Suggested Activities for Ontario Science and Technology Curriculum
Science 9 Academic: Characteristics of Electricity

The following table identifies important curriculum expectations described in the Ontario Science and Technology Curriculum for Science 9 Academic, the unit on Characteristics of Electricity. The curriculum is summarized in the left hand column, and the suggested investigations and activities made possible by Re-energy.ca are listed in the right hand column. If you are teaching about renewable energy in this unit, this table will help you identify excellent supplementary activities and term project ideas that take advantage of the learning materials on Re-energy.ca, and match them to the required curriculum in your course.

Relevant Curriculum Expectations	Suggested Re-Energy Activity Ideas
Overall Expectations	
evaluate the social, economic, and environmental costs and benefits arising from the methods of electrical energy production used in Canada	Assign the Re-energy.ca backgrounders "Renewable Energy Basics" and "Putting It All Together" along with other readings to address the topic of energy production in Canada, and alternatives to the conventional sources of coal, natural gas, hydroelectricity, and nuclear power.
Specific Expectations	
describe the concepts of electric current, potential difference, and resistance, with the help of a water analogy	With a completed water wheel or wind turbine as a demonstration model, show how the wire forms a continuous closed loop, passing through the coils and through the light-emitting diode. 20 minute class demonstration.

Specific Expectations	
explain how electric current, potential difference, and electrical resistance are measured using an ammeter and a voltmeter explain how electric current, potential difference, and electrical resistance are measured using an ammeter and a voltmeter	A completed wind turbine or water wheel can be used to demonstrate several settings on a digital voltmeter, and their differences: Clip a voltmeter to exposed connections on either side of a coil to measure the resistance of the coil. Measure the resistance (in ohms) of the other coils, and demonstrate how because they are connected in series, their resistances are an arithmetic sum. Similarly, use the (digital) voltmeter to show that the turbine produces alternating current, and that the voltage changes depending on how fast the turbine spins. Similarly, amps setting can be used to measure changes in the turbine's current output. Using a completed solar car, use the volt meter to show that various components of the car (i.e. the motor, the solar panel, the wires, etc.) produce electrical resistance, which can be measured using a digital or analogue volt meter. Using an ammeter or a digital voltmeter adjusted for measuring amperage and direct current volts, you can demonstrate the characteristics of a solar panel: that it produces a measurable current (amps) and voltage depending on the brightness of the light directed towards it. Twenty minutes to half an hour class demonstration. If you have a class set of small PV panels and multi-meters, you could set up an excellent investigation. Use the "Solar Electricity" backgrounder from the Re-energy.ca web site as a background reference.

Specific Expectations	
state the SI units of potential difference, electric current, electrical resistance, electrical energy, and power (e.g., volt, ampere, ohm, joule, watt, and kilowatt)	Use a digital voltmeter to create a table of technical specifications for student-built model water wheels or wind turbines. If students have built model turbines or solar cars (or any other model using electrical circuits, batteries, etc.), you can have them develop a complete "tech spec" sheet where, using the voltmeter, they determine the resistance of the system, the voltage and amperage range it produces or is best suited for, and other parameters that help describe the electrical characteristics of the system.
describe the relationship among electrical resistance R, potential difference V, and current I solve simple problems involving these quantities (V=IR)	Use the solar car, wind turbine, or water wheel to test predictions using the relationship V=IR. Measure any two variables, and calculate the third. Check to see if the calculated value is close to the actual value, determined through measurement.
describe the potential difference and current characteristics in a series and a parallel circuit compare the electrical resistance of a series and a parallel connection of identical resistors to that of a single resistor	The wind turbine and water wheel utilize coils of wire in series to generate a voltage by electrical induction. Have your students examine the changes in output that occur when different wiring patterns are used. What happens for instance when the coils are connected in parallel rather than in series? What happens when two banks of two series-connected coils are connected in parallel? Compare these circuits to similar ones using batteries instead of coils. How would you draw this as a circuit diagram? This activity could comprise a double period lab exercise.

