Brightwater Site

Solar Studies Activity Cards

There are six easy activities you can do right at the site with very little preparation because the infrastructure already exists at the site. For preparation and post-visit guidance, consult the Guide to Solar Activities available from the Brightwater Project Leader. Also, check out the Cooking with Solar Power booklet created in solar oven test 'kitchens'.

Pick from the following activities:

1) **Cooking with the sun**….Experience solar cooking first hand!

2) **Solar car kits**……Build solar cars from a kit with students!

3) **Tour a Solar Toilet** - Learn about the spirit of water and sun!

4) **Solar ice melting**….design and build a solar ice melter!

5) **Take a solar tour**….Tour a solar light system and solar hot water system as well as a solar powered weather station a solar incinerating toilet and a model of a straw bale house.

6) **Tour the Loo with View**… Learn about alternative building and ways to use less resources – water, building resources, energy, space for sewage lagoons, landfills.

Each activity card will outline the important aspects of the exercise and guide you and your students through the process. It will provide practical guidance and offer some questions to pose to the students.

Card One…….Solar Oven

You will need: The solar oven, some cookie dough, a baking pan, and some sunshine! (Don't forget oven mitts!) Pans and oven mitts are available at Brightwater.

You will find a few solar ovens at the site in Brightwater storage. Each model is an evolution in the inventor's thoughts and design plans. Choose one for your demonstration.

Set the oven up with the students. If the solar oven is not set up, consult the project leader to ensure the metal pieces do not get damaged. As well, orienting the oven to receive maximum heat is necessary. A marker hole in the top collecting panel will focus light on the screw on the oven box if aligned correctly.

Solar ovens are essentially a heat trap and demonstrate the extreme of greenhouse warming. They are simple and effective devises for changing the light energy from the sun to heat energy for cooking!

Key words…..Reflection…Absorption…..Insulation

Notes created by Craig Shearer. As you talk tell the students that if you are to build a solar oven you have to know some simple math and know how it applies.

The formula for designing any solar oven is T = HG - HL

T= Temperature inside the Solar Oven.

HG= The amount of heat gained by design.

HL= The amount of heat lost by design. Ask the students about each part on the solar oven, what it is for, adding heat gain or stopping heat loss?

Reflectors? (for HG)

Glass door? (for HG and HL)

Black bake chamber? (for HG)

Outside shell? (to stop HL)

The seal on the door? (to stop HL)

Insulation? (to stop HL)

For each item ask HOW does it do its job?

What happens to the temperature in the oven if? :

The reflectors are dirty? (decreases due to less HG)

The glass is dirty? (decreases due to less HG)

If the bake chamber was white? (decreases due to reflection less HG)

If there is pollution in the atmosphere? (decreases Less HG)

If it's intermittently cloudy? (fluctuates due to clouds)

If it is totally overcast? (no HG no temp)

Can it cook at night? (no)

If it is early in the morning or late in the day? (low temps less HG)

If it is winter? (lower due to higher HL)

If you put lots of heavy food in to cook? (lower due to mass)

If it is a very humid day? (lower due to less HG)

If you leave the door open a crack? (lower due to HL)

If its not aimed directly at the sun? (lower due to less HG)

If the glass door were larger but volume stays same(higher more HG)

If you open and close the door lots? (lower due to HL)

For each of the above questions ask WHY? And relate back to our equation.

Of course you will be encouraged to bake the cookies as this is going on and everyone will look forward to a taste of one so make sure you have enough for all.

ANSWER THESE QUESTIONS:

How hot did your oven get today?

What environmental factors contributed to your experience?

What was their effect on the temperature?

How long did it take to bake your cookies?

Looking at the oven itself is there anything you could do to improve its performance?

How the oven was made:

Students built the solar oven you are using. The plastic form was created out of recycled plastic and molded to create the baking chamber. The chamber was insulated with pink insulation and then covered with metal. After that the chamber was painted black (because black absorbs more heat). Then the unit was caulked to create a seal. To catch the rays of the sun, sheet metal was cut to create large solar reflectors. The reflectors focus the heat of the sun on the baking chamber. While the glass door is fragile, the clear glass is necessary to allow heat to enter the chamber. The oven can reach 400F on a clear spring day! Notice the small hole in the top reflector. It helps the user to align the oven with the direct sunlight. The wood stand helps to keep the right angle of the oven as well as to provide balance so the baking does not spill into the bake chamber.

You could also compare the prototypes of the solar ovens created by Solar Freedom International to see evolutions in the inventive process. Which cooks the best brownies? The ovens are in storage at Brightwater.

Jenna Ostrander shows off her baking skills

Card Two…….Solar Car Kits

You will need: the box of solar car kits from the storage shed at Brightwater.

