Toronto District School Board

OUR SOLAR FUTURE

RICH PERFORMANCE TASKS

GRADE 6 ELECTRICITY

SEPTEMBER 2011

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OUR SOLAR FUTURE

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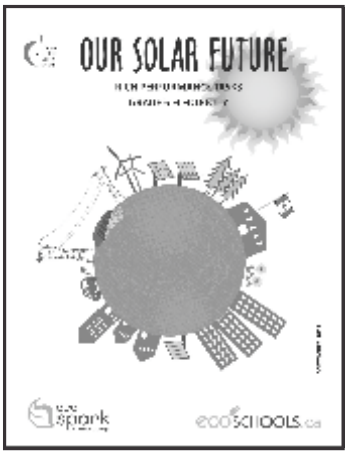

ACKNOWLEDGEMENTS

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"I'd put my money on the sun and solar energy.
What a source of power!
I hope we don't have to wait till oil and coal run out
before we tackle that."

– Thomas Edison

INTRODUCTION

The resource addresses Ontario Science and Technology curriculum expectations from Grade 6: Electricity and Electrical Devices. (Teachers of grades 5/6 combined classes can adapt many of the activities to teach Grade 5: Energy Conservation and Grade 6: Applications of Electricity.)

This resource aims to excite grade 6 students by engaging them in rich performance tasks.

The three rich performance tasks in this resource reflect new developments in renewable energy, specifically solar electricity. The tasks, which include a series of related "training activities," help students to learn the fundamental concepts of solar energy, explore the larger questions and big ideas regarding the role of solar PV in Ontario's future, and dive into the challenge of solar array design. The resource focuses on solar electricity for two main reasons:

1. Ontario is currently making big decisions about how to generate our electricity. For their own futures, our students need to know about the potential of solar electricity.
2. An increasing number of school boards are installing solar PV arrays on their school roofs, presenting a valuable educational opportunity for students.

▸ Engaging Students in Reshaping Our World

In our communities, significant investments in infrastructure will be made over the next thirty years. The approach that these investments take will define our world and determine its course, from an energy perspective, for the remainder of this century. What do we want our energy landscape to look like? Will we move toward a solar age by harvesting light, or continue the path of the industrial revolution, which favours the combustion of fossil fuels to power our society? The implications for our ecosystems and our global economies are immense. This resource aims to excite teachers and students by placing students in roles meant to engage them in reshaping our world.

▸ Structure and Use of this Resource

This resource is designed for a grade 6 class. It offers three rich performance tasks, all based on the topic of solar energy. They are:

1. Solar Architect: Design a Solar Village (page 15)
2. Solar Educator: Amaze Young Children (page 31)
3. Solar Entrepreneur: Pitch Your Idea (page 45)

A set of 10 activities, called "training activities," is provided as related lead-up or preparatory activities for each of the tasks. Each training activity has one or more blackline masters that help students complete the activity. A list of recommended training activities is provided with each performance task, but teachers can choose those that are most suitable for the needs and interests of their class. Also, any training activity can also be used as a stand-alone activity. A concluding activity is also provided.

There are a number of ways to use this resource:

- ❏ use one or more of the three performance tasks as rich learning opportunities
- ❏ use one or more of the performance tasks as culminating tasks
- ❏ use any of the training activities as a stand-alone activity
- ❏ use the performance tasks as models for developing your own performance task that meets your particular teaching needs

• The Teaching Plans

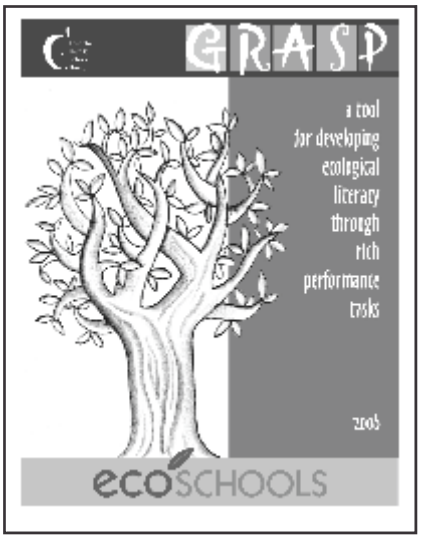
Each performance task has a series of components, or steps. This resource offers step-by-step teaching plans for each of these components, including an overview, a list of the recommended training activities, planning notes, and teaching/learning strategies. Each training activity also includes step-by-step teaching plans, with the same format: overview, planning notes, and teaching/learning strategies.

The teaching plans also include correlating materials such as student worksheets, planning sheets, and other organizational tools, as well as assessment and evaluation tools in the forms of a rubric and a checklist for student self-evaluation for each performance task.

- The GRASP Model

The rich performance tasks are based on the GRASP model, which has students assume a role in a given scenario, with a given audience, to create a product or performance for that audience. The tasks are intended to be meaningful and relevant for students, and they also provide great opportunities for integrated and cross-curricular learning.

GRASP is a planning template advocated by Grant Wiggins and Jay McTighe (1998). For more information on using the GRASP model, see the TDSB publication *GRASP: a tool for developing ecological literacy through rich performance tasks*, available for download at:
http://www.tdsb.on.ca/ wwwdocuments/programs/ecoschools/docs/GRASP%20FINAL.pdf



G	Goal	goal of the task
R	Role	role of the student
A	Audience	audience for students' work
S	Scenario	scenario that gives meaning to students' work
P	Product	product/performence that is to be assessed/evaluated

Overview of the Rich Performance Tasks

GRASP	Solar Architect: Design a Solar Village	Solar Educator: Amaze Young Children	Solar Entrepreneur: Pitch Your Idea
G Goal of the task	Design a village that uses solar energy to power its buildings, and persuade City Council that a solar village should be built instead of a non-solar village	Write and present a brief lesson on solar PV for younger students	Create a presentation (a "pitch") to convince a panel of investors to invest in a new solar-based business
R Role of the student	Architect for Solar Village Inc.	Educator with the Solar Experts Company	Entrepreneur
A Audience for students' work	City Council (played by principal, other teachers, other students)	Students in grades 2-4 (actual grades 2–4 students in your school)	Panel of investors (like the CBC television show *Dragons' Den*; played by principal, other teachers)
S Scenario that gives meaning to students' work	City Council has asked companies to submit designs for a new village	Educators explain solar energy to a group of grades 2–4 students and answer their questions	Entrepreneurs present their pitch to a panel of investors who want a viable idea and are skeptical about solar energy
P Product/ Performance that is to be assessed/ evaluated	Create an information folder; create a model solar building and energy budget; assemble a model village (as a class) design and install a circuit; create a persuasive poster	Create an information folder; create and present a lesson featuring an audiovisual component and a circuit demonstration; answer questions	Create an information folder; create a business concept and an advertisement; perform the pitch and answer questions

Training Activities

You will see the box above on the teaching plans, showing the requisite training activities for students.

- The Training Activities

The training activities, listed below, begin on page 62. They will provide the necessary background for students to successfully complete the performance tasks. You do not have to do all the suggested training activities; any that are requisite are identified in the teaching plans. For more information, see the Getting Started section on page 13, and also the Conducting the Training Activities section in each performance task.

Training Activity 1:	Building Circuits
Training Activity 2:	Photovoltaic Circuits
Training Activity 3:	How Much Electricity Do We Use?
Training Activity 4:	Our Electricity Sources
Training Activity 5:	Solar Technology
Training Activity 6:	How Do Solar PV Systems Work?
Training Activity 7:	A Closer Look at Electricity Generation Types
Training Activity 8:	Solar Angles
Training Activity 9:	How Much Electricity Can Solar Produce Anyway?
Training Activity 10:	Electricity Budgeting
Concluding Activity 11:	Collecting the Facts on Solar

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These activities are designed for use with a school board-supplied electricity toolkit, specifically the TDSB Grade 6 Science Kit, which can be obtained through Medianet. The kit includes small solar panels and basic circuit components.

▸ Integration with Technology

The activities listed below involve the use of basic circuit components such as light bulbs, switches and motors, and small solar panels, also called photovoltaic cells (PV cells):

- ❏ Performance Task 1—Solar Architect: Design a Solar Village (page 15)
- ❏ Performance Task 2—Solar Educator: Amaze Young Children (page 31) (optional use)
- ❏ Training Activity 1: Building Circuits (page 62)
- ❏ Training Activity 2: Photovoltaic Circuits (page 66)

You will need to adjust your grouping plans according to the number of small solar panels available. The more panels you have, the smaller the groups you can form. If you are unable to obtain solar panels, there are still many activities in this resource (including Performance Tasks 2 and 3) that you can use.

▸ Curriculum Connections

The topic of solar energy is embedded in *The Ontario Curriculum Grades 1–8, Science and Technology*, 2007, curriculum expectations and the Grade 6 unit: Electricity and Electrical Devices. The activities in this resource address the overall expectations except for static electricity. The activities also provide teachers with many opportunities to integrate other subject areas, such as mathematics, language arts, and the arts. See the following chart.

- Overall Expectations—Grade 6: Electricity and Electrical Devices

1. *Evaluate the impact of the use of electricity on both the way we live and the environment*
2. *Investigate the characteristics of static and current electricity, and construct simple circuits*
3. *Demonstrate an understanding of the principles of electrical energy and its transformation into and from other forms of energy*

– The Ontario Curriculum Grades 1–8, Science and Technology, 2007

Overall Expectations and Opportunities for Integration

Performance Tasks	Overall Expectations for Grade 6: Electricity and Electrical Devices	Opportunities for Integration with Other Subject Areas
Solar Architect: Design a Solar Village Recommended Training Activities: 1, 2, 4, 5, 6, 7, 8, 10, 11	Expectations 1, 2, 3	Language – Reading; Writing; Oral Communication; Media Literacy The Arts – Visual Arts
Solar Educator: Amaze Young Children Recommended Training Activities: 1–11	Expectations 1, 2, 3	Language – Oral Communication; Writing; Media Literacy
Solar Entrepreneur: Pitch Your Idea Recommended Training Activities: 1–5, 7–11	Expectations 1, 3	Language – Writing; Oral Communication; Media Literacy
Training Activities	**Overall Expectations for Grade 6: Electricity and Electrical Devices**	**Opportunities for Integration with Other Subject Areas**
1. Building Circuits	Expectation 2	Language – Writing
2. Photovoltaic Circuits	Expectation 2	Language – Writing; Oral Communication
3. How Much Electricity Do We Use?	Expectation 1	Mathematics – Data Management and Probability Language – Writing
4. Our Electricity Sources	Expectation 2	Mathematics – Data Management and Probability; Number Sense and Numeration
5. Solar Technology	Expectation 3	Language – Reading; Oral Communication
6. How Do Solar PV Systems Work?	Expectation 3	Language – Writing; Oral Communication
7. A Closer Look at Electricity Generation Types	Expectation 1	Language – Oral Communication; Reading; Writing
8. Solar Angles	Expectation 3	Mathematics – Measurement; Geometry and Spatial Sense
9. How Much Electricity Can Solar Produce Anyway?	Expectation 1	Mathematics – Data Management and Probability Language – Oral Communication
10. Electricity Budgeting	Expectation 1	Mathematics – Data Management and Probability; Number Sense and Numeration; Measurement
11. Concluding Activity: Collecting the Facts on Solar	Expectations 1, 2, 3	Language – Reading

Scientific Inquiry and Technological Problem Solving

The Ontario Curriculum Grades 1–8, Science and Technology states:

> *Along with a knowledge foundation, the study of science and technology offers students varied opportunities to learn and master skills that are relevant to their everyday world.*
>
> *In the specific expectations, reference is made to the following three skill areas:*
>
> - *scientific inquiry/experimentation skills*
> - *scientific inquiry/research skills*
> - *technological problem-solving skills*
>
> – *The Ontario Curriculum Grades 1–8, Science and Technology,* 2007, page 12

The three rich performance tasks in this resource provide students with opportunities to develop their skills in each of the three skill areas listed above, especially if opportunities for inquiry are derived from listening to students' initial thoughts and questions. It is worthwhile to review the curriculum's scientific inquiry skills continuum and technological problem-solving skills continuum to gain a better understanding of how to help students move along them.

Through technological problem solving, scientific discoveries are translated into applications that benefit society. From the point of view of scientific knowledge, capturing solar energy has been a solved problem for decades. Scientific inquiry in this area is still important, however, because we continue to improve our understanding of the exact mechanisms by which light is captured and electricity is produced. By combining special materials, we continue to catch up to nature in improving the efficiency of solar cells—a problem solved expertly by green plants all over the world. Technological problem solving continues because technologies that were developed for space, or communications, or consumer electronics, continually find new applications in other areas. *The Ontario Curriculum Grades 1–8, Science and Technology,* 2007, recognizes the importance of technological problem solving, and states:

> *Through technological problem solving, students develop the ability to design solutions to problems. Students create models of new devices or new processes to help address human needs and desires, as well as new knowledge about those devices or processes.*

When engaged in technological problem solving, students should be given opportunities to be creative in their thinking, rather than merely to find a prescribed answer. Critical aspects of technological problem solving are: careful planning; purposeful selection of tools and materials; testing, retesting, and modifications of a product or process; communicating about the solution; and recommending of changes or improvements.

– The Ontario Curriculum Grades 1–8, Science and Technology, 2007, page 16

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You can also refer to the other resources in the Science Kit for sample assessment and evaluation tools and ideas. See:

- *Hands-on Science and Technology* by Jennifer Lawson, pages 10–19
- the TDSB document *GRASP: a tool for developing ecological literacy through rich performance tasks*, pages 28–29. See pages 32 and 33 for sample Reflective Learning Logs.
  See page 3 for download details.

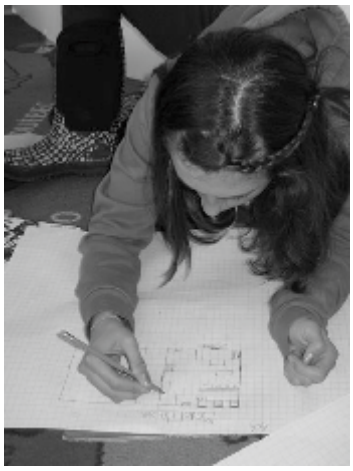
Assessment and Evaluation

Rich performance tasks allow students to demonstrate their understanding of key concepts in engaging and authentic ways and are suitable for addressing a wide range of student abilities. Part of their richness lies in the wide scope of what can be assessed—they can address an array of expectations, including cross-curricular connections and learning skills. Following are some considerations for your assessment and evaluation planning.

- Ensure that students understand the assessment and evaluation criteria before they begin the task; ideally, the criteria should be developed with input from students. Provide students with exemplars of products/performances whenever possible.
- Assess throughout the process, and assess a variety of tasks and products (for example, students' planning forms, task sheets, and learning skills).
- Provide students with frequent feedback as they work toward the performance task, so they know what they need to improve.
- Provide students with tools such as learning logs and completion checklists to ensure that they are completing the steps in the process and following any set timelines.
- Use a variety of assessment tools (for example, anecdotal checklists, student self-evaluation checklists, and rubrics).

Note that this resource offers a sample rubric and checklist for each of the three performance tasks (see pages 28–29, 42–43, and 59–60).

▸ Teaching/Learning Approaches



- Science and Technology Vocabulary: Keeping a Glossary

To promote a student-led approach to literacy and the use of science and technology vocabulary, consider having students keep a running glossary of terms that are introduced throughout the performance task. To follow a recommended organizing strategy of the GRASP model, students could keep the glossary in their unit folder.

The teaching notes for each training activity list some terms that students could add to their glossary. At the end of each activity, you could work as a class to define and discuss the terms. A complete glossary appears on page 99.

- Integrating Literacy and Numeracy with the Performance Tasks

The authentic, problem-solving, and project-based nature of the performance tasks and training activities create great opportunities for integrating literacy and numeracy. Following are some further approaches for integration.

- ❏ Encourage students to develop their own questions on related topics and then research, experiment, or design and construct items to determine the answers.
- ❏ Have students practise stating their opinion and backing it up with facts.
- ❏ Have students collect primary and secondary data to support their ideas and projects and then present and explain the data.
- ❏ Share newspaper and online articles that are related to energy use and solar energy, and any new developments in the area of solar energy.