Specific Expectations	
determine quantitatively the percent efficiency of an electrical device that converts electrical energy to other forms of energy, using the relationship $$\text{percent efficiency} = \frac{\text{energy output}}{\text{energy input}} \times 100$$	The Re-energy.ca water wheel, a simple micro-hydro turbine, provides an excellent case for testing ideas about efficiency, in this case, the efficiency of hydroelectricity production. It is possible to calculate the kinetic energy of water that is falling or moving under pressure. The kinetic energy is related to the velocity of the water at any given point, and the volume or mass at that same point, and is expressed in units of watts. It is also possible to calculate the energy output of the water wheel in terms of its ability to do work (watts). Thus, your students can calculate the efficiency of the Re-energy.ca water wheel. The same methodology can be extended to automobiles, appliances, and other systems where energy is converted from one form to another. This could be done as a class demonstration, or if students have built their own water wheels, this could be done as a lab investigation for small groups. We recommend using a lab with sinks where students can accurately control the rate of flow of water.
describe the relationship among electrical energy transformed E, power P, and elapsed time Δt, and solve simple problems involving these physical quantities ($E=P\Delta t$)	The wind and water turbines, and the solar car could be used to calculate power, efficiency, and solve simple problems involving energy conversion, time, and power. These calculations could form the basis of fruitful and pertinent investigations, such as comparisons between different renewable energy sources, and their appropriateness for different sites.
compare methods of producing electrical energy, including their advantages and disadvantages (e.g., voltaic cells; primary and secondary cells; photoelectric cells and thermocouples; hydro-electric and fossil-fuelled power; wind, and tidal power)	Use Re-energy.ca models to demonstrate how moving air, moving water, and sunlight can be sources of electricity, and contrast this with nuclear, oil, coal, natural gas, and other "conventional" sources of electricity. Assign readings such as the Re-energy.ca backgrounder "Renewable Energy Basics". Compare micro-hydro and large-scale hydroelectricity in terms of their practicality, environmental impact.

Developing Skills of Inquiry and Communication	
formulate scientific questions about electricity and restate them in a testable form, identifying the relationships among variables (e.g., "What is the relationship among the number of dry cells connected, in series or in parallel, the potential difference of the source, and the electric current that passes through a resistor?" demonstrate the skills required to plan and conduct an inquiry into electricity, using instruments, tools, and apparatus safely, accurately, and effectively (e.g., use an ammeter and a voltmeter to measure current and potential difference in a circuit select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen gather and record qualitative and quantitative data using an appropriate format, and analyze the data to explain how the evidence gathered supports or refutes an initial hypothesis (e.g., explain the variations in the monthly costs of electrical energy) communicate ideas, procedures, results, and conclusions using appropriate SI units, language, and formats, and evaluate the processes used in planning, problem solving, decision making, and completing the task	Students may be given the task of designing a model wind turbine or water wheel with six or more coil / magnet pairs, and calculating the theoretical voltage and current output based on V=IR, and other relationships. They may build and test the design and compare the theoretical output with the actual output. You could give your students several variables to examine: the number of coils, the number of turns of wire in each coil, the strength of the magnets, the spacing and connection pattern of the coils, etc. You could assign different variables to groups, and as a class see what effect these variables have on the design of the machine. As a culminating experience, you could have your class build and test a machine that optimizes several variables together to see if their benefits add up. Have your students prepare detailed reports that communicate the questions or variables they test using Re-energy.ca models, the results, and conclusions they draw from the results. Use graphing technology and methods to summarize results.
Relating Science to Technology, Society, and the Environment	
devise a plan for a self-contained system to generate energy, using renewable energy sources, to meet the energy requirements of a dwelling, farm, or community in Ontario (e.g., design a plan to use any combination of wind, solar, or hydroelectric power);	Based on student experience and knowledge derived from building and testing Re-energy models, have your students propose designs for "off-grid" homes or communities, based on local renewable energy production. Build a scale of an off-grid home, showing how the design would accommodate passive solar heating and lighting, plus any active form of renewable energy production such was wind energy, photovoltaic panels, or small-scale hydroelectricity.