Introduce the topic by asking: Have any of you ever used a solar powered device before? Most have used a calculator run on solar.

Let them tell of their experiences for a while.

Next ask: What kinds of energy comes from the sun? You will hear: solar energy, sun energy, heat energy, light energy etc.

Key in on light energy and ask: How does light energy travel?…… What happens when an object gets in the way of light energy? Let them talk about this for a bit.

Then ask: Can we change light energy into heat energy?….. Can we change light energy to electrical energy? Again let them talk out loud about this for a bit.

NOW you have introduced the idea of light as energy. Daylight is light energy that does not change form unless it strikes an object. When light hits an object it changes to heat energy. When it strikes the surface of a solar panel it changes to a small amount of heat energy and electrical energy because of the panels' special design. When light hit's a white or shinny object it changes direction. It reflects. Key words……Light energy…Heat energy….electrical energy….Reflection…..

Explain how, in general, solar energy is not best suited for an application such as transportation and the car kits they are about to build are designed to demonstrate the concept of "Photovoltaic "(the process of changing light energy to electrical energy) only. But maybe someday this technology will be applied in our everyday transportation. [Perhaps find some articles or websites about this topic].

Solar PV panels "photovoltaic panels" are best suited to applications that do not require the electricity that is produced for heat. If you require heat it is best done with a solar THERMAL panel. (A panel that changes light energy to heat energy directly)

So PV panels are best used for lighting, stereos, TV, computers, small motors and pumps, small household appliances etc.

In the car kit the small PV panels are going to drive a small electric motor to drive the wheels of the car.

Have the students work in pairs or threes….remind them that lots of other students will be using the car kits in the future and ask them to be mindful of ALL the small parts that must return to the kit when they are finished.

Have them follow the instructions included in the kit to build their car.

When they are finished have a little solar car race!

You will need a smooth, level, friction free, sunny surface to run the race!

When finished check that all parts get back into each kit and that they have been taken apart before being put away.

ANSWER THESE QUESTIONS:

Did friction have a part to play in this exercise?

How would a bigger heavier solar panel affect the performance?

Would the time of day or season affect performance? How and why?

Would atmospheric humidity or air pollution affect performance? How and why?

How does the angle of the solar panel in relation to the sun affect performance?

Card Three……Tour the Solar Incinerating Toilet

Please note – this activity will need to be modified because the Solar Toilet is in the Loo. Please check with the Project Leader to confirm the supplies necessary for this activity

Take the students on a short walk to the 'schoolhouse' located on the Saskatoon Public School land adjacent to the Salvation Army land. Behind the hall, you will find a weather station and the solar toilet.

Solar Incinerating Toilet located on the SPS property by the 'schoolhouse'. This toilet had been dismantled by the stand still exists.

Introduce the Solar incinerating toilet by asking: **How do you use water in your daily lives?**

Then ask: **Where the water comes from that they use?**

Then ask: **Where does it go when they are finished with it?**

Ask: **If you had to walk to the river to get your water each day in a bucket would you use more water or less water for your bath, shower toilet etc.?**

Talk about ways to reduce the amount of water we use each day. Things like turning off the tap as you brush teeth, having shorter showers and smaller baths, not hosing down your driveway with water but using a broom etc.

Then ask: **Would any of you think of pooping in the bathtub?** You will get a BIG reaction! Then point out that is exactly what we do when we dump raw sewage into our water ways!

You may want to point out how precious water is and that it is a finite resource that is continually being recycled. Mention that some of the water molecules they drank today were probably in dinosaur pee at one time. Again you will get a BIG reaction.

Now ask: **Why do you think we need a solar toilet anyway?** You will get all kinds of answers….what you are looking for is to reduce the amount of water that requires cleaning by sewage treatment plants.

Point out that all the water we send to the treatment plant is not all that contaminated. It is only when we flush a toilet and add a relatively small amount of human waste to this larger volume of water that we have a serious problem. Not to mention the amount of water we use in the flushing process!

Ask them: **Can you think of a way to improve on the current situation?**

Someone will point out that "if it is yellow let it mellow and if it is brown flush it down" That is a good first step you can point out.

You will often have someone come up with the idea to separate the "gray water" from the "black water". That also is a good second step.

Someone will say we could use a solar toilet!

Ultimately this is a real great solution because it means we can reuse our gray water for greening up the neighborhood and enrich our gardens with friendly compost from the solar toilet!

NOTE: This toilet is different than a composting toilet because the temperatures will be high enough to kill all harmful bacteria in the waste before it is composted this means we can process the waste much more quickly and handle a larger volume.