- Considerations for Students with Special Education Needs

To accommodate the wide diversity of learning styles and needs in any classroom, include plans for adjusting the performance tasks and training activities and for possibly modifying or accommodating the related curriculum expectations. Following are some ideas for adapting your program to address varied needs.

- ❏ Create groups that reflect a variety of skills and learning styles.
- ❏ Chunk the tasks into small, manageable parts.
- ❏ Use a checklist for students to help them visualize and track their own progress.
- ❏ Provide access to appropriate technology to support student reading, writing, and drawing (for example, Read & Write Gold software, clip art files, and word processing software).

- ❏ Provide reading materials at various levels.
- ❏ Allow more time for activities and more time for students to explore the materials prior to an activity.
- ❏ Offer the choice of several formats for the final product (for example, a poster, taped presentation, written report, and presentation using software).
- ❏ Hold conferences frequently and provide ample, descriptive feedback.

- Tips for Presenting Language for ELL Learners

Receptive Language Skill Development

1. Present language that is accessible and easy to recognize and read (e.g., printed text).

2. Speak so that students understand. Here are some suggestions:

   - ❏ Use simple vocabulary to introduce new concepts.
   - ❏ Speak clearly and pause often.
   - ❏ Say the same thing in different ways.
   - ❏ Avoid or explain idiomatic expressions.
   - ❏ Use images and objects to illustrate content.
   - ❏ Use gestures and body language to supplement words.
   - ❏ Print key words and instructions on the board while saying them aloud.
   - ❏ Use overheads and charts where appropriate.
   - ❏ Check frequently to ensure that students understand.
   - ❏ Give students who are thinking in two languages time to process your questions.

3. Present classroom objects in an accessible way: use readable labels; point to the objects; say each object's name; and ask students to repeat the word. Write the names of objects in the classroom on index cards, and ask students to match the words with the objects.

4. Use concrete objects and manipulatives whenever possible as a basis for talking, reading, and writing, e.g.:
   - ❏ photographs, brochures, pamphlets, and posters
   - ❏ household and found objects
   - ❏ manipulatives to teach the language used for numeracy skills
   - ❏ art materials and art activities to teach terms and also for students to create and explain their thinking (drawings, models, sculptures)
   - ❏ clocks and watches to teach the language of time
   - ❏ timetables and schedules to teach expressions of time and plans

5. Present concepts using visuals or graphic organizers (e.g., charts, Venn diagrams, classification trees, flow charts, story maps, and visual timelines.

Productive Language Skill Development

1. Have students make picture dictionaries, labels, and/or mnemonics of key terms.
2. Have students discuss focus questions in pairs to produce concrete responses.
3. Encourage students to use their first languages as learning aids and to share their previous knowledge and experiences with the content subject matter with others and you. For example, many countries from which our students come already have extensive solar energy infrastructures.
4. Encourage students to create their own visuals or graphic organizers to represent their ideas (e.g., charts, Venn diagrams, classification trees, flow charts, story maps, and visual timelines).

- Learning Centres or Stations

Consider establishing learning centres or stations in your classroom as areas for students to conduct the training activities and the various steps in the performance task. As explained by Gayle Gregory and Carolyn Chapman (2007) in their *Differentiated Instructional Strategies: One Size Doesn't Fit All*, centres have an established purpose, or established tasks, as set by the teacher. Centres are designed to let students work hands-on and at their own pace, while accessing their creativity, complex thinking, problem-solving skills, and particular learning styles.

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A copy of *Be Safe!* (2nd edition) is included in the Science Kit. All teachers should read the introduction on pages 1–2 and review pages 17–19 on electricity prior to having students work with circuits.

Gregory and Chapman (2007) state, "Centers are places where the work can be made to fit the learner's needs, ranging from basic learning, to remediation, to enrichment. They set up opportunities for understanding a skill or a concept through a variety of experiences" (page 134). Examples of types of centres that would be appropriate for the tasks and activities in this resource are:

- ❏ resource centres, with a variety of relevant material at a variety of levels
- ❏ centres for experimentation and discovery
- ❏ writing centres
- ❏ computer centres
- ❏ art and media centres
- ❏ centres for further investigation

You will see this symbol on activity pages when reviewing safety procedures is recommended.

Safety Considerations

It is important to build a culture of safe practice when implementing the Science and Technology curriculum. As a class, develop and post a set of rules for working with circuits, such as the following.

Rule 1: Keep work areas clear of clutter. Be sure that work areas are dry.

Rule 2: Use all materials carefully.

Rule 3: Be aware that a circuit with only wires and a battery will heat up quickly because there is no load (such as a light bulb) that can get rid of the heat. Such circuits can reach temperatures high enough to cause burns.

Rule 4: Work with your teacher's supervision and check all work with your teacher. For example, prior to closing a switch in the first circuit that you build, show your circuit to your teacher to ensure that it will be safe.

Getting Started

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Review the other print resources included in the Science Kit to identify material you wish to incorporate in your planning and teaching: *Hands-on Science and Technology; Electric Gadgets and Gizmos*; *Be Safe!* (2nd ed.); GRASP: a tool for developing ecological literacy through rich performance tasks.

Below are suggested steps for beginning the unit.

1. Read the teaching plans for all three performance tasks to understand their purpose, components, curriculum expectations, and assessment and evaluation opportunities. Skim all the training activities and their blackline masters. Then, choose the performance task that you want to do.

2. Read the suggested training activities for your chosen performance task. You may want to follow the resource's suggested plan for doing the training activities immediately after introducing the performance task and then reviewing them as they are referenced in the task. In this way, students have the chance to practise their learning and skills before they complete the performance task. Or, you may prefer to do the training activities as they arise during the performance task. You do not have to do all the suggested training activities; any that are requisite are identified.

3. To assess students' existing knowledge of electricity sources and solar energy, you could begin the unit by having them complete a brief questionnaire or start a KWL chart. The results will help you choose the training activities that are most appropriate for your class's needs.

4. Plan the groupings you will use for the tasks (individual, pairs, or small groups). For some activities, the groupings will depend on the number of solar cells available. The following groupings are suggested.

   - ❏ Performance Task 1: individual, followed by pairs or small groups
   - ❏ Performance Task 2: pairs or individual
   - ❏ Performance Task 3: pairs

5. Plan your assessment and evaluation criteria and tools.

6. Schedule the various components of the task, including the training activities.

7. Implement the unit and have fun!

Performance Task 1

SOLAR ARCHITECT: DESIGN A SOLAR VILLAGE

Performance Task 1

SOLAR ARCHITECT: DESIGN A SOLAR VILLAGE

▸ Overview

Students play the role of an architect in the company Solar Village Inc. The City Council has asked companies to submit designs for a new village. Solar Village Inc. will design a village powered mostly by solar energy. The company must persuade the Council to build the solar village rather than a conventional village. Students will first learn about solar energy and then design a building for the village and create a budget. They construct a model of their building and assemble the village as a class. They design and create a PV circuit for a part of the village (the number depends on your available PV cells). They also create a persuasive poster to convince the Council to build the solar village.

- Task Components
  1. Introducing the Task
  2. Conducting the Training Activities
  3. Planning the Village and Buildings
  4. Designing the Building and PV Circuit
  5. Making the Buildings, Village, and PV Circuit
  6. Persuading the Council to Go Solar

- Groupings

Students could work on their own to create the budget, model building, and circuit design, and then work in groups to install the circuits (depending on the number of solar panels available). Alternatively, you could have students work in pairs or small groups for all steps in the task.

- Planning

❑ Review all components of this task, including all blackline masters.
❑ Choose the training activities you wish to do (see page 19).
❑ Decide whether you will have students work individually, in pairs, or in small groups, and plan the groupings.
❑ Plan and prepare the assessment and evaluation tools you will use.
❑ Make a schedule.

SOLAR ARCHiTECT

TIME: 15 – 30 Minutes

1. Introducing the Task

- Overview

In this lesson you will introduce students to the performance task. You will explain the task, components, criteria, and glossary assignment. The purpose of this lesson is to build excitement about the task and ensure students' understanding.

- Planning Notes

❏ Ask students to gather recycled materials at home for making a model building.
❏ Make copies of BLM 1.1: Official Contract (next page).
❏ Provide folders for each student.

- Teaching/Learning Strategies

1. Explain the scenario and roles to students (see the suggestion below).
2. Discuss the assessment and evaluation criteria and share the tools you plan to use.
3. Distribute the folders and explain their use.
4. Present students with BLM 1.1. They are to sign it and keep it in their folders.
5. Explain that students will be keeping a glossary of terms throughout the task.

Here's a suggestion for presenting the scenario:

City Council is planning to build a new village for about a thousand people and is asking companies to submit design ideas.

You have just been hired as an architect by a company called Solar Village Inc. As a company, you will brainstorm the buildings needed in the village. Then you will each design one building, including a plan and budget for its solar energy use. You will then create a model of your building.

Once the buildings are complete, all the architects will place their models together to present the solar village to the Council. You will also each design a persuasive poster showcasing your building and explaining why the Council should build this solar village.

To design a solar building, you need to learn about solar energy. Before starting your project you will undergo training. You will research solar energy, learn the math and science behind it, and learn how it works.

Keep all your training activities in your folder. You will need them when we begin planning the solar village.

SOLAR VILLAGE INCORPORATED

OFFICIAL CONTRACT

..... , hereby agrees to accept the position of Architect at Solar Village Incorporated.

As part of your job, you will undergo a rigorous training process in order to become an expert in Solar Energy. This will include the science, mathematics, and design involved in solar electric projects.

Once training is complete, you will take on your first project. You will be part of a team responsible for planning a new Solar Village and persuading the Council to build this village rather than a conventional one. You will design one solar-powered building and build a model of it. As a team you will then assemble your models into a model village as a display for the Council.

You will then have to create a poster to persuade the Council to build our village.

Your job begins immediately!

Signed: .....

Date: .....

Solar Village Incorporated
147 Spadina Avenue
Toronto, Ontario M5V 2L7

SOLAR ARCHITECT

2. Conducting the Training Activities

The training activities listed below are recommended for this task. You may choose to do the training activities at this point and then review them as they arise within the task components that follow. In this way, students have the chance to practise their learning and skills before they complete the performance task.

Alternatively, you may choose to do the training activities only as they arise within the performance task.

To gauge students' existing knowledge of electricity sources and solar energy, you could have them complete a brief questionnaire or a KWL chart. The results will help you choose the training activities that are most appropriate for your class needs.

It is recommended that you begin with Training Activities 1 and 2, which are about building circuits. Activities 4, 5, 6, and 7 provide more general background information on electricity sources and solar energy, and you may choose to do one or more of these. Activities 8 and 10 are required for this performance task.

To conclude the performance task, use Concluding Activity 11: Collecting the Facts on Solar Energy, which has students identify what they have learned about solar energy, and what they still want to know.

Note that each of the following training activities includes accompanying blackline masters.

Training Activity 1:	Building Circuits (page 62)
Training Activity 2:	Photovoltaic Circuits (page 66)
Training Activity 4:	Our Electricity Sources (page 73)
Training Activity 5:	Solar Technology (page 78)
Training Activity 6:	How Do Solar PV Systems Work? (page 81)
Training Activity 7:	A Closer Look at Electricity Generation Types (page 83)
Training Activity 8:	Solar Angles (page 86)
Training Activity 10:	Electricity Budgeting (page 93)
Concluding Activity 11:	Collecting the Facts on Solar (page 97)

SOLAR ARCHITECT

TIME: 2 – 2.5 Hours

Training Activities

Training Activity 4: Our Electricity Sources (page 73)

Training Activity 5: Solar Technology (page 78)

Training Activity 6: How Do Solar PV Systems Work? (page 81)

Training Activity 7: A Closer Look at Electricity Generation Types (page 83)

Training Activity 10: Electricity Budgeting (page 93)

3. Planning the Village and Buildings

- Overview

Students brainstorm a list of buildings needed for their village. Each student chooses (or is assigned) a building and prepares a description and an energy budget.

- Planning Notes

Make copies of BLM 10a: Solar Electricity Budget (page 95) and BLM 1.2: Summary: My Solar Building (page 21).

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.
2. Have a class brainstorming session about buildings needed in the solar village. Remember that this is a small community of about a thousand people. Ask: *What buildings are needed in a community? What services are needed?* List students' responses.

   Suggested Buildings

- school	- seniors' residence	- library
- post office	- clothing store	- hospital/health clinic
- houses	- bike shop	- restaurant
- town hall	- pet store	- grocery store
- bank	- museum	- office building

3. Ask each student to choose a particular building (or assign the buildings).
4. Refer to Training Activity 10: Electricity Budgeting and hand out BLM 10a, which students will use to create an electricity budget for their building. They will calculate what percentage of their electricity budget can be provided by a small, 5-panel solar array. Remind students to include only the appliances that they will need and to think of ways to conserve electricity.
   If students have selected a large building such as a town hall, you might ask them to do a budget for only one room. Also, some buildings might have appliances for which the power draw cannot be measured. See *http://www.ecospark.ca/solar* for a list of appliances that might be found in these buildings.
5. Hand out and have students complete BLM 1.2, which is a planning sheet.

Name: .....

Date: .....

Summary: My Solar Building

Use your calculations on the "Solar Electricity Budget" handout to fill in this planning sheet.

1. My building is a: .....

2. My building is important to the village because: .....

.....

.....

.....

3. My building will use ..... watt hours of electricity in one day.

4. My array of 5 solar panels will provide ..... watt hours of the needed electricity.

5. My array of 5 solar panels will provide ..... % of the electricity needed.

6. This means that my building will need to draw..... watt hours from other sources.

7. Some benefits of installing panels on buildings are: .....

.....

.....

.....

.....

SOLAR ARCHITECT

TIME: 1 – 1.5 Hours

4. Designing the Building and PV Circuit

Training Activities

Training Activity 1: Building Circuits (page 62)

Training Activity 2: Photovoltaic Circuits (page 66)

Training Activity 8: Solar Angles (page 86)

- Overview

Students draw a sketch of their building, They also draw and label a circuit diagram for a PV circuit that could be placed in the village (depending on your PV panel availability).

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.

2. Explain to students that they will draw two 2-D sketches of their building. The first is a technical drawing of the front of the building. The second is any other side. Students should:
   - ❏ use rulers and protractors
   - ❏ draw and label the position of the 5 solar panels
   - ❏ indicate if the solar panels will be stationary or if they will tilt (if stationary, the angle of the panels should be included—see Training Activity 8: Solar Angles)

3. Reiterate that students will be creating a model of their building as part of an entire model village they will present to the Council. To demonstrate that the village is partially powered by solar energy, they will install a few working PV circuits. Ask students to think of what they could "make work" either on their models or as a feature in the village (e.g., street lights or a fun-fair ride). Have students draw and label the circuit on a separate piece of paper.

4. Remind students to place all their work in their folders.

Extension Idea: Students could also draw a floor plan of their building.

Toronto District School Board

See page 60 of the *Hands-On-Science and Technology* document in the Science Kit to see examples of simple milk carton buildings wired as parallel and series circuits using a battery.

SOLAR ARCHITECT

TIME: 2 – 3.5 Hours

5. Making the Buildings, Village, and PV Circuit

- Overview

Students construct their solar buildings, using recycled materials, and then assemble the solar village. They install some of the circuit designs (depending on the availability of PV panels).

Training Activities

Training Activity 1: Building Circuits (page 62)

Training Activity 2: Photovoltaic Circuits (page 66)

- Planning Notes

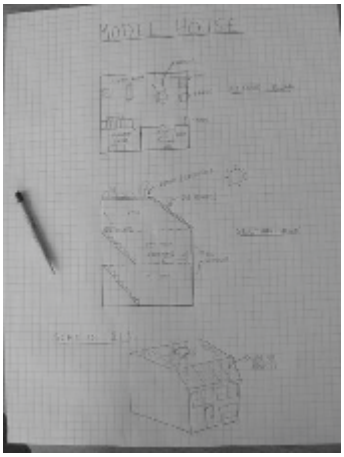
❏ Remind students to bring in their recyclable materials.
❏ Gather building supplies such as glue, tape, and scissors.
❏ Prepare an area to assemble the village (ideally outside, to power the PV panels).
❏ Prepare the PV circuit equipment.
❏ Decide which circuits to build and how to group students (depending on availability of PV panels).
❏ Bring a camera to photograph the village (mailto:info@ecospark.ca).

