... But it’s more: Is this the best backyard?” she added.

The meeting was to discuss installing an anemometer – which measures wind speed and direction – offshore to collect data for a year. “We’re going to find wind, for sure,” McLean said, noting the question was whether it would prove the plan financially justified.

Large turbines already stand at Exhibition Place and in Pickering. Oakville Hydro experimented with placing one in a park but, as with the others, inconsistent onshore winds led to inconsistent results. Toronto’s move is part of a broader effort to harness wind energy from the Great Lakes, McLean said, adding Cleveland already has an anemometer in Lake Erie. Projects elsewhere, for instance off Denmark, have been highly successful.

Peg Graham, who lives near the bluffs, said there was a lot of misinformation being spread, citing a pamphlet that claimed turbines in the lake would lower local property values. “I think it’s a great idea,” she said. “We have to do something other than nuclear power