Smarter Science Better Buildings
Western Development Museum - Saskatoon

Workstation Guiding Questions Answer Key – Pages 1 - 6

Heating and Cooling

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. What factors make ***cellulose insulation*** an environmentally beneficial insulation choice? **(Student choice, options below)**

   The following factors make cellulose insulation an environmentally beneficial choice:

   - It's made of recycled materials, typically recycled newspaper.
   - Reduced transportation kilometres. This insulation is manufactured in Canada, specifically Manitoba and Alberta, and is trucked up to 800km rather than other insulation that may be shipped from across the globe.
   - Long lasting, it lasts for the life of the house (20/30 years).
   - It's reusable, biodegradable, and can be recycled after use as insulation in homes.
   - R-value is 3.70/inch, making it more efficient as an insulating material when compared to fiberglass batts or some of the other insulation choices.
   - Uses fewer chemicals in its production process than other types of insulation material.

2. ***Heat Pumps*** use electrical energy to move heat energy from one location to another. Compare the size of the blue "electrical energy coming in" arrow, to the size of the red "heat energy coming out" arrow. What does that tell you about the efficiency of the heating system?

   The blue arrow for the "electrical energy coming in" is much smaller than the red arrow for the "heat energy coming in". From this, diagram, we can see that heat pumps systems can heat or cool a home by using a relatively low amount of electrical energy as input.

   Heat pumps can move much more energy (in the form of heat) than it consumes. In this case, heat pumps move two times as much energy as it consumes. Making it one of the most highly efficient choices for heating and cooling homes (above -20 ºC).

3. Name three things ***Beardy's and Okemasis' Cree Nation*** wanted to accomplish with their new homes**. (Student choice, options below)**

- Create healthy, comfortable, and accessible homes.
- Make homes energy efficient with lots of insulation in walls, roof, and flooring.
- Reduce energy costs by 35%.
- Have homes be ready to be retrofitted with solar panels if the owner chooses.
- Create small, compact homes that are designed well.

4. In ***How Heat Moves***, which home would be warmer and less drafty in winter? Which home uses the least amount of energy?

The Radiance Cohousing (Passive House) would be warmer and less drafty in the winter. This home uses the least amount of energy at only **53 GJ/year!**

It is much more efficient than the Eaton's home which uses **759 GJ/year.**

The diagram in the display shows that the heat loss arrows are MUCH larger in the cross-section of the Eaton's house wall than in the cross-section of the Radiance Cohousing wall. This shows how efficient the design and the amount of insulation is in the Passive House.

5. Set the ***thermostats*** in the display to 15ºC. If you set the thermostat in your home back to 15ºC at night, how would it help you to save energy?

Setting a lower temperature on the thermostat either manually or by programming it helps you save energy by reducing heating at night in the home or during the day when no one is home. This reduces energy consumption (gas or electricity), lowers heating costs, and reduces greenhouse gas emissions.

If you have a programmable thermostat, you can program and set an automatic schedule for when your home heating should increase or decrease. Programmable thermostats make it easier to put this type of sustainable behaviour in action in your home - so you don't forget!

Setting the thermostat back by 2ºC can save up to 5% on your heating bill!

Net Zero Home

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. List the things that make up the ***building envelope***. Why is it important for the envelope to be airtight and have good insulation?

The building envelope includes the wall, roof, windows, and doors. It separates the inside environment from the outside environment. An airtight home doesn't let air leak in and out, wasting energy. Good insulation reduces heat loss through walls, roof, and the foundation.

2. ***Canada's National Energy Code:*** How much more energy efficient is a tier 4 than the current SK code? List three actions that would increase a home's energy efficiency.

Tier 4 is 60% more energy efficient than the current SK code (tier 1).

(Student choice, options below)

- LED Lighting
- Add LOTS of insulation (ie., in the walls, foundation, and attic)
- Choose Energy Star appliances and lighting.
- Install energy-efficient windows and doors.
- Install heat pumps or a high-efficiency furnace.
- Install solar panels.
- Efficient water systems (tankless water heater, drain water heat recovery).
- Include efficient ventilating and air conditioning systems.

3. What is **thermal bridging** and how does the double wall construction reduce it?
Thermal bridging is when heat is lost by **conduction** through wood or joins in construction. Double wall construction surrounds wood studs, and joins with uninterrupted insulation, reducing heat loss.

4.

$Q = \frac{A \times DT}{R}$	When you "turned down" the thermostat (DT), what happened to the power (Q), consumption of the house? Why?