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.

Review safety procedures (see page 13).

2. Have students construct their model building. Ensure that they are all building to the same scale and that their solar panels (which can be replicas, if necessary) are at the correct angle. Provide ample time.



3. Consider using BLM 1.3 Steps in Technological Problem Solving (modified with permission from SmarterScience.ca) to guide students while constructing their buildings. (See next page.)

4. Identify the student-designed circuits to be installed and form groups of students to install them (depending on the number of panels available). Have students create the circuits and then test them (either outside or with a lamp to simulate the sun if the weather is cloudy).

5. Once all the buildings are complete, draw a basic street grid pattern on the board. (The size will depend on your class size.) Draw plots on the grid to equal the number of buildings. Together, develop the village plan by deciding on the location of the buildings. Then, have students assemble the village according to the grid. If possible, build the village outside so that the solar panels work naturally.

Name: ..... Date: .....

Steps in Technological Problem Solving

INITIATING AND PLANNING

Step 1: Understanding the Problem Describe the situation and identify the problem that needs a solution. You can also draw a diagram to help identify the problem.

.....

.....

.....

Step 2: Brainstorming Use words, pictures, and/or diagrams to brainstorm possible solutions to the problem.

.....

.....

.....

Step 3: Keep the End in Mind What exactly must your solution do to be successful? How will you know which of the possible solutions might be the best? How will you judge the success of your design?

.....

.....

.....

Step 4: Assess Your Own Ideas Describe which possible solution you like the best, and why.

.....

.....

.....

Step 5: Visualize Your Solution Draw a technical drawing of your proposed solution.

Step 6: Map Out Your Solution Describe the steps you will follow in order to build your solution, and make a list of materials that you will need. (Refer to the sample template below)

Materials	Size/Type	Quantity
Steps to Follow		

PERFORMING AND RECORDING

Step 1: Safety First Think ahead of time and review your "Steps to Follow" to identify safety concerns related to your plan. Describe these safety concerns below. Identify the precautions you will take to prevent injury, and discuss these with your teacher before moving forward with your plan.

Step 2: From Ideas to Action Once you have a safe plan, you can begin to build your solution.

Step 3: Document the Process Keep a point-form record of key accomplishments as you build your solution so you can tell people the story of your success.

ANALYZING AND INTERPRETING

Step 1: Evaluate Your Solution

What changes did you make as you worked? Evaluate how well your solution worked. Did it achieve its task? Refer back to your work in "Step 3: Keep the End in Mind" in Initiating and Planning to remember exactly what you wanted your solution to do.

Step 2: The Solution Is Now a New Beginning

What changes would you make if you could start over? Did you discover any new problems that need to be solved? If yes, what are the problems, and who will solve them?

SOLAR ARCHITECT

TIME: 2 – 3.5 Hours

Training Activities

Training Activity 4: Our Electricity Sources (page 73)

Training Activity 5: Solar Technology (page 78)

Training Activity 7: A Closer Look at Electricity Generation Types (page 83)

6. Persuading the Council to Go Solar

- Overview

Students each create a poster that describes their building and includes a persuasive argument for building a solar village.

- Planning Notes

❏ Gather poster-making supplies.
❏ Arrange for people to play the role of City Council members (principal, teachers, older students).

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.
2. Tell students that they will be making a poster for the Council. The poster should describe their building, explain its use of solar energy, and convince the Council to build the solar village. The poster should include:
   - ❏ a persuasive headline
   - ❏ a persuasive paragraph
   - ❏ all the information from BLM 1.2: Summary: My Solar Building
   - ❏ a sketch of the building
3. To prepare, students should look through their folders and record facts about energy sources that will help convince the Council to build a solar village rather than a conventional village.
4. As a class, compile a list of persuasive facts and ideas and write them on the board. You could also address some perceived drawbacks, such as cost.
5. Have students use the information to write their persuasive paragraph. Have them review their paragraphs with other students for revising and editing.
6. Have students create their poster. Review the criteria and remind students that the posters are meant to persuade their Council audience.
7. Display the finished posters. Have your Council review them along with the model village and circuits.
8. To conclude the performance task, use Concluding Activity 11: Collecting the Facts on Solar, page 97, which has students identify areas for further study.

SOLAR ARCHiTECT

Rubric

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
UNDERSTANDING OF KEY CONCEPTS				
Knowledge and Understanding (impact of electricity use; static and current electricity; energy transformations and types of circuits)	demonstrates a limited understanding of concepts	demonstrates some understanding of concepts	demonstrates a considerable understanding of concepts	demonstrates a thorough understanding of concepts
PROCESS				
Inquiry and Safety Procedures	has difficulty following inquiry procedures	follows inquiry procedures with some competence	consistently follows inquiry procedures	expertly follows inquiry procedures; may assist others in doing so
	has difficulty following safety procedures	follows safety procedures with some competence	consistently follows safety procedures	expertly follows safety procedures; may assist others in doing so
Technological Problem Solving	with support (e.g., as a class or in small groups), selects one possible solution to implement	selects a possible solution to implement	selects a possible solution to implement, and provides reasons for the choice	selects a possible solution, and provides reasons for the choice; considers function, aesthetics, environmental impact
PRODUCTS/PERFORMANCE				
Planning and Diagrams (budget and planning sheet; labelled drawings of the building)	needs considerable support in creating a budget and planning sheet; has many errors and omissions in calculations	creates a partial budget and planning sheet; makes several errors and/or omissions in calculations	creates a complete budget and planning sheet; makes only a few minor errors in calculations	skillfully creates a complete budget and planning sheet; makes no or almost no errors in calculations
	has limited success in creating drawings; has many inaccuracies; has difficulty indicating panel angles	creates drawings that are partially complete; has several inaccuracies in labels and panel angles	creates accurate and complete drawings; may have some errors in panel angles	creates superior and accurate drawings; no errors in panel angles
Model of Building and Circuit	shows minimal attention to scale, angle of panels, or use of materials in model	shows some attention to scale, angle of panels, and use of materials in model	demonstrates appropriate use of scale, angle of panels, and use of materials in model	demonstrates highly accurate use of scale, angle of panels, and innovative use of materials in model
	requires considerable support in creating a circuit; shows limited understanding of circuits	requires some support in creating a circuit; shows some understanding of circuits	successfully creates a circuit; shows a solid understanding of circuits	skillfully creates a circuit and helps others to do so; shows a thorough understanding of circuits
Poster (headline, sketch, persuasive paragraph, facts)	creates a poster with limited effectiveness; paragraph lacks persuasiveness; may be missing some elements and/or lack clarity	creates a poster that is somewhat effective; may contain all the elements but some may not be effective; paragraph is somewhat persuasive	creates an effective poster, with all the elements; paragraph is persuasive	creates a highly effective and creative poster, with all the elements used in very persuasive ways; paragraph is highly persuasive
	uses very little scientific evidence	uses scientific evidence fairly effectively	uses scientific evidence effectively	includes scientific evidence that provides a great deal of support for the message

Name: .....

Self-Assessment Checklist

Date: .....

For each question, place a checkmark in the "Yes" or "No" column.
In the "My Comments" column, write some notes about how you think you did.

PLANNING	YES	NO	MY COMMENTS
Do I understand the goal?			
Do I understand my role?			
Did I complete the handout called "Solar Electricity Budget"?			
Did I complete the handout called "Summary: My Solar Building"?			
Did I do a technical drawing of my building?			
Did I draw and label a circuit diagram for my solar PV circuit?			
MAKING THE MODEL	**YES**	**NO**	**MY COMMENTS**
Did I build my model using recycled materials, and using the correct scale and correct angles?			
Did I make and test a solar PV circuit?			
COMMUNICATION	**YES**	**NO**	**MY COMMENTS**
Did I write a persuasive paragraph using special words like certainly, surely, or without a doubt?			
Did I create a persuasive poster that has punchy headline, the persuasive paragraph, important facts, and a sketch of my building?			

"Tell me, I forget.
Show me, I remember.
Involve me, I understand."

– Ancient Chinese Proverb

Performance Task 2

SOLAR EDUCATOR: AMAZE YOUNG CHILDREN

Performance Task 2

SOLAR EDUCATOR: AMAZE YOUNG CHILDREN

▸ Overview

Students play the role of an educator in an organization called Solar Experts. They first learn about solar technology and then organize their knowledge into a presentation suitable for younger students (grades 2–4 students in your school). Each educator, or group of educators, will give a five-minute lesson to younger students using visual and/or audiovisual aids such as posters, PowerPoint or Prezi software, or video. If you wish, students could design and present a sample PV circuit as part of the presentation.

- Task Components
  1. Introducing the Task
  2. Conducting the Training Activities
  3. Planning the Presentation
  4. Writing the Presentation
  5. Being Solar Experts

- Groupings

Students could work either individually or in pairs for all steps in this task. If you choose to include circuit-making, groupings will depend on the equipment you have available. Students could present their information individually and then demonstrate the circuit as a group.

- Planning

❑ Review all components of this task, including all blackline masters.
❑ Choose the training activities you wish to do (see page 35).
❑ If you plan to have students build a demonstration solar circuit or model, consider using BLM 1.3: Steps in Technological Problem Solving (page 24).
❑ Decide on the groupings.
❑ Plan and prepare the assessment and evaluation tools you will use.
❑ Make a schedule.

SOLAR EDUCATOR

TIME: 15 – 30 Minutes

1. Introducing the Task

- Overview

In this lesson you will introduce students to the performance task. You will explain the task, components, criteria, and glossary assignment. The purpose of this lesson is to build excitement about the task and ensure students' understanding.

- Planning

❏ Make copies of BLM 2.1: Solar Experts Training Program (next page).
❏ Provide folders for each student.

- Teaching/Learning Strategies

1. Explain the scenario to students (see the suggestion below).
2. Discuss the assessment and evaluation criteria and share the tools you plan to use.
3. Distribute the folders and explain their use.
4. Present students with BLM 2.1. They are to sign it and keep it in their folders.
5. Explain that students will be keeping a glossary of terms throughout the task.

Here's a suggestion for presenting the scenario:

Your school wants all of its students to be knowledgeable about solar PV energy. They want all students to know how it works, its benefits, and its challenges. This is why they have hired a company called Solar Experts Inc. In turn, Solar Experts is asking grade 6 students to train to become solar educators. You will be responsible for educating the younger grades in your school.

To be an effective educator and solar expert, you will need to first learn all about solar electricity. Before you start your teaching you will undergo a training process. You will research solar energy, learn the math and science behind it, and learn how it works.

After you have become a solar expert, you will prepare a 5-minute presentation to present to younger students. They will ask you questions that you can answer right then, or you can do more research and answer them later.

Keep all your training activities in your folder. You will need them when you begin to plan your solar presentation.

Solar Experts

TRAINING PROGRAM

REGISTRATION FORM

You have been selected to become a solar educator with Solar Experts. You will help educate younger students at your school about solar electricity.

As part of the training program, you will do a series of activities, including research, writing, science experiments, and math assignments. These will train you to be a real solar expert.

After your training, you will create and deliver a presentation to younger students to pass along your knowledge of solar electricity.

Name: .....

School: ..... Class: .....

Signature: .....

Date: .....

Solar Experts
147 Spadina Avenue
Toronto, Ontario M5V 2L7

SOLAR EDUCATOR

2. Conducting the Training Activities

The training activities listed below are recommended for this task. You may choose to do the training activities at this point and then review them as they arise within the task components that follow. In this way, students have the chance to practise their learning and skills before they complete the performance task.

Alternatively, you may choose to do the training activities only as they arise within the performance task.

To gauge students' existing knowledge of electricity sources and solar energy, you could begin the unit by having them complete a brief questionnaire or a KWL chart. The results will help you choose the training activities that are most appropriate for your class needs.

It is recommended that you begin with Training Activities 1 and 2, which are about building circuits, to ensure that students understand the principles of current electricity. Activities 3, 4, 5, 6, 7, 9, 10, and 11 provide more general background information on electricity sources and solar energy, and you may choose to do one or more of these.

To conclude the performance task, use Concluding Activity 11: Collecting the Facts on Solar, page 97, which has students identify what they have learned about solar energy, and what they still want to know.

Note that each of the following training activities includes accompanying blackline masters.

Training Activity 1:	Building Circuits (page 62)
Training Activity 2:	Photovoltaic Circuits (page 66)
Training Activity 3:	How Much Electricity Do We Use? (page 69)
Training Activity 4:	Our Electricity Sources (page 73)
Training Activity 5:	Solar Technology (page 78)
Training Activity 6:	How Do Solar PV Systems Work? (page 81)
Training Activity 7:	A Closer Look at Electricity Generation Types (page 83)
Training Activity 9:	How Much Electricity Can Solar Produce Anyway? (page 89)
Training Activity 10:	Electricity Budgeting (page 93)
Concluding Activity 11:	Collecting the Facts on Solar (page 97)

SOLAR EDUCATOR

TIME: 1 – 1.5 Hours

3. Planning the Presentation

- Overview

Students extract the most important and interesting facts and concepts they learned during their training and organize them into topics for their presentation.

- Planning Notes

❑ Make copies of BLM 2.2: What I Have Learned about Solar PV and BLM 2.3: Planning My Presentation (next pages).

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.

2. Hand out BLM 2.2. Ask students to look through their folders (and their memories!) to select six points or concepts that they think are the most important or most interesting facts about solar PV. You might ask: *What do you think are the most important points about solar PV that the younger students need to know?*

3. Have students write their six points on BLM 2.2.

4. Explain that a presentation should have a logical flow, so they should first group similar ideas together. Ask students to examine their list of six points. Ask: *Which of these points are similar to another?* or *Which of these points have similar topics?* Ask students to connect similar points on BLM 2.2 by highlighting with the same colours or with symbols.

5. Hand out BLM 2.3. Ask students to use this organizer for recording their similar points in one box. (They can use the back of the page if they need another box.)

6. Ask students to name each group of points and write the topic name in the space provided. These names (and the points) provide the organizational plan for their presentation.

Training Activities

Training Activity 3: How Much Electricity Do We Use? (page 71)

Training Activity 4: Our Electricity Sources (page 73)

Training Activity 5: Solar Technology (page 78)

Training Activity 6: How Do Solar PV Systems Work? (page 81)

Training Activity 9: How Much Electricity Can Solar Produce Anyway? (page 89)

BLM 2.2

What I Have Learned about Solar PV

Name: .....

Date: .....

Look through your folder. What are the most important or the most interesting points or facts that you have learned? You will be making a presentation for younger students. What do you think they should know about solar PV? Write six points in the spaces below.

1. .....

.....

.....

2. .....

.....

.....

3. .....

.....

.....

4. .....

.....

.....

5. .....

.....

.....

6. .....

.....

.....

Planning My Presentation

Name: .....

Date: .....

Now it's time to think about how to organize your presentation.

1. Look at your six points. Group similar points together. For example, if two points are about how solar energy works, put them together.
2. Give a name to each group of points. Write the name in the space provided.

GROUP A	NAME:

.....

.....

.....

.....

.....

GROUP B	NAME:

.....

.....

.....

.....

.....

GROUP C	NAME:

.....

.....

.....

.....

.....

SOLAR EDUCATOR

TIME: 2 – 3 Hours

Training Activities

Training Activity 1: Building Circuits (page 62)

Training Activity 2: Photovoltaic Circuits (page 66)

Review safety procedures (see page 13).

4. Writing the Presentation

- Overview

Students use their completed BLM 2.3: Planning My Presentation as a guide to writing a script for their presentations. They review one another's scripts and revise. Then, they plan a visual or audiovisual component for their presentations (e.g., a sample PV circuit, PowerPoint, and/or video).

- Planning Notes

❏ Make copies of BLM 2.4: My Presentation Outline (next page).
❏ Gather the equipment for making solar PV circuits.
❏ Note that students could present individually but demonstrate the circuit as a group.