That is your clue to explain how the toilet works…The light energy from the sun heats the waste to such a high temperature to kill all the bad stuff in it so that it is no longer harmful to humans or the environment.

There are signs up in the toilet to explain it and all you have to do is go over that information with the students……

ANSWER THESE QUESTIONS:

What are some ways to save water that you can do today?

How precious is water in your life?

Would it be more precious if clean water were hard to find?

Would it be more precious if you had to haul it by hand?

What are some things we can use our waste water for around our house and yard?

What are some things we can use the byproducts of human waste for once they have been cleaned by the sun?

Card Four……Solar Ice melting Project

The Idea of this session is to have the students design and build a solar ice melting unit.

You will require the following: The box at Brightwater in the storage shed marked **Solar Ice Melting kit.**

This is a good exercise to do if the weather is not suited to outdoor solar activities. The main idea is that the students will construct some kind of devise from the material available in the kit to melt a predetermined amount of ice or snow in the shortest time possible time. In this project we will use a heat lamp instead of the sun so that we can set the distance and intensity of the heat source so that if you have more than one team the parameters are the same for all teams. (1/4 cup of ice or snow recommended.)

Here you will want to stress to the students that this is not a competition between teams or individuals but rather a challenge to design the best solar ice maker possible. This will take collaboration and sharing to meet this goal. **Encourage talk and communication amongst teams and individuals.**

The formula for designing any solar device that changes light energy to heat energy is: T = HG - HL

T= Temperature inside the device.

HG= the amount of heat gained by design.

HL= the amount of heat lost by design.

The devise they are going to design and build uses light energy to produce heat energy and therefore melt the ice or snow.

Key words…..Reflection…Absorption…..Insulation…Heat Gain…Heat Loss….

Introduce the topic by asking the following questions:

Ask the students about each part in the solar ice melting kit, what it might be used for. Will it help increase the heat gain or stop heat loss in their design? (Watch out for a few tricky materials in the kit!)

Reflective materials (for HG)

Glass or clear plastic materials (for HG and HL)

Black metals or containers (for HG)

Shell materials or insulation (to stop HL)

What about sealing units' verses open units? (To stop HL)

What about the volume of air in the unit? (Less air Higher HG)

Insulation? (To stop HL)

For each item ask HOW does it do its job?

What happens to the temperature in the design if? :

(some of these refer to real outdoor situations)

The reflective material is dirty? (Decreases due to less HG)

The glass is dirty? (Decreases due to less HG)

If the melting chamber was white? (Decreases due to reflection less HG)

If there is pollution in the atmosphere? (Decreases Less HG)

If its intermittently cloudy? (Fluctuates due to clouds)

If it is totally overcast? (No HG no temp)

Can it melt ice at night? (No)

If it is early in the morning or late in the day? (Low temps less HG)

If it is winter? (Lower due to higher HL)

If you put lots of ice or snow in it to melt? (Lower due to mass)

If it is a very humid day? (Lower due to less HG)

If you leave the door open a crack? (Lower due to HL)

If it's not aimed directly at the sun? (Lower due to less HG)

If you open and close the unit lots? (Lower due to HL)

For each of the above questions ask WHY? And relate back to our equation.

Now let them build with not too much input from you so they can talk and think and work on the problem. It helps to give them a time line …say 20 minutes. When the

units are finished it is time to test them by time. Turn the lamp on and start the timer. This is the time to discuss what they see and talk about what they would do differently if they could. Record the time.

ANSWER THESE QUESTIONS:

How long did it take to melt the ice?

What could you change about your design to improve on this time and why?

What was the best idea you had and why?

Card Five…….Alternative energy tour

Take the students on a tour of the Brightwater project to see alternative energy in action! We have a number of demonstrations in the area that help to see alternative in actual use. This tour is intended to be an overview and not an in depth study.

This is largely an outdoor activity and some set up and walking is required.

SITE LOCATIONS AND DEMONSTRATIONS AVAILABLE

You can visit any or all of these sites.

1) Solar oven (stored in shed requires some set up)

2) Straw Bale house model (stored in shed)

3) Solar PV (photovoltaic) for path lighting (in front of Moose Jaw Hall)

4) Solar PV for weather station operation (behind Somers hall)

5) Solar PV for pumping water (on Loo with a View building)

6) Solar Thermal panels for heating hot water (in front of Loo with a View)

7) Solar incinerating toilet (prototype) (behind 'schoolhouse')

KEY WORDS: Absorption , Reflection , Heat loss , Heat gain , Light energy , Heat energy , Photovoltaic (PV Panel) , Electrical energy , Insulation , Indigenous building material , Thermal panel , Embodied energy , Life Cycle cost , Conservation.