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.
2. Explain to students that they will be writing a script for their 5-minute presentation. Ask them to think about the purpose, audience, and how to make their presentation suitable for that audience. Discuss criteria of success by reviewing your assessment tool with students (see page 42).
3. As a class, discuss interesting ways to introduce and conclude a presentation, as well as different types of visual or audiovisual aids that would be suitable for the audience, e.g., a sample of solar PV circuitry, PowerPoints, Prezis, and/or videos.
4. Hand out BLM 2.4 and ask students to complete it, based on what they have just thought about and discussed.
5. Have students use both planners (BLMs 2.3 and 2.4) to write a script for their presentation.
6. When the scripts are complete, have students first practise a reading and then deliver it to a partner. Peer reviewers should ensure that:
   ❏ the language is suitable for the audience
   ❏ the information is pertinent
   ❏ the oral presentation is clear and effective
   ❏ the presentation is around 5 minutes

   Students should then rewrite their scripts, incorporating any feedback.
7. Ask students to think of questions that younger students might ask, and encourage students to be prepared to answer them.
8. Have students develop their visual and/or audiovisual aids to accompany their presentations.

My Presentation Outline

Name: .....

Date: .....

Now it's time to write your presentation! This page will help you create an outline.

1. The PURPOSE of my presentation is to: .....

.....

2. My AUDIENCE is: .....

3. What will you say to introduce your presentation? INTRODUCTION:

.....

.....

.....

4. In what order will you present the groups of points you selected on "Planning my Presentation"?

First: .....

Second: .....

Third: .....

5. What will you say to conclude your presentation? CONCLUSION:

.....

.....

.....

6. My visual and/or audiovisual aids will be:

.....

.....

.....

SOLAR EDUCATOR

TIME: 1 – 1.5 Hours

5. Being Solar Educators

- Overview

Students practise their presentations and then present them to younger grades.

- Planning Notes

❏ Give students time to practise their presentations.

❏ Meet with grades 2–4 teachers to arrange the time and location for the presentations. (You might arrange for students to present to a small group within each class. In this way, each younger group will hear only one presentation.)

❏ Make solar circuitry equipment available and ensure that there is adequate space and equipment for the presentations.

Review safety procedures (see page 13).

- Teaching/Learning Strategies

1. Confirm with students which class or group they will be presenting to, and the location.

2. At the scheduled time, have students make their presentations to the younger students. You might consider video-recording their presentations.

3. After the presentations, ask students to write a reflection about their presentation experience. You could use the following questions (write them on the board or provide a handout that you can use as a student self-assessment):
   - ❏ How do you feel about your presentation?
   - ❏ Did you keep the younger students interested? How?
   - ❏ How useful do you think your visual or audiovisual aid was?
   - ❏ What questions did the students ask?
   - ❏ Were there any questions that you could not answer?
   - ❏ Was there anything that you wish you had included but did not?
   - ❏ What do you think you did really well while presenting?
   - ❏ Is there anything that you can improve in your presentation approach?

4. To conclude the performance task, have students complete Concluding Activity 11: Collecting the Facts on Solar, page 97, which has them identify areas for further study.

SOLAR EDUCATOR

Rubric

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
	UNDERSTANDING OF KEY CONCEPTS			
Impact of electricity use; static and current electricity; energy transformations and types of circuits	demonstrates a limited understanding of concepts	demonstrates some understanding of concepts	demonstrates a considerable understanding of concepts	demonstrates a thorough understanding of concepts
	PROCESS			
Planning the Presentation (gathering information; creating an outline)	identifies one or two points; may not be of most importance	identifies some points; may have fewer than six; may not be the most important	identifies six important and interesting points	identifies six of the most important and interesting points
	has limited success in creating an outline	creates an outline of some clarity and organization	creates an effective, organized outline	creates a highly effective and organized outline
Inquiry and Safety Procedures (for circuitry presentation, if teacher chooses)	has difficulty following inquiry procedures	follows inquiry procedures with some competence	consistently follows inquiry procedures	expertly follows inquiry procedures; may assist others in doing so
	has difficulty following safety procedures	follows safety procedures with some competence	consistently follows safety procedures	expertly follows safety procedures; may assist others in doing so
Technological Problem Solving (for circuitry presentation, if teacher chooses)	with support (e.g., as a class or in small groups), selects one possible solution to implement	selects a possible solution to implement	selects a possible solution to implement, and provides reasons for the choice	selects a possible solution, and provides reasons for the choice; considers function, aesthetics
	PRODUCTS/PERFORMANCE			
Script (meets purpose and audience; includes important points; presents accurate, clear information; is organized)	script meets few of the criteria; may lack organization and clarity	script meets some of the criteria; may lack clarity or be somewhat inaccurate and/or unorganized	script meets all or almost all of the criteria; is appropriate for purpose and audience; is clear and accurate; well organized	script meets or exceeds the criteria; shows strong awareness of purpose and audience; is clear, accurate, highly organized, and engaging
Presentation (delivery; use of audiovisual aid and/or circuitry, if teacher chooses)	has limited success in presenting; shows limited oral communication skills	presents somewhat effectively; shows some oral communication skills; audience is fairly engaged	presents effectively; shows effective communication skills; engages audience	presents skillfully; shows highly effective communication skills; thoroughly engages audience
	makes limited or ineffective use of audiovisual aid (and/or circuitry)	uses audiovisual aid (and/or circuitry) with some effectiveness	uses audiovisual aids (and/or circuitry) effectively	uses audiovisual aids (and/or circuitry) expertly

Name: .....

Self-Assessment Checklist

Date: .....

For each question, place a checkmark in the "Yes" or "No" column.
In the "My Comments" column, write some notes about how you think you did.

PLANNING	YES	NO	MY COMMENTS
Do I understand the goal?			
Do I understand my role?			
Did I complete the handout called "What I Have Learned about Solar PV"?			
Did I complete the handouts called "Planning My Presentation" and "My Presentation Outline"?			
Did I write my script, using the above handouts as a guide?			
Did I keep the purpose and audience in mind?			
Did I choose an effective visual and/or audiovisual aid?			
THE PRESENTATION	**YES**	**NO**	**MY COMMENTS**
Was my presentation well organized, informative, and suitable for the audience?			
Did I use effective oral communication skills (clear voice, effective body language and tone)?			
Did I use the visual and/or audiovisual aid effectively?			

"Unless someone like you cares a whole awful lot, nothing is going to get better. It's not."

– *The Lorax*, by Dr. Seuss

Performance Task 3

SOLAR ENTREPRENEUR: PITCH YOUR IDEA

Performance Task 3

SOLAR ENTREPRENEUR: PITCH YOUR IDEA

▸ Overview

Students play the role of an entrepreneur. First, they learn about solar PV technology through a training plan. Then, they think of a business concept that involves that technology; it could be a new product, store, or service. They also create a business name, an advertisement, and a "pitch." They present their pitch, including the ad, to a panel of investors and answer questions, in a format similar to the CBC television show *Dragons' Den*.

- Task Components

1. Introducing the Task
2. Conducting the Training Activities
3. Inventing a Solar Business
4. Advertising
5. The Pitch

- Groupings

Students could work in pairs for all steps in this task.

- Planning

❑ Review all components of this task, including all blackline masters.
❑ Choose the training activities you wish to do (see page 49).
❑ If you plan to have students build a prototype or mock-up of a solar invention, consider using BLM 1.3: Steps in Technological Problem Solving (page 24).
❑ Plan the pairing of students.
❑ Plan and prepare the assessment and evaluation tools you will use.
❑ Make a schedule.

SOLAR ENTREPRENEUR

TIME: 15 – 30 Minutes

1. Introducing the Task

- Overview

In this lesson you will introduce students to the performance task. You will explain the task, components, criteria, and glossary assignment. The purpose of this lesson is to build excitement about the task and ensure students' understanding.

- Planning Notes

❏ Prepare BLM 3.1: Calling All Entrepreneurs! (next page).
❏ Provide folders for each student.
❏ Prepare to show some clips from the CBC show *Dragons' Den* (optional).

- Teaching/Learning Strategies

1. Explain the scenario and roles to students (see the suggestion below). You might also wish to show some clips from *Dragons' Den* episodes.
2. Discuss the assessment and evaluation criteria and share the tools you plan to use.
3. Distribute the folders and explain their use.
4. Hand out BLM 3.1 and review it with students. They are to keep it in their folders.
5. Explain that students will be keeping a glossary of terms throughout the task.

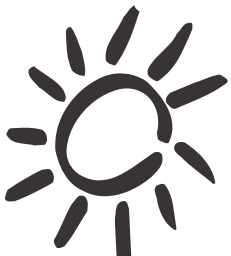
Here's a suggestion for presenting the scenario:

You are an entrepreneur, meaning someone who thinks of new business ideas. You are going to come up with an exciting business idea involving solar energy. It could be a new product, a store, or a service. You have been invited by a panel of investors (people who lend money to entrepreneurs) to pitch your idea (like the show Dragons' Den*).*

To come up with a solar business idea, you need to first go through a training process about solar electricity and how it can be used.

The training will prepare you for creating a great business idea, a creative advertisement, and a clear, persuasive pitch to convince the investors to invest in your idea. The pitch should be approximately 2 minutes long.

When you're ready, you will present to the investors. You will have to be prepared to answer their questions about your business idea and your knowledge of solar energy.



Calling all Entrepreneurs!

We are looking for exciting new business ideas that involve the use of solar photovoltaic panels.

You are invited to bring your latest business idea and pitch it to The Investors, a panel of expert business people.

You must have:

- ❑ extensive knowledge of solar energy
- ❑ a great business idea
- ❑ an exciting, 2-minute presentation that includes
  an advertisement you have created for your business

Last date for submission

SOLAR ENTREPRENEUR

2. Conducting the Training Activities

The training activities listed below are recommended for this task. You may choose to do the training activities at this point and then review them as they arise within the task components that follow. In this way, students have the chance to practise their learning and skills before they complete the performance task.

Alternatively, you may choose to do the training activities only as they arise within the performance task.

To gauge students' existing knowledge of electricity sources and solar energy, you could begin the unit by having them complete a brief questionnaire or a KWL chart. The results will help you choose the training activities that are most appropriate for your class needs.

It is recommended that you begin with Training Activities 1 and 2, which are about building circuits, to ensure that students understand the principles of current electricity. The remaining activities provide general background information on electricity sources and solar energy, and you may choose to do one or more of them.

To conclude the performance task, use Concluding Activity 11: Collecting the Facts on Solar, page 97, which has students identify what they have learned about solar, and what they still want to know.

Note that each of the following training activities include accompanying blackline masters.

Training Activity 1:	Building Circuits (page 62)
Training Activity 2:	Photovoltaic Circuits (page 66)
Training Activity 3:	How Much Electricity Do We Use? (page 69)
Training Activity 4:	Our Electricity Sources (page 73)
Training Activity 5:	Solar Technology (page 78)
Training Activity 6:	How Do Solar PV Systems Work? (page 81)
Training Activity 7:	A Closer Look at Electricity Generation Types (page 83)
Training Activity 9:	How Much Electricity Can Solar Produce Anyway? (page 90)
Concluding Activity 11:	Collecting the Facts on Solar (page 97)

SOLAR ENTREPRENEUR

TIME: 1 – 1.5 Hours

3. Inventing a Solar Business

Training Activities

Training Activity 3: How Much Electricity Do We Use? (page 69)

Training Activity 4: Our Electricity Sources (page 73)

Training Activity 5: Solar Technology (page 78)

Training Activity 6: How Do Solar PV Systems Work? (page 81)

Training Activity 7: A Closer Look at Electricity Generation Types (page 83)

Training Activity 9: How Much Electricity Can Solar Produce Anyway? (page 89)

Overview

This lesson helps students plan their solar business by engaging them in a series of brainstorming activities and by posing questions that they answer in writing. The outcome will be a short description of their intended solar business.

Planning Notes

❑ Review BLM 3.2: Sample for "Creating a Business Idea." Make copies of BLM 3.3: Creating a Business Idea and BLM 3.4: Planning and Describing Your Business for handing out. (The BLMs are on the following three pages.)

Teaching/Learning Strategies

1. Review (or conduct) the training activities.
2. Arrange students in pairs. Hand out BLM 3.3, which is an organizer, and go through it with them, using examples from BLM 3.2, so they can see what they are to do.
3. Have students work together to brainstorm ideas and fill in the left column of the chart.
4. Share ideas on the board, an overhead, or Smartboard.
5. Ask students to revisit their lists and think about how solar PV could be used with the item they identified to make it more environmentally friendly. They then jot down those ideas in the column on the right.
6. Tell the partners to discuss and then circle the idea they are most excited about, and to write one sentence describing what the business would do. Provide an example (from BLM 3.2).
7. Hand out BLM 3.4. Have the partners complete the sentences on BLM 3.4 to describe their business idea.
8. Show a sample summary paragraph (from the bottom of BLM 3.2), and explain the key elements. Have students use their planners to write their paragraph.
9. Have students join with another pair to review each other's work and generate feedback on the summary paragraphs. Students then make their revisions.

SAMPLE for Creating a Business Idea

1. Fill in this chart with your great ideas.

Things I like that use electricity (in making them or enjoying them)	How solar panels could be used to supply the electricity
video game ice cream smoothies	a solar panel on my house a solar-powered freezer a solar-powered blender
Activities I do that use electricity	**How the activity could use solar energy**
make toast listen to my Mp3 surf the Internet	solar panels on the toaster a solar-powered charger a solar-powered laptop

2. Now, circle the thing or activity that would make the best solar business.

3. How would you turn the circled idea into a business? (Answer in one sentence.)

I would freeze ice cream using a solar panel to create electricity, and sell it from a truck.

4. Is your business a: PRODUCT (SERVICE) STORE (circle one)

Write a descriptive paragraph about your business.

My solar business is an ice cream truck. My business uses solar energy to power the freezers that keep the ice cream cold. I will put the PV panels on top of the ice cream truck. Solar PV will provide most of the power needed to run the freezers (500W). Other power sources will be needed when it is cloudy. My business will help the environment because it will produce fewer greenhouse gases than other ice cream trucks do. My business will be called "The Sunshine Truck." The customers of my business will be children and their parents. To start my business I will need money to buy a truck and solar panels as well as the ice cream to sell. I will also need to make a jingle for the truck to play.

Name: .....

Creating a Business Idea

Date: .....

1. Fill in this chart with your great ideas.

Things I like that use electricity (in making them or enjoying them)	How solar panels could be used to supply the electricity
Activities I do that use electricity	**How the activity could use solar energy**

2. Now, circle the thing or activity that would make the best solar business.
3. How would you turn the circled idea into a business? (Answer in one sentence.)

.....

.....

4. Is your business a: PRODUCT SERVICE STORE (circle one)

BLM 3.4

Planning and Describing Your Business

Name: .....

Date: .....

1. Our business will (describe what your business does) .....

.....

2. Our business uses solar PV to (describe how your business uses solar power)

.....

3. Solar PV will / will not (circle one) produce all of the electricity needed by our business because:

.....

.....

4. Our business helps the environment because: .....

.....

5. The name of our business is: .....

6. The customers for the business will be .....

7. To start this business, we will need: .....

.....

.....

.....

.....

Think about: staff, materials, equipment, money, buildings: be specific!

When you have completed this page, write a paragraph to describe your solar business.
Your paragraph should have correct grammar and sentence structure.
You can write your first draft on the back of this page.

SOLAR ENTREPRENEUR

TIME: 1.5 – Full Day

4. Advertising

- Overview

Students answer a set of questions to help them plan an effective advertisement (including identifying the audience, message, medium, and mood). They then create the advertisement.

- Planning Notes

❑ Make copies of BLM 3.5: Planning Your Advertisement (next page).

❑ Gather any materials or equipment students will need to create their advertisements.

- Teaching/Learning Strategies

1. Explain the goal of the activity: students create an advertisement that will be used to promote their solar business. The investors like to see good advertising strategies!

2. Hand out and review BLM 3.5. Explain that the answers students give for each question will help shape their advertisement.

3. Once students are finished the planner, they can begin to create their advertisement. List the various media forms that they can choose from (this will depend on your time and resources).

4. Ask students to create a draft of their advertisement (a script for a radio commercial, a sketch for a print ad or poster, or a storyboard for a TV ad).

5. Have students present their advertisement in small groups, to give and receive constructive feedback based on: audience, choice/use of the medium, mood, facts, and persuasiveness.

6. Have students create their final advertisement, using the feedback they received from the group.

Planning Your Advertisement

Name: .....

Date: .....

Who is your audience or target market? .....

.....

How can you reach this audience through advertising? What types of media do they pay attention to (for example, television, radio, websites, magazines, billboards)? List all your ideas and then circle the best one.

.....

.....

Why should this audience buy your product (or use your solar business) instead of another's?

.....

.....

What facts about the environmental benefits of your business can you use to persuade your audience? Look through your folder to find some key facts and concepts.

.....

.....

What sort of mood or tone should your advertisement have? For example, should it be funny, factual, dramatic? Why would this be the best mood to promote your product or business?

.....

.....

What other important facts do you want your audience to remember about your business?

.....

.....

SOLAR ENTREPRENEUR

TIME: 3.5 Hours

Training Activities

Training Activity 3: How Much Electricity Do We Use? (page 69)

Training Activity 4: Our Electricity Sources (page 73)

5. The Pitch

- Overview

Students write and rehearse the pitch for their solar business idea and then present it to the investors.

- Planning Notes

❏ Make copies of BLM 3.6: Building Your Pitch (page 58).
❏ Gather supplies for making visual aids (e.g., props, diagrams, models)
❏ Arrange for people (the principal, other teachers) to play the roles of the investors.

- Teaching/Learning Strategies

1. Review (or conduct) the training activities.

2. Explain the concept of a pitch (a short, clear, persuasive speech that covers all the necessary points). Ask the class: What are some aspects of an effective oral presentation? Brainstorm with the class and record their ideas on the board. After brainstorming, clearly list the key parts of the pitch on the board.
   ❏ persuasive, concise, clear speech
   ❏ effective tone and body language, and a clear speaking voice
   ❏ catchy introduction and conclusion
   ❏ use of visual aids (in this case)

3. Hand out BLM 3.6 and instruct students to use it to write a draft of their pitch. They will need to refer back to BLM 3.4 and BLM 3.5, as well as their folders.

Review safety procedures (see page 13).

4. Give students the opportunity to make visual aids for their pitches (e.g., props, diagrams, models).

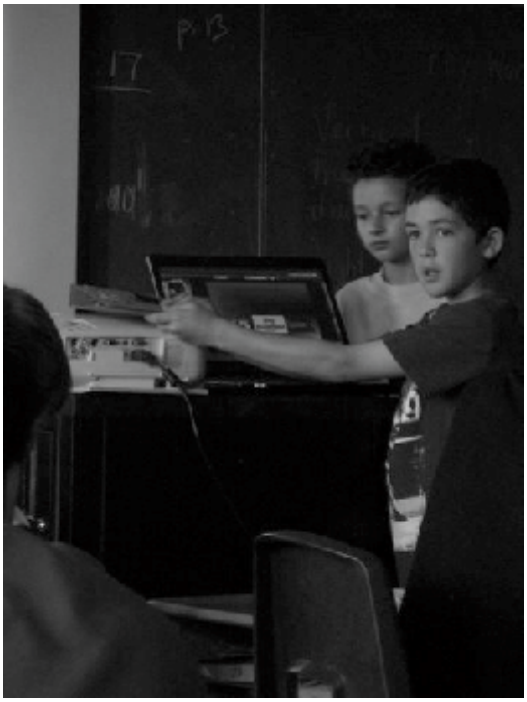
5. Once students have created a draft pitch, have them practise it and then present it, with their ad and their visual aids, to a group of students. The group will give feedback on the key features listed above. Students should also pretend to be the investors and ask the questions listed on BLM 3.6.

6. After students have received feedback, instruct them to revise their pitch.

7. Now it is time to hear the pitches. Students might want to "dress the part" for their presentation. You might want to create an atmosphere of a set for a TV taping, or a board room. Have the panel of investors sit together to hear the pitches, and encourage them to ask questions based on those on BLM 3.6.

8. The investors can write down their investment decisions, and you can hand out an invitation to a meeting for "further negotiations." (In the reality TV shows, the decisions are made in real time, but for your classroom purposes, it may be more appropriate to provide feedback to each group separately.)

9. To conclude the performance task, use Concluding Activity 11: Collecting the Facts on Solar, page 97, which has students identify areas for further study.



Name: .....

Building Your Pitch

Date: .....

What to Do for Your Pitch

1. Describe your business clearly and precisely (using your visual aid).
2. Look in your folder to find at least 3 environmental facts that will help you argue why the panel should invest in your solar business.
3. Describe who your main customers would be.
4. Explain why these customers will want to buy your product or service.
5. Present your advertisement.
6. Explain why your business will be successful.

Questions the Investors Could Ask

1. What makes your business unique?
2. Solar is expensive—why should I invest in your business rather than another business that doesn't use it?
3. I thought solar was intermittent. How will this impact your business?
4. Please explain how you plan to market your business to your customers.
5. Do you think that people will care that your business is a solar business?
6. I hear that solar panels have arsenic in them and are a problem to dispose of. How will you deal with this?

Practising for the Pitch: Checklist

- ❑ I maintain eye contact with my audience.
- ❑ I use good posture and body language.
- ❑ I speak clearly.
- ❑ I listen carefully to the questions asked and respond directly.
- ❑ I have memorized my pitch, or know it really well.

SOLAR ENTREPRENEUR

Rubric

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
UNDERSTANDING OF KEY CONCEPTS				
Impact of electricity use; static and current electricity; energy transformations and types of circuits	demonstrates a limited understanding of concepts	demonstrates some understanding of concepts	demonstrates a considerable understanding of concepts	demonstrates a thorough understanding of concepts
PROCESS				
Planning the Business (creating the plan; writing a descriptive paragraph)	shows limited planning: business idea lacks clarity and limited understanding of how solar energy will benefit the business and environment; shows limited understanding of market and the resources needed	shows some degree of planning: business idea is fairly clear and shows some understanding of how solar energy will benefit the business and environment; shows some understanding of market and the resources needed	shows effective planning: business idea is clear and shows a good understanding of how solar energy will benefit the business and environment; shows solid understanding of market and the resources needed	shows highly effective planning: business idea is very clear and shows an exceptional understanding of how solar energy will benefit the business and environment; shows thorough understanding of market and the resources needed
	paragraph lacks organization; describes the business in a limited way; has several grammatical errrors	paragraph is organized fairly well; describes the business to some extent; has quite a few grammatical errors	paragraph is well organized; describes the business effectively; has one or two grammatical errors	paragraph is very well organized; describes the business thoroughly and creatively; has no grammatical errors
Planning the Advertisement	demonstrates limited understanding of target audience or chosen medium; includes no or very few facts about environmental benefits; shows limited planning for mood and persuasiveness	demonstrates some understanding of target audience and chosen medium; includes a few facts about environmental benefits; shows some evidence of planning for mood and persuasiveness	demonstrates solid understanding of target audience and chosen medium; includes many facts about environmental benefits; has effective plans for mood and persuasiveness	demonstrates thorough understanding of target audience and chosen medium; includes many highly effective facts about environmental benefits; has highly creative plans for mood and persuasiveness
PRODUCTS/PERFORMANCE				
Advertisement	meets few of the criteria; has limited focus, tone, clarity, and sense of purpose and audience	meets some of the criteria; may lack clarity, tone, persuasiveness, and/or appeal to audience	meets most or all of the criteria; is clear, has an effective tone; is persuasive; appeals to audience	meets or exceeds the criteria; is creative and clear, has an engaging tone, is very persuasive, has strong audience appeal
The Pitch (delivery; use of the advertisement and visual aids; response to questions)	meets few of the criteria; has limited oral communication skills; uses ad and visual aids in a limited way; responds to questions in a limited way	meets some of the criteria; has some effective oral communication skills; uses ad and visual aids fairly effectively; responds to questions fairly well	meets most or all of the criteria; has effective oral communication skills; uses ad and visual aids effectively; is prepared for and responds to questions smoothly	meets or exceeds the criteria; has very effective oral communication skills; uses ad and visual aids creatively; is highly prepared for and responds to questions expertly

Name: .....

Self-Assessment Checklist

Date: .....

For each question, place a checkmark in the "Yes" or "No" column.
In the "My Comments" column, write some notes about how you think you did.

PLANNING	YES	NO	MY COMMENTS
Do I understand the goal?			
Do I understand my role?			
Did I complete the handout called "Creating a Business Idea"?			
Did I complete the handout called "Planning and Describing Your Business"?			
Did I complete the handout called "Planning Your Advertisement"?			
Did I prepare my pitch, using the above handouts as a guide?			
Did I prepare for being asked questions?			
THE ADVERTISEMENT	**YES**	**NO**	**MY COMMENTS**
Did I create a persuasive ad?			
Did I use feedback to revise it?			
THE PITCH	**YES**	**NO**	**MY COMMENTS**
Did I make an effective pitch? • Was it persuasive, concise, and clear? • Did I have a catchy introduction and conclusion? • Did I use effective oral communication skills (clear voice, effective tone and body language)? • Did I present my advertisement? • Did I use visual aids effectively? • Did I answer the questions effectively?			

Training Activities

Training Activity 1

TIME: 1.5 – 2 Hours

Building Circuits

- Overview

Students are challenged to make a light bulb glow with only one battery and one wire. They then move on to build more complicated series and parallel circuits with multiple wires, switches, and multiple light bulbs. The activity includes drawing labelled diagrams, identifying the components in each, and describing the role of each component in the circuit.

- Planning Notes

❏ Make copies of BLM 1a: Make a Circuit and BLM 1b: Electrical Circuits Inquiry Sheet (next pages).

❏ Gather the materials for making a circuit.

Toronto District School Board

Science and Technology Loan Centre, TDSB

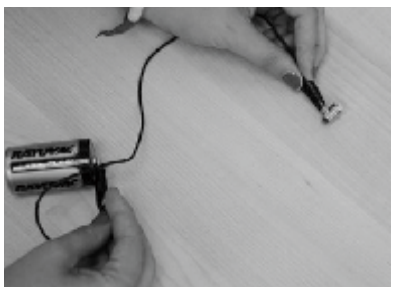
As a part of this introductory activity, use the stations approach to provide students with experience building circuits. The Science Kit contains most of the materials needed for activities in *Hands-On Science and Technology*, such as Activity 4: Part One (page 43), Activity 5: Electrical Conductors and Insulators (page 48), Activity 6: Electrical Switches (page 51), Activity 8: Parallel and Series Circuits with Multiple Light Bulbs (page 58).

- Teaching/Learning Strategies

1. Explain to students that they will try to make a light bulb glow using only one wire, one battery, and one light bulb. There are several ways of connecting these three components to make the light bulb glow. The key to success is understanding how the wires inside the light bulb are connected to the outside.

2. Hand out BLM 1a. As students try different arrangements, they should record both working and non-working circuits in BLM 1a.

3. Review at least one design that works and one that doesn't work with the whole class. For example, the circuit in the photograph on the left forms a complete loop. Each component is connected at both ends. On the outside of the light bulb, there are two parts that need to be connected. This enables the flow of current, which heats the filament in the bulb and makes it glow. In the photograph on the right, the circuit doesn't work, because the battery and the light bulb are only connected at one point, and so no complete pathway for current to flow has been made.



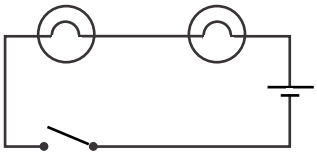
Training Activity 1

Building Circuits

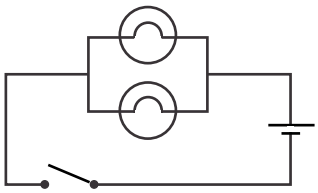
Review safety procedures (see page 13).

4. Explain that even though the students have constructed working circuits, the circuits do not give us much control, because there is no on-off switch. Show students a switch, and explain to students how a switch is connected to a circuit.

5. Introduce students to the concept of series and parallel circuits. Show students technical drawings used to represent these circuits as shown below.



Series Circuit



Parallel circuits

Toronto District School Board

Science and Technology
Loan Centre, TDSB

Materials in the
Grade 6 Science Kit
Dry cell batteries
Insulated copper wire
Miniature light bulbs and sockets
Small screwdrivers
Small blocks of wood
Electrical switches

Materials to prepare
on your own
Thumbtacks
Chart paper
Various objects to test
conductivity, (pencils, pens, rulers,
keys, aluminum foil, paper)

6. Group students to explore (in a hands-on way) these more complicated circuits at various stations (see margin note on additional station activities).

7. Hand out BLM 1b. Have students complete it to help guide their hands-on exploration of series and parallel circuits. The knowledge and skill developed here is critical for moving forward to make circuits with solar panels.

8. Ensure that students add the following words to their glossary sheets in their folders: *switch, closed circuit, open circuit, series circuit, parallel circuit*.

Make a Circuit

Name: .....

Date: .....

Sketch of circuits that work	Explain why you think it works	Sketch of circuits that don't work	Explain why you think it doesn't work

Electrical Circuits Inquiry Sheet

Name: .....

Date: .....

1. An electrical circuit is: .....

.....

2. Series Circuits
   a) Here is a technical drawing of a series circuit we made:

   b) A series circuit is:

   .....

   c) If there is a break in a series circuit, what happens? Why?

   .....

   .....

3. Parallel Circuits
   a) Here is a technical drawing of a parallel circuit we made:

   b) A parallel circuit is:

   .....

   c) Is it possible for a light to still work in a parallel circuit if there is a break? Why?

   .....

Training Activity 2

Photovoltaic Circuits

TIME: 1.5 – 2 Hours

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Loan Centre, TDSB

Materials in the
Grade 6 Science Kit
Solar panels (1.5 V, 500 mA)
Motors with fans
75 W bulb
Fixture with cage
Buzzers

Materials to prepare on your own

Note: Due to their high cost, only 12 solar panels are provided. Two panels per group of students are needed for these activities.

Review safety procedures (see page 13).

Overview

In this activity, students create circuits with PV panels. They will explore the different ways to set up a PV circuit and discuss the energy transformations involved.

Planning Notes

❑ Gather circuitry materials including: mini-photovoltaic cell (1.5 volt recommended), wires with alligator clips, devices (LEDs, bulbs, buzzers, fans, etc.) and a lamp with a 75 W bulb for testing the circuits.

❑ Prepare BLM 2a (two per group) or blank paper for students to use.

Teaching/Learning Strategies

1. Explain to students that they will explore how to build circuits with PV panels and examine the energy transformations involved.
2. Make groups of three to four students.
3. Demonstrate how the mini solar panels, motors, and fans work together.
4. Write the following questions on the board. Give each group a kit of circuitry materials and ask them to answer the questions.

   - The effect of circuit design on fan speed
     - Can you make the fan spin? Can you make two fans spin?
     - How can you make the fan spin at different speeds?
     - How does the speed of the fan change when the circuit changes from two solar panels in series to two solar panels in parallel?

   - The effect of shade on solar circuits
     - How can you stop the fan without unplugging it?
     - What happens if you cover the panel partially with your hand?
     - What happens if you put two panels in series and cover one?
     - What happens if you put two panels in parallel and cover one?

Training Activity 2

Photovoltaic Circuits

5. Discuss what the students found. Concentrate on what this means for setting up the most effective PV circuit. Ask: *What are the advantages of PV cells in parallel versus in series?* Provide a hint, if necessary: *If in series their voltage is higher; if in parallel they are less vulnerable to shade.*
6. Hand out BLM 2a (two each) or have students use their own paper.
7. Ask students to make a series circuit. Have them draw and label the circuit on BLM 2a. Then ask them to draw a flow diagram of the energy transformations that occur in their circuit.
8. Have students repeat step 7, but with a parallel circuit.

Drawing Solar PV Circuits

Name: .....

Date: .....

Draw a diagram of your circuit. Label all of the components.

This is a series circuit / parallel circuit. (circle one)

Energy Transformations in My Circuit

Light energy has been transformed several times in your circuit. Draw an energy flow diagram to illustrate the various forms it has taken. You might need to add extra arrows.

Light Energy → ..... → .....

TIME: 1 Hour

Training Activity 3

How Much Electricity Do We Use?