Following are a few key points for each demonstration:

1) **Solar oven**…..light energy from the sun is changed to heat energy in the oven for cooking food. Average temperature on a clear day is 375 F or 190 C……Works in the winter ….requires that you can see your shadow to work….will cook almost anything a regular oven will cook….You adjust the temperature by aiming it in or out of the sun.

2) **Straw Bale House Model** …This model of a straw bale building was built by grade 7 students here at Brightwater. It is stored in the 'Schoolhouse' on the SPS land. The idea was to demonstrate how we could use indigenous materials to build a building that cost less, was easier to heat and keep warm, that had low annual maintenance costs, that would last a long time, and where the embodied energy was low … (That means that we didn't bring cedar trees all the way from B.C to use as siding which uses a lot of energy in transporting long distances.) The idea is to build

with material we can find right here on the prairie. You will notice we even experimented with mud plasters as a possibility for covering the bales to make them weather and fire proof and to keep the insects and mice out .Normally we use a cement plaster just like stucco but that has a very high embodied energy…Someday maybe we will have to make houses out of straw because it will be hard to get good trees for building. This kind of building is much closer to being sustainable for many generations to come!

3) **Solar powered path lights** PV or photo voltaic means changing light energy into electrical energy…These Solar Panels do just that!. Wire connects the solar panels to a battery so that stored energy can be used later when the sun is not shining. In this application solar energy is used to light up the path in front of the cabins here at Brightwater! Solar energy is clean, quiet, reliable, environmentally sound and inexpensive in the long haul…Panels will last a very long time with very little maintenance.

4) **Solar powered weather station**…. Solar panels are very well suited to this type of application because it is reliable…low cost and low maintenance. In this case we had to replace 3 "D" size batteries approximately 4 times per year (not much fun if it was 40 below zero) so that was 9 batteries per year at a cost of about 20.00 .Since this station has been running on solar power we have saved about 45 batteries from cluttering the planet and about $100.00 ….This system has pretty much paid for itself! (It has saved some freezing fingers too!)

5) **Solar powered water pump**…..If you look up on top of the BIG solar thermal panels you will see a PV panel that provides the electricity for a pump that circulates water and glycol through the solar thermal panels. This is a great way to make sure the pump does not work when the sun is not out. No other switching is required. {Note this pump is not in use at this point as panels are moved to Loo]

6) **Solar Thermal panels** ……These big panels are for gathering heat as the name indicates. They change the light energy from the sun into heat energy for heating domestic hot water…..This kind and size of system can provide up to 65% of the domestic hot water to a family of 4 to 5 people over the year. This will reduce the heating costs by other methods and in doing so will save you money and reduce the greenhouse gas emissions to the environment. The water simply starts to circulate through the panels when the sun shines and picks up the heat as it goes. The heat is then transferred to your hot water tank in your house Walla! Hot water! These systems work well all year round and will often pay for themselves through energy savings in about 6 to 10 years.

The system requires some electrical energy to operate a pump so the smaller panel on top of the solar thermal panels is a Photovoltaic panel that changes the light energy from the sun into electrical energy to run the pump.

7) **Solar incinerating toilet** ….This toilet uses the energy from the sun to clean human waste….It is the first and only solar incinerating toilet to be built and tested anywhere in the world that we know of…Because it is a prototype it is being used to gather information…So far the tests look promising….This application of solar energy is twofold it has to do with saving water and reducing the load on our rivers lakes and oceans as well as using the suns energy to do the cleaning instead of using chemical treatment of the waste…Please have a look at the descriptions inside the toilet to find out more!

We hope you enjoyed your tour. You will likely have thought of many questions to ask of you students. Feel free to test their listening skills by asking some questions.

How much electricity do you use? Where does it come from? How much water do you use? Where does it come from? Can you think of ways to save both water and electricity?

Card Six… Loo with a View

Brightwater Science and Environment Centre

The straw bale compost toilet building is located on Saskatoon Public Schools land 30 metres from the 'schoolhouse' (because it has the well that serves the tenant's house in the basement of the building). The loo will would the chemical toilets currently rented as porto-potties for the high school and elementary students in the fall and spring.

The building is around 8x13 with three stalls: One Sunmar composting toilet, one solar incinerating toilet and one liquid (pee) toilet. There is also a sink area for washing. The building makes use of the existing solar panels to have radiant floor heating, (cozy and also keeps the composting going longer), the photo-voltaic cell will run the pump for the floor and evening lighting and there are four discreet windows for light.

The design is by Craig Shearer of Solar Freedom International, Marcia Klein Brightwater Project Leader and Building Skills, Building Homes initiative through Youth Services Canada.

The building is more than 30 meters from Brightwater Creek and 30 meters from the well that services the tenant house.