- Overview

This activity has students explore how much electricity Ontarians consume in a day.

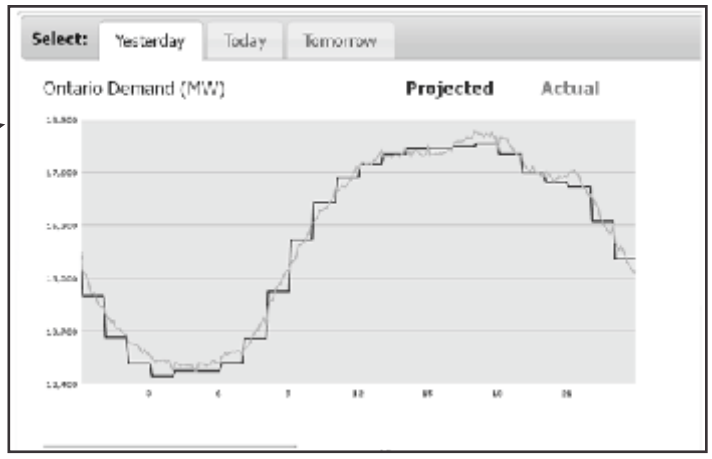
- Planning Notes

❏ Make copies of BLM 3a: How Much Electricity Do We Use? (next page).

❏ Gather data from *http://www/ieso.ca* (see step 1, below) or arrange for students to have Internet access to do so.

- Teaching/Learning Strategies

1. Students need access to the data (either through a computer or through a display) found at:
   http://www.ieso.ca/imoweb/siteShared/demand_ price.asp?sid=ic.
   You can also access the website by going to *www.ieso.ca*. Click on the "Ontario Demand" graph and then the tab for "yesterday."



Training Activity 3

How Much Electricity Do We Use?

2. Explain to students that that they are looking at data regarding how much electrical power Ontario used *yesterday*. Explain that the unit of measurement of electrical power used is the watt. Explain the meaning of the common units used, and their relationships, using a chart like the one below.

Unit of Power	Symbol	Meaning
watt	W	Base unit of power
kilowatt	kW	One thousand watts
megawatt	MW	One thousand kilowatts or one million watts
1 kW = 1 000 W		
1 MW = 1 000 kW		
1 MW = 1 000 000 W		

3. Hand out BLM 3a. Explain that students must examine the smooth line to answer questions 1–9 on BLM 3a. (The line is green on the website.)

4. Explain that, to fill out the *Family Electricity Journal*, students must think about the activities that their families do throughout the day. They will then rate the electricity intensity of the activities in various time periods to see if it corresponds to the smooth line. Provide some examples of possible activities for each period.

5. Finally, ensure that students add the following words and their symbols to their glossary sheets in their folders: *watt*, *kilowatt*, and *megawatt*.

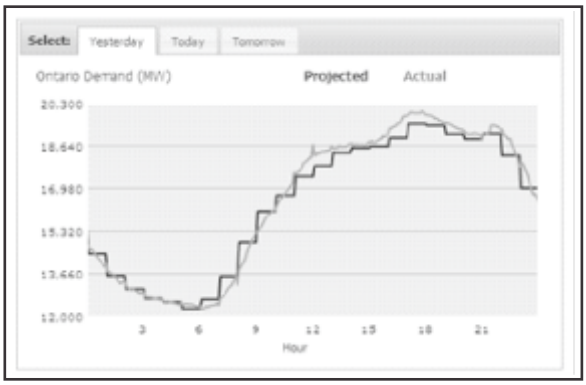
How Much Electricity Do We Use?

Name: .....

Date: .....

In Ontario we use a lot of electricity. In this activity you are going to explore how much.

1. Go to *http://www.ieso.ca*
2. Click on the line graph titled "Ontario Demand (MW)."
3. Then click on the first tab titled "Yesterday." The smooth line is the amount of electrical power used at different hours of the day. The graph will look something like the graph on the right:



4. Note that the graph uses a 24-hour clock where the hours count from 0 to 24, instead of the 12-hour clock which repeats twice with "a.m." and "p.m." showing the time of day. So on the graph, 3 means 3 a.m., 12 means 12 noon, and 15 means 3 p.m. (found by subtraction: 15-12=3).

   a. What does 18 mean? .....

   b. What does 21 mean? .....

5. Use the graph to answer the following questions:
   a. At what time of day was the least power used? Why do you think this was so?

   .....

   b. At what time of day was the most power used? Why do you think this was so?

   .....

   c. Describe the shape of the graph. When is the power used increasing or decreasing?

   .....

   d. In your opinion, at what time of day should we think about conserving electricity the most? Why? .....

   .....

6. Create a brief journal to track your family's electricity use.
   a. What types of activities are you and your family doing in each time period? Write these in the spaces provided for each time period.

   b. How much electricity do you think you are using in each time period? For each time period, check *high*, *medium*, or *low* to show how much electricity is being used.

Time	Activities	Intensity
6 a.m. – 9 a.m.	.....	❑ high ❑ medium ❑ low
9 a.m. – 4 p.m.	.....	❑ high ❑ medium ❑ low
4 p.m. – 9 p.m.	.....	❑ high ❑ medium ❑ low
9 p.m. – 6 a.m.	.....	❑ high ❑ medium ❑ low

7. Examine your Family Electricity Journal. In what periods does your family use the most amount of electricity? How does this compare with the graph you have been examining?

.....

.....

.....

Training Activity 4

TIME: 1 Hour

Our Electricity Sources

- Overview

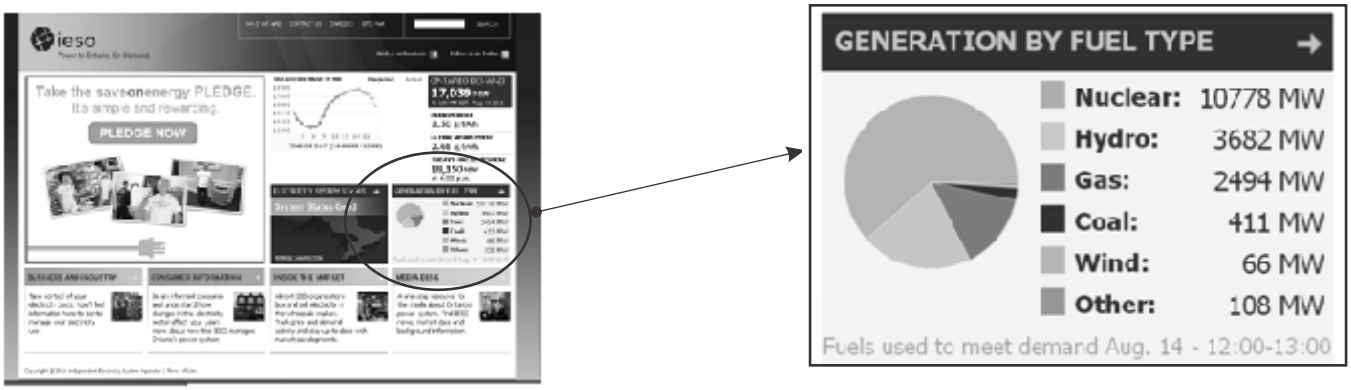
This activity guides students in exploring how Ontario generates its electricity.

- Planning Notes

❏ Make copies of BLM 4a: Where Did Our Electricity Come from Today? (next page).
❏ Give students time to review how much electricity we use.
❏ Collect today's MW generated by fuel type from *http://www.ieso.ca*.

- Teaching/Learning Strategies

1. Display today's data for MW of electricity generated per fuel type (available at *www.ieso.ca*). You should scramble the data to change its order so that it is not descending.



2. Explain to students that in this activity they will examine how we in Ontario generate electricity.

3. Hand out BLM 4a and review it with students. Once students are finished, lead a discussion about questions 5 to 10. Students will revisit many of these questions in later activities.

4. Ensure that students add the following words to their glossary sheets in their folders: *renewable resources* and *non-renewable resources*.

Where Did Our Electricity Come From Today?

Name: .....

Date: .....

In Ontario our electricity comes from a variety of sources. In this activity you will examine how Ontario's electrical power is being generated *today*.

1. For each source of electricity, complete the chart to show how much electrical power Ontario generated using that source. Your teacher will provide you with this information.

Source of Electricity	Electrical Power Produced (in MW)
Coal	
Gas	
Hydro	
Nuclear	
Wind	
Other	

2. How many megawatts of electrical power are being produced in Ontario by all sources of electricity at the moment this measurement was taken?

.....

.....

3. Which electricity source is Ontario's biggest today? And the smallest? Write Ontario's electricity sources in order from the biggest to the smallest source. Write the megawatts (MW) each is producing next to the appropriate source.

Biggest Source ↓ Smallest Source

Source of Electricity	Megawatts

4. Another way to look at where we get our electricity from is to calculate the percentage. Calculate the percentage of total electrical power supplied by each source, and then complete the chart below.

Source of Electricity	Percentage of Total Electrical Power Supplied
Coal	%
Gas	%
Hydro	%
Nuclear	%
Wind	%
Other	%

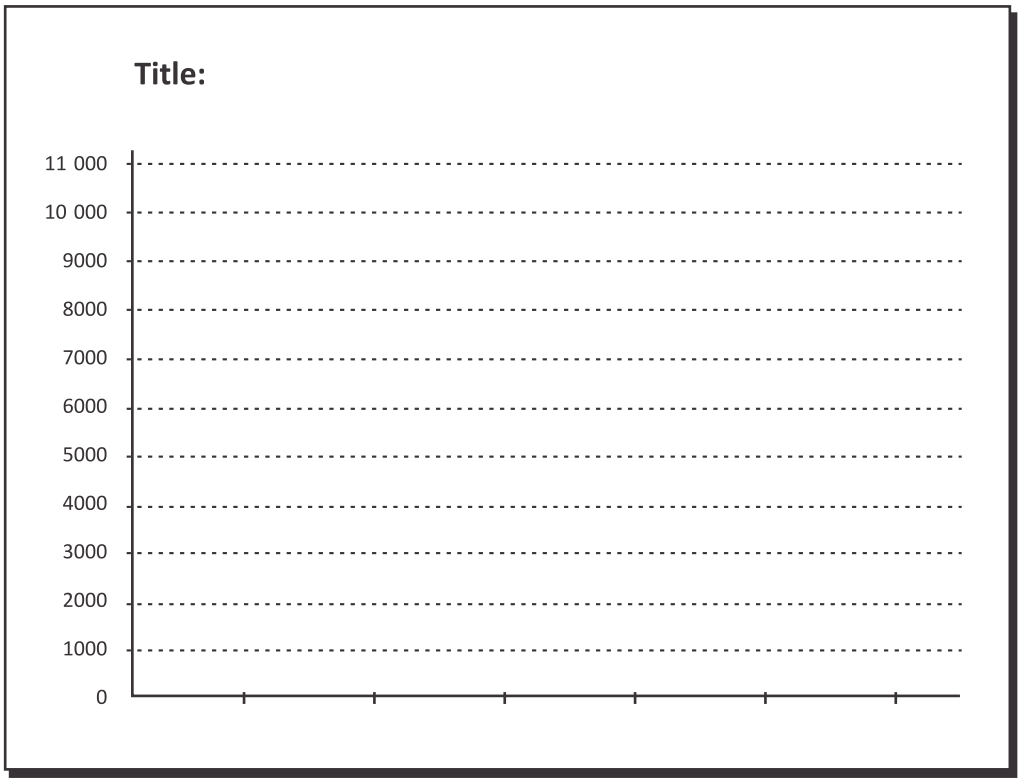
5. Now we're going to convert the data into a bar graph.

a. Create a title for your graph.

b. Create a title for the x-axis.

c. Create a title for the y-axis (include the units!)

d. Plot bars for each electricity generation type on your graph.



6. List the electricity sources that are renewable. How much electrical power are the renewable electricity sources producing (in megawatts)? What percentage of electrical power is from renewable sources in Ontario?

7. List the electricity sources that are non-renewable. How much electrical power are the non-renewable electricity sources producing (in megawatts)? What percentage of electrical power is from non-renewable sources in Ontario?

8. What are some generalizations you can make about Ontario's electricity generation? What types of electricity generation are most important to our electricity supply?

9. Look at the data that you have been working with. What are some of the major environmental impacts of Ontario's electricity generation? We will look at these in more depth later, but what do you already know?

10. Is there anything you would like to see change about the way we generate our electricity?

Training Activity 5

TIME: 1 Hour

Solar Technology

- Overview

In this activity students read a brief article about the various types of solar technology that exist.

- Planning Notes

❏ Make copies of BLM 5a: Solar Technologies: Reflect and Respond and BLM 5b: Solar Technologies (on next pages).

- Teaching/Learning Strategies

1. Explain to students that in this activity they will learn about various solar technologies and how they work.

2. Hand out BLMs 5a and 5b. Review BLM 5a with students. See if students already know the answers to the questions. Then ask students to read BLM 5b and answer the questions on BLM 5a.

3. Lead a class discussion about the article once students have completed their responses. Possible questions are:
   - ❏ What did you learn about solar energy?
   - ❏ Do you think it is a simple or a complicated technology?
   - ❏ How would you personally like to use solar energy? At home? At school?
   - ❏ What do you think are some of the drawbacks about solar?

4. Ensure that students add the following words to their glossary sheets in their folders: *photovoltaic, electron, thermal, semiconductor, turbine*.

Solar Technologies: Reflect and Respond

Name: .....

Date: .....

Reviw the questions below, and then read the article "Solar Technologies"

1. What are the 3 main technology types to harness the sun's energy?

.....

2. Where can you often find solar electric panels (photovoltaic panels)?

.....

3. What are solar cells made of? .....

4. What happens when sunlight strikes a photovoltaic cell?

.....

.....

.....

5. Explain, in your own words, how solar thermal works:

.....

.....

.....

Light Energy  ⇨ ..... ⇨ ..... ⇨ .....

6. If solar panels are so great, why don't you think they are more common?

.....

.....

Solar Technologies

Every hour the sun beams onto Earth more than enough energy to satisfy global energy needs for an entire year. Solar technology is the technology used to capture the sun's energy and make it useable. There are three main ways to harness the sun's energy:

Photovoltaic

You might already know about photovoltaic cells, or solar panels. They are found on things like spacecraft, rooftops, and handheld calculators. There are even a few solar PV power stations. The cells are made of semiconductor materials like those found in computer chips. When sunlight hits the cells, it knocks electrons loose from their atoms. As the electrons flow through the cell, they generate electricity.

Solar Thermal

On a much larger scale, solar thermal power plants use various techniques to concentrate the sun's energy as a heat source. The heat is then used to boil water to drive a steam turbine that generates electricity, supplying electricity for thousands of people. In one technique, long U-shaped mirrors focus sunlight on a pipe of oil that runs through the middle. The hot oil boils water for electricity generation. Another technique uses moveable mirrors to focus the sun's rays on a tower, which uses heat to run a steam turbine.

Passive Solar Heat

Other solar technologies are passive. For example, big windows placed on the sunny side of a building allow sunlight to strike heat-absorbent materials on the floor and walls. These surfaces then release the heat at night to keep the building warm. Similarly, absorbent plates on a roof can heat liquid in tubes that supply a house with hot water. Solar energy is a virtually unlimited fuel source that is pollution free. The technology is also versatile. For example, solar cells generate energy for far-out places like satellites in orbit and cabins deep in the Rocky Mountains. Just as easily, they can power downtown buildings and cars.

Source: adapted from *National Geographic* *http://environment.nationalgeographic.com/environment/global-warming/solar-power-profile/*

TIME: 1 – 1.5 Hours

Training Activity 6

How Do Solar PV Systems Work?

Prior Training Activity Referenced

Training Activity 2: Photovoltaic Circuits (page 66)

• Overview

In this activity students learn how a solar PV system works. They will interpret a diagram to learn about the three ways that solar electricity can be used.

• Planning Notes

❏ Make copies of BLM 6a: The Path of Solar Electricity (next page).

• Teaching/Learning Strategies

1. Remind students of their Photovoltaic Circuits training activity. Ask them what they powered with their solar cells. Explain that solar arrays can be much bigger than the little cells they used, and can power larger things.

2. Explain that in this activity students will look at the components of a large solar array and will discuss the various options for using the electricity it makes.

3. Hand out BLM 6a. Explain to students that they need to interpret the diagram and write a paragraph (using correct spelling and grammar) about the different components of a solar array system and the path that energy takes from the sun to our homes and schools. They should particularly note that there are three ways that we can use the electricity produced.

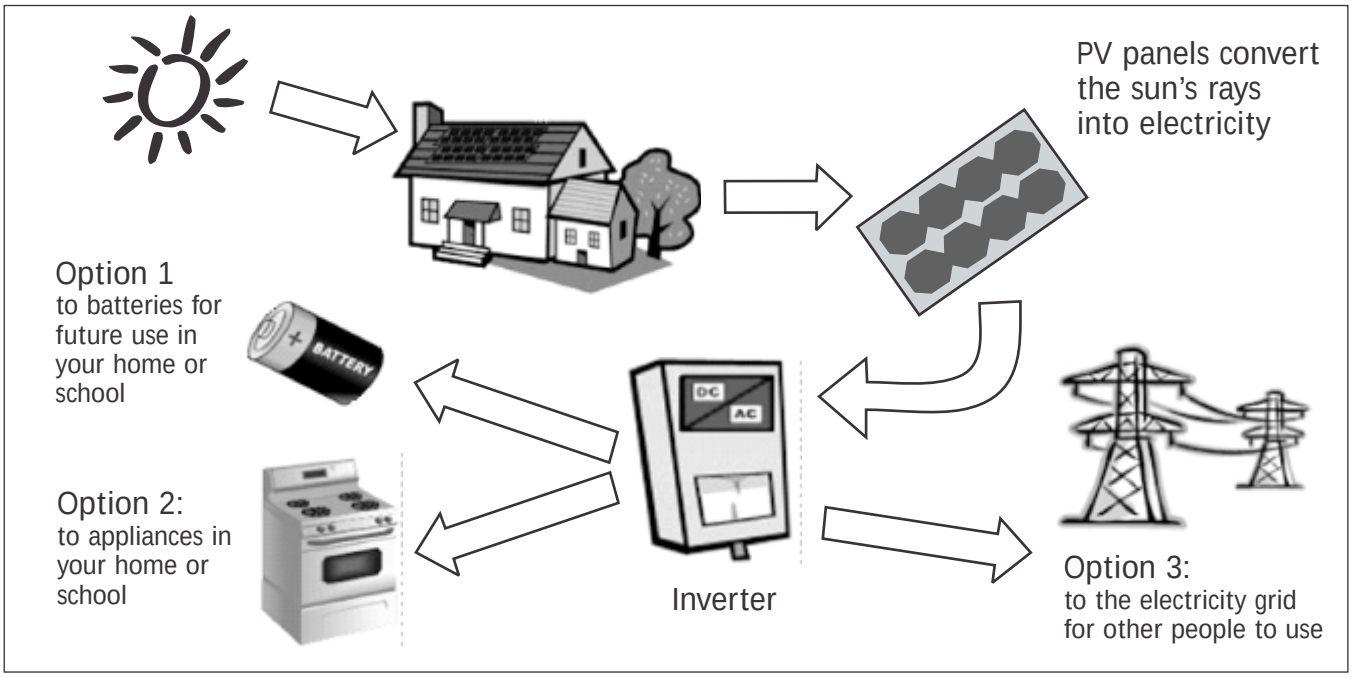
4. When students have finished their paragraphs, lead a discussion about the different options for solar arrays. Suggested questions are:
   - ❏ What are the three options for how we use the electricity produced by solar arrays?
   - ❏ When you made a small circuit, which option was it most like?
   - ❏ Why would we want to use batteries? What does this allow a home to do?
   - ❏ What are the advantages of supplying energy to the whole grid?
   - ❏ Has anyone heard of the Feed In Tariff (FIT) program? (The FIT program means the government will pay for solar electricity supplied to the grid. To find out more see: *http://fit.powerauthority.on.ca/*.)
   - ❏ What do you think of the FIT program? What are its benefits? Are there any disadvantages?

5. Ensure that students fill in the following words on their glossary sheets in their folders: *inverter*, *grid-connected system*, *solar array*.

The Path of Solar Electricity

Name: .....

Date: .....



Look at the diagram above. In paragraph form, describe the path that energy takes from the sun to our homes and schools. Be sure to note that there are three different options for how we use the electricity produced.

.....

.....

.....

.....

.....

.....

.....

Training Activity 7

A Closer Look at Electricity Generation Types

TIME: 1.5 – 2 Hours

Prior Training Activity Referenced

Training Activity 4: Our Electricity Sources (page 73)

• Overview

In this activity students research the advantages and disadvantages of the various electrical generation sources. Each group will research one type and present their findings.

• Planning Notes

❑ Prepare BLM 7a: A Closer Look at Electricity Generation and BLM 7b: Advantages and Disadvantages (next pages).

❑ Book library/computer time for research, or have the research material available.

Toronto District School Board

Science and Technology Loan Centre, TDSB

The Grade 6 Electricity Kit includes a generator. It converts the mechanical energy of rotation to electricity. It can be used to make a light bulb glow or a motor spin.

• Teaching/Learning Strategies

1. Explain to students that they will learn about the advantages and disadvantages of the various electricity generation types in Ontario.
2. Ask the class to recall which electricity generation types are used in Ontario (see BLM 4a: Where Did Our Electricity Come From Today?, page 74).
3. Split the class into six groups and assign each group an electricity source (including solar).
4. Hand out BLM 7a and explain that students will use it to guide their research and record their findings.
5. Discuss the available resources. Some suggested websites are:
   http://www.ecospark.ca/wattwize/students/electricitygeneration
   http://www.centreforenergy.comhttp://environment.nationalgeographic.com
   http://www.pembina.org/re/sources
   http://www.davidsuzuki.org/issues/climate-change/science/energy/
6. Hand out BLM 7b and review it. Each group will make a 3-minute presentation about their research. During the presentations, the class uses BLM 7b to record notes about the disadvantages and advantages the presenters describe.
7. Finally, ensure that students add the following word to their glossary sheets in their folders: *intermittent*.

A Closer Look at Electricity Generation

Name: .....

Date: .....

Electricity generation type:

1. What resource is *directly* being used to produce electricity by this generation type?

.....

2. Is this resource renewable or non-renewable? .....

3. Explain how electricity is created from this energy source. What is the process?

.....

.....

4. Draw an energy-flow diagram showing the energy transformations involved in the process.

5. Is this electricity generation type intermittent? ☐ Yes ☐ No

6. What are the environmental impacts? Are there environmental impacts in building the equipment; obtaining the resources; in the electricity generation process itself; or in disposing of any wastes (including the equipment)?

.....

.....

7. How much does it cost to produce electricity with this resource?

.....

Advantages and Disadvantages

Name: .....

Date: .....

Listen to your classmates' presentations on energy sources.
For each energy source presented, write down two advantages and two disadvantages.

Energy Source	Advantages	Disadvantages

Training Activity 8

Solar Angles

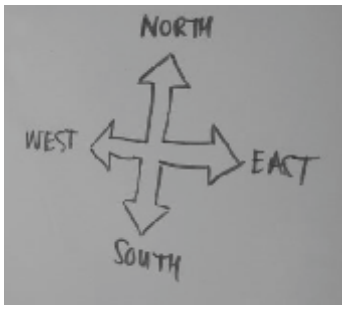
TIME: 1.5 Hours

Overview

In this activity students learn how the sun's rays reach us at different angles depending on the time of day and the season. Students will also learn how this impacts solar PV systems and the angle at which the panels should be installed.

Planning Notes

- ❑ Prepare BLM 8a: The Sun's Angles and Solar PV: Days and BLM 8b: The Sun's Angles and Solar PV: Seasons (next pages).
- ❑ Prepare graph paper, a flashlight, and protractors.



Teaching/Learning Strategies

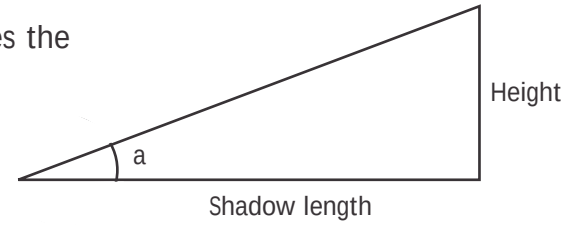
1. Explain that in this activity students will learn about how the sun's angle affects how well solar panels work and how they should be installed.
2. Hand out BLM 8a and review it with students.
3. For Task 1, take students outside and have them complete the task in pairs.
4. For Task 2, conduct a demonstration indoors with a flashlight in a darkened room to illustrate how the intensity of the beam hitting a table (the pretend PV panel) changes with the angle. Students should conclude that the most intense rays are when the light beam is at 90° with the table (PV panel). Students should then fill in the remaining parts of BLM 8a.
5. Have a class discussion based on students' responses to the "applying the lesson" section of BLM 8a. Students should realize that the sun hits PV panels with varying intensity throughout the day because of the changing angles. To ensure that the most electricity is produced, it is ideal to keep the angle between the sun and the PV panel at 90° (illustrate with the flashlight). In order to do this the panel will need to move.
6. You might want to demonstrate a moving solar panel with a video from YouTube: search "solar panel tracker."
7. Hand out BLM 8b. Have students read it and do the measurements to learn about seasonal effects. They will need to research the school's latitude.
8. Finally, ensure that students add the following words to their glossary sheets in their folders: *latitude*, *summer solstice*, *winter solstice*.

The Sun's Angles and Solar PV: Days

Name: .....

Date: .....

The sun moves across the sky during the day. This changes the angle at which the sun's rays will hit PV panels.



- Part 1: Measuring Shadows

1. Stand outside in a sunny area.
2. Your partner will measure your height and the length of your shadow.
3. Using graph paper, draw a triangle representing your height and your shadow's length.
4. Then measure the angle a. This is the angle at which the sun would hit a solar panel.
5. Repeat once in the morning and then again just after lunchtime.

The sun's angle (a) in the morning was: ..... °

The sun's angle (a) at lunchtime was: ..... °

- Part 2: The Flashlight Demonstration

Observe your teacher's demonstration and answer the questions below.

1. At what type of angle are the flashlight's rays the most intense? When does this happen during the day?

.....

2. At what type of angle are the flashlight's rays the least intense? When does this happen during the day?

.....

Applying the Lesson

1. What do your findings above mean for the intensity of the sun's rays hitting PV solar panels throughout the day? Will they always have the same intensity? When are they the most intense?

.....

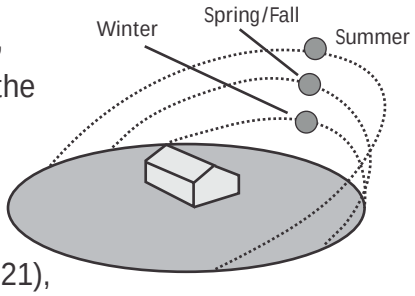
2. What design feature could you include when installing solar panels to ensure the sun's rays hit the PV panels with greatest intensity? At what angle should the rays hit the solar panel?

.....

The Sun's Angles and Solar PV: Seasons

Name: .....

Date: .....



The sun appears to move across the sky from the east in the morning, toward the west in the evening. Throughout the year, the position of the sun relative to the horizon changes, depending on the season. In the summer, the sun is higher in the sky. In the winter it is lower.
On the summer solstice (June 21st), which is the longest day of the year, the sun is at its highest angle. On the winter solstice (December 21), which is our shortest day of the year, the sun is at its lowest angle.

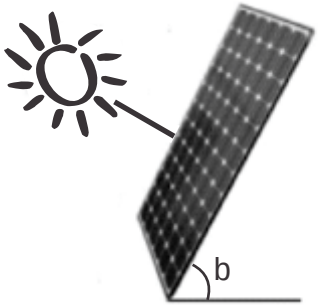
The Problem

This means that the sun's rays hit PV panels at different levels of intensity at different times of the year. So, they produce less electricity in winter.

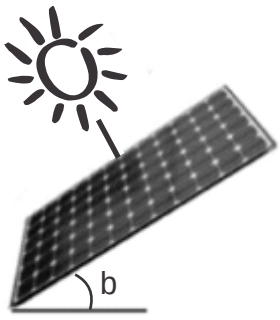
The Solution

To overcome this, we can just change the angle of the panels in different seasons. We can move them! We want the sun's rays to hit the PV panel at 90° (as you concluded on BLM 8a: The Sun's Angles and Solar PV: Days).
Below are three seasonal scenarios. Each panel has been adjusted to intersect with the sun at 90°. Using a protractor, measure the angles at which the panels are mounted (angle b).
Sometimes we cannot adjust the angle of the PV panels since it is expensive to do so. So, we need to choose an angle that produces the best average power throughout the year. A good rule of thumb is to use your latitude as the angle to mount your PV panels.

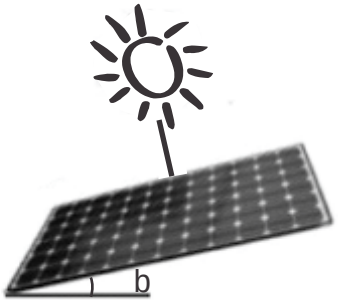
▶ What is the latitude where you are?
This is the angle at which you should mount your panels. My latitude is: ..... °



Winter
b = ... °



Spring/Fall
b = ... °



Summer
b = ... °

Training Activity 9

How Much Electricity Can Solar Produce Anyway?

TIME: 1.5 Hours

Prior Training Activities Referenced

Training Activity 3: How much Electricity Do We Use? (page 69)

Training Activity 5: Solar Technology (page 78)

Training Activity 8: Solar Angles (page 86)

Overview

This exercise will allow students to explore, through graphing and data analysis, how solar cells produce different amounts of electricity at different times. The activity ends with a class discussion on the prospects of solar PV being used to produce our electricity.

Planning Notes

❏ Prepare BLM 9a: How Much Electricity Can Solar Produce Anyway?

Teaching/Learning Strategies

1. Ask students if they have ever heard people say that solar cannot provide all of our electricity. Ask students to think back to the Solar Angles training activity to think about why. The sun's angles are just one reason. Explain that they will look at some other reasons.

2. Hand out BLM 9a. Have students work through the activity. Note: if your school has solar panels and you have access to their generation data, you might want to replace the data on the BLM with it.

3. Afterward, lead a class discussion about question #8. Discuss intermittency as a challenge to solar PV. Ask: *Does this mean we shouldn't use it? Why should we?* Discuss environmentally minded ways to overcome the intermittency issue, such as: conserving electricity, storing solar electricity in batteries (this is difficult), using solar in conjunction with other renewable electricity generation types (see the smart grid in Denmark as an example), using solar PV in the most productive regions, etc.

4. You might want to have a follow-up discussion about using solar PV. Possible questions are:
   - ❏ How could Ontario use this information when deciding where to install solar panels?
   - ❏ At what time of the year do you think we use the most energy? Does this match with when the most solar is being produced?
   - ❏ Look back at BLM 3a: How Much Electricity Do We Use? (page 71). What times of day do we use most of our electricity? Could solar help us supply electricity at peak demand?

How Much Electricity Can Solar Produce Anyway?

Name: .....

Date: .....

1. The amount of electricity that solar panels can produce depends upon many things. What are two or three factors affecting the output of solar panels?

.....

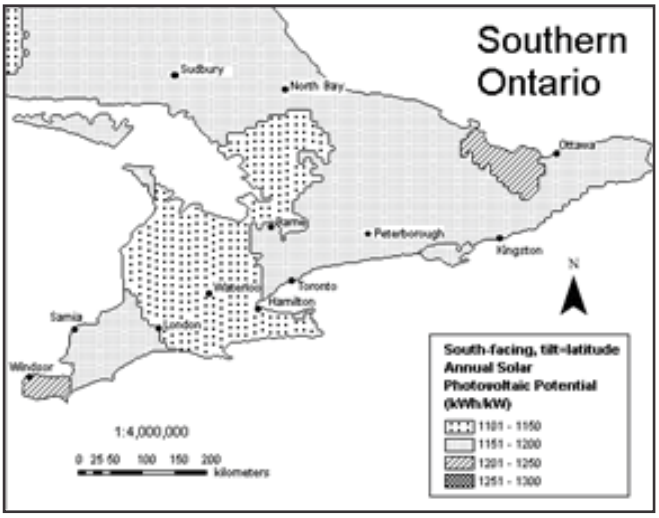
2. The geographic location of solar panels affects the amount of electricity they can produce.
   Examine this map of southern Ontario. Rank these 3 cities in terms of which cities could generate the most solar power:

   Toronto Windsor Waterloo

Most: .....

.....

Least: .....



http://www.omafra.gov.on.ca/english/engineer/facts/sol_elec.htm#f8

3. The amount of sunlight also affects the output of solar panels. Table A (below) shows two different sets of data indicating how many watts are produced at different points in a day by five 200 W panels.

	Watts Produced	
	Monday	Tuesday
12 a.m. – 6 a.m.	0 W	0 W
7 a.m.	0 W	0 W
8 a.m.	233 W	47 W
9 a.m.	444 W	146 W
10 a.m.	649 W	368 W
11 a.m.	534 W	386 W
12 p.m.	755 W	406 W
1 p.m.	276 W	138 W
2 p.m.	147 W	64 W
3 p.m.	98 W	7 W
4 p.m.	0 W	0 W
5 p.m.	0 W	0 W
6 p.m. – 12 a.m.	0 W	0 W

TABLE A

4. Using the data from Table A, create a line graph showing the watts produced related to the time of day. Your graph should have two lines: one for Monday and one for Tuesday.

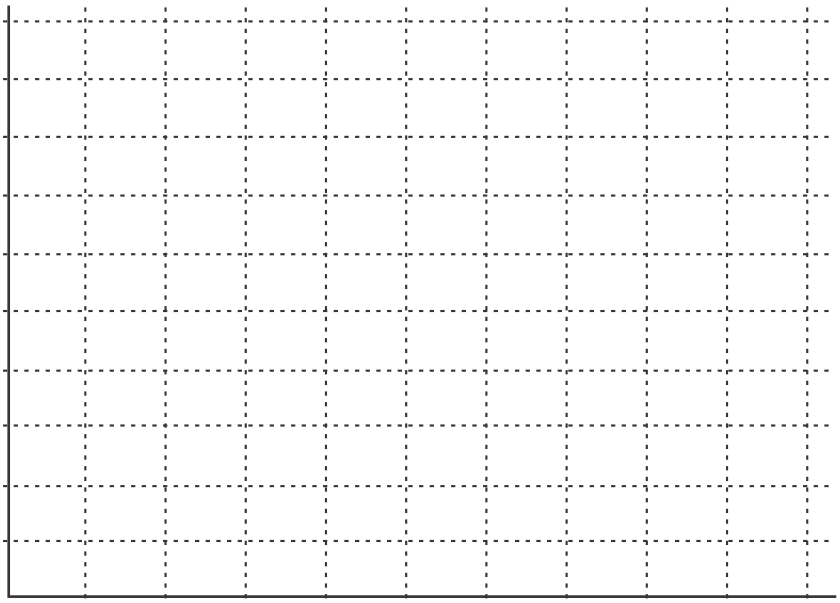
a. Create a title for your graph.

b. Create a title and scale for the x-axis (include the units!)

c. Create a title and scale for the y-axis (include the units!)

d. Plot the data from 7 a.m. to 3 p.m.

Title:



5. What are some reasons that could explain why the amount of watts produced Monday is different than on Tuesday?

6. At what time of day are the most watts produced? Why do you think this is?

7. The amount of sunlight that solar panels receive changes over the course of a year. Table B (below) shows the amount of kilowatt hours that are produced in one year by five 200 W panels.

JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
68 kWh	71 kWh	89 kWh	93 kWh	96 kWh	103 kWh	88 kWh	84 kWh	75 kWh	72 kWh	67 kWh	25 kWh

TABLE B

Using Table B, create a bar graph showing the kilowatt hours produced related to the time of year.

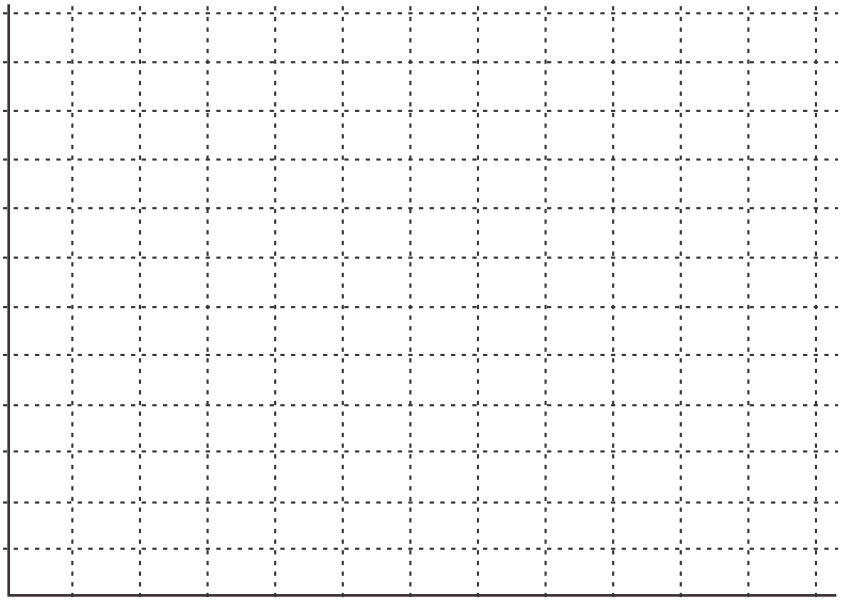
a. Create a title for your graph.

b. Create a title and scale for the x-axis (include the units!)

c. Create a title and scale for the y-axis (include the units!)

d. Plot the data.

Title:



8. What trends do you notice on your bar graph? Think about the season and how sunny it is.

9. Given what you have learned, do you think that solar PV can be relied upon for all of our electricity? Why? Are there any environmentally minded ways to overcome these problems? (You can discuss your ideas as a class.)

Training Activity 10

Electricity Budgeting

TIME: 1.5 Hours

Prior Training Activities Referenced

Training Activity 5: Solar Technology (page 78)

Training Activity 6: How Do Solar PV Systems Work? (page 81)

Training Activity 9: How Much Electricity Can Solar Produce Anyway? (page 89)

Overview

In this activity students will determine how much electricity is used in one day (while doing their utmost to conserve electricity) in a room either at school or at home. Students will then calculate how much of that electricity can be provided by 5 solar panels.

Planning Notes

- ❏ Prepare BLM 10a: Solar Electricity Budget (more than one copy per student might be needed). See next page.
- ❏ Prepare wattmeters or access to EcoSpark's energy users' guide at *www.ecospark.ca/solar*

Teaching/Learning Strategies

1. Explain to students that they will calculate how much electricity a room (or building) will use if they are really vigilant at conserving electricity. They will then find out how much of that electricity can be supplied by a small 5-panel solar array.

2. Hand out BLM 10a and review it with students.

3. Have students choose to measure either a room at home or their classroom (or you can assign this). Ask students: *In your room what are the appliances that you absolutely need?* Remind students that part of the activity is to conserve electricity, so they should think only about the things they need. They can assume that heating is not electric. Ask students to write their appliances in column one of the chart.

4. Remind students of the definition of phantom load and how they should avoid it.

5. If you have access to wattmeters, have the students measure the maximum power draw (W) that their appliances use, as well as the phantom load. If you are not using wattmeters, you can have students consult EcoSpark's Energy User's Guide. Students should fill in column two of the chart.

6. As a class, discuss with students how we can eliminate phantom load.

Training Activity 10

Electricity Budgeting

7. Have students complete the chart by estimating how many hours they use each appliance (in the day and at night). Remind them to think about ways they can conserve electricity. They can then calculate the watt hours used in each period.

8. Explain to students that they are to install a 5-panel solar array to power their room or building. This will be a grid-connected PV system. That means that the electricity produced will go directly to the grid. They can still think of the electricity produced as powering their room (or building). Ask students to fill in the second page of BLM 10a. The purpose is to determine how much of their electricity budget will be powered by solar.

9. Discuss students' findings. In particular, discuss question 5 on the BLM. Students should realize that they can increase the percentage of their electricity provided by solar by increasing the amount of solar produced or by conserving.

10. Ask students to write a paragraph about how they reduced their electricity load through conservation. Have them consider what more they could do.

11. Ensure that students fill in the following phrases on their glossary sheets in their folders: *phantom load*, *grid-connected system*, *solar array*.

Solar Electricity Budget

Name: .....

Date: .....

How much electricity do you need?

1. List any appliances, lights, or anything requiring electricity in your room or building. Then calculate how much electricity you will need to power it. We will later see how much of this can be powered with a small solar array!

Remember: watt hours = power X number of hours

Appliance	Power Draw (in watts)	8 a.m. – 6 p.m.		6 p.m. – 8 a.m.	
		# Hours Used	Watt Hours	# Hours Used	Watt Hours
		Total		Total	

2. How much electricity (in watt hours) will the appliances in your room or building require in one day according to your chart?

3. You are to install five 200W solar PV panels on your roof. The electricity that they produce will feed into the electricity grid. It will be a grid-connected solar PV array. Table A (below) demonstrates a typical day's electricity production.
How much electricity (in watt hours) will be produced in a day?

4. What percentage of your electricity budget will be supplied by your solar PV array?

5. If your solar array supplies less than 100 percent of your electricity budget, from what sources will you obtain the remaining electricity? What are the major sources of electricity on the grid?

	Watts Produced
12 a.m. – 6 a.m.	0 W
7 a.m.	0 W
8 a.m.	233 W
9 a.m.	444 W
10 a.m.	649 W
11 a.m.	534 W
12 p.m.	755 W
1 p.m.	276 W
2 p.m.	147 W
3 p.m.	98 W
4 p.m.	0 W
5 p.m.	0 W
6 p.m. – 12 a.m.	0 W

TABLE A

6. What are two things that you can do to increase the percentage of your electricity budget produced by solar?

Concluding Activity 11

Collecting the Facts on Solar

TIME: 1 – 2 Hours

- Overview

In this activity, students use a KWL chart to identify any outstanding questions they have about solar PV, and then conduct the research or investigations.

- Planning Notes

❑ Prepare BLM 11a: KWL Chart: More about Solar (next page).

❑ Gather resources (see the Suggested Resources section on page 100).

- Teaching/Learning Strategies

1. Explain to students that this is their opportunity to answer any remaining questions they have about solar PV.

2. Hand out BLM 11a and review the purpose of a KWL chart. Have students fill in the first two columns. After they conduct their research, they can fill in the third column.

Here is an example of the KWL chart:

What I KNOW	What I WANT to know	What I LEARNED
• Solar panels make electricity	• How do solar panels work?	• They convert photons into electricity
• Solar energy is renewable	• What does "renewable" mean?	• a source that is based on a cycle of nature and renews itself regularly
• The sun has a lot of energy	• How much energy does the sun produce?	• The sun shines 1000 watts on every square metre

KWL Chart: More about Solar

Name: .....

Date: .....

What I KNOW	What I WANT to know	What I LEARNED

Glossary

battery backup system a solar electric system that stores electrical energy in batteries

closed circuit an electrical circuit with no breaks, allowing the current to flow

electricity grid the network of wires and towers that connects consumers to the sources of electricity

electron a negatively charged particle that is part of every atom

grid-connected system a solar electric system that feeds electricity into the electrical grid

intermittent having to start and stop at irregular intervals (not continuous)

inverter an electronic device that converts direct current (DC) into alternating current (AC)

kilowatt (kW) a measure of power (the rate of electricity use), equal to 1000 watts

kilowatt hour (kWh) a unit of electricity used or produced, equal to 1000 watt hours

latitude the north/south coordinates to measure your position on the Earth measured as the angular distance to the Equator

megawatt (MW) a measure of power (the rate of energy use), equal to 1 million watts

non-renewable resource a type of material that can run out

open circuit an electrical circuit with a break in it, stopping the current from flowing

parallel circuit a closed electrical circuit in which the current divides into two or more branches before rejoining to complete the circuit

phantom load the watts a device uses when it is switched off

photon a light energy particle (coming from the sun)

photovoltaic the effect that turns light energy into electricity (abbreviation: PV)

renewable resource a type of material that is based on a cycle of nature and renews itself regularly

semiconductor a material that only partially conducts electricity

series circuit a closed circuit in which the current passes through all devices in turn

solar array a connected group of photovoltaic (PV) panels that produce power together

solar thermal turning light energy into heat

summer solstice the point when the sun is at its highest angle (the longest day of the year, June 21)

thermal using heat

turbine a rotating device turned by steam or air

watt (W) a measure of power (the rate of electricity use)

watt hour (Wh) a unit of electricity used or produced

winter solstice the point when the sun is at its lowest angle (the shortest day of the year), December 21

Suggested Resources

These resources will help you and your students learn more about solar PV.

Centre for Energy
http://www.centreforenergy.com

David Suzuki Foundation
http://www.davidsuzuki.org/issues/climate-change/science/energy/

EcoSpark
http://www.ecospark.ca/wattwize/students/electricitygeneration

EIA energy Kids
http://www.eia.doe.gov/kids/index.cfm

Energy Quest
http://www.energyquest.ca.gov/story/chapter15.html

National Geographic
http://environment.nationalgeographic.com

Pembina Institute
http://www.pembina.org/re/sources

Pollution Probe
http://www.pollutionprobe.org/

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http://www.worldsolarchallenge.org/home/about

"Canadian Solar PV Market." *CanSIA*. Web. June 2011.
http://www.cansia.ca/market-intelligence/market-research/canadian-solar-pv-market

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Ontario Ministry of Education. *The Ontario Curriculum Grades 1–8, Science and Technology*. Toronto: Queen's Printer for Ontario, 2007.

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http://www.omafra.gov.on.ca/english/engineer/facts/sol_elec.htm#f8.

"Solar Energy." *David Suzuki Foundation*. Web. June 2011.
http://www.davidsuzuki.org/issues/climate-change/science/energy/solar-energy/

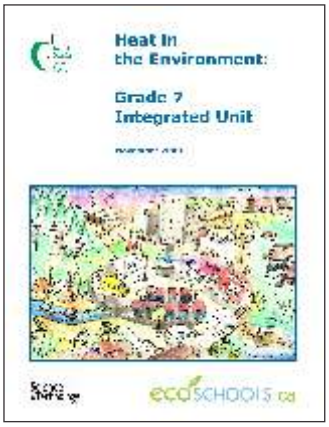
"Solar Energy." *National Geographic.* Web. June 2011.
http://environment.nationalgeographic.com/environment/global-warming/solar-power-profile/

Toronto District School Board. *GRASP: A Tool for Developing Ecological Literacy through Rich Performance Tasks.* Toronto: Toronto District School Board, 2006.

OTHER RESOURCES YOU MIGHT LIKE TO LOOK INTO

Changing Currents

This program will provide your students with the opportunity to (re)discover their local stream. Through in-field workshops students will evaluate the river's health and learn of its importance to them and the local ecosystem.
http://www.ecospark.ca/changingcurrents

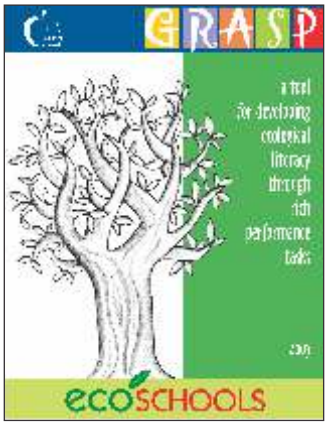


Heat in the Environment

Measure the temperature of your ceiling with a click. Prove that e-coatings on glass reflect heat. If you want to use cutting edge scientific tools to sharpen your students minds, thumb through this guide.

Wattwize

This program will allow your students to take the lead in reducing electricity consumption in their school. EcoSpark staff will coach students in running an electricity audit as well as designing and implementing an electricity conservation plan.
http://www.ecospark.ca/wattwize



GRASP

Help students grasp environmental issues deeply! Brainstorm new approaches and enhance your environmental questions by dipping into this EcoSchool's favourite.

Funding for this resource provided by:

Toronto District School Board

Community Environment Fund

Sobeys Inc.

Earth Day Canada