Power consumption went down. When the thermostat is lower, less energy is needed to keep the house at that temperature.

The mathematical answer is: if you reduce the value of the numerator of the right side of an equation, it will reduce the value of the left side of the equation.

5. What is the connection between the energy our home uses and ***climate change?***

The gas, electricity, and water we use daily in our homes create greenhouse gas emissions like carbon dioxide. Greenhouse gases cause climate change. We have the knowledge and tools to take action on climate change now.

Good insulation, energy-efficient technology and behaviour, and using renewable power sources in our homes all reduce greenhouse gas emissions.

There are things you can do to act on climate change in your home:

- Adding insulation to the attic.
- Turning down the thermostat at night.
- Close the blinds at night.
- Seal drafts around windows and doors.
- Fix leaking toilets.
- And many others students may name

Lighting and Appliances

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. ***Innovative Design:*** How does the reflective material bring natural light into the interior of the buildings?

Daylighting is when natural light is brought deep into the building using reflective surfaces. These reflective surfaces can be mirror ducts, light shelves, or light pipes. These reflective surfaces bounce, reflect, and direct natural light into the rooms and interior of the building.

Daylighting reduces energy use by increasing available natural light and reducing the need for electrical lighting within the building or home.

2. The ***average Saskatchewan home*** uses a lot more electricity than the Vereco NET ZERO home. Name three ways the NET ZERO home uses less. **(Student choice, options below)**

Electricity is reduced in the NET ZERO home through:

- LED lighting; ENERGY STAR appliances; occupancy sensors; solar panels; designing a smaller-sized home and efficiently using space.

3. Look at the circle graph of household electricity use. Check (✓) ways you think you and your family could make changes to save electricity. (**Student choice)**

Use LED lights	Turn out lights that aren't needed	Dry clothes on a clothesline
Use timers for lights and vehicle block heaters	Use a power bar to turn off phantom load	Unplug electronics not in use
Buy ENERGY STAR® appliances	Reduce Air Conditioner use by setting the thermostat to 24ºC or higher	Other:

4. Look at the ***light display***. Excluding the exit lamp, which light uses the least amount of power?

The Bright LED uses 9W. The soft LED uses 9.5W.

5. ***Energy = Power x Time.*** If your lamp has two, 15watt bulbs, and you have them on for five hours, how much energy do they use?

Energy (watt hours) 150 kWh = 2(15w) x 5hrs

Explain how reducing power (W) and time (hrs) can reduce overall energy use?

Power is the number of watts a lightbulb uses. A good technology change is reducing the overall energy use in a home by replacing less efficient lightbulbs that use more watts, like fluorescent and compact fluorescent with more efficient lightbulbs like LEDs.

Time is the number of hours that a lightbulb is on. A good behaviour change is turning off lights when they are not needed. This habit reduces overall energy use by reducing the number of hours lights are on in your home.

The mathematical answer: Reducing the value of the numbers on the right side of the equation reduces the value of the left side of the equation.

Water

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. How does the **drain water heat recovery Powerpipe** use **conduction** to save energy? Look at the large copper pipe on the left side of the display.

   Warm wastewater from the shower flows down the drain inside the copper pipe, cool fresh water is pumped up and passes the warm wastewater. Warmth is transferred to the cool water by conduction through the copper pipes on its way to the shower.

   Drain Water Heat Recovery (DWHR) can capture 40-75% of drain water heat.

2. Explain how the ***rain water system*** described here works to make use of rainwater.

   Rainwater is captured in a tank (or cistern), filtered, chlorinated, and pressurized for use in toilets or for watering outside (irrigation) instead of fresh treated water being used for those purposes.

3. What role do wetlands play in the ***Logan Green Water Management System?***

   The City of Yorkton filters its drinking water to remove iron and manganese. Previously, when filters were cleaned, a lot of “backwash” water was created that needed to be treated in their sewage treatment system.

   The Logan Green Water Management system now uses constructed and natural wetlands to treat this “backwash” water naturally. Water from the sedimentation ponds is filtered as it moves through constructed wetlands. Then, it continues to flow into the existing natural wetlands to be further filtered before it soaks back into the ground re-filling the aquifer and the greater watershed.

4. Check (✓) ways you could save water in your home and at school. **(Student Choice)**

Turn off the tap while brushing your teeth	Replace your old dishwasher with an ENERGY STAR® dishwasher	Take a shorter shower
Fix a leaking toilet	Turn off the tap after washing your hands	Install a low-flow showerhead
Collect rainwater to water your lawn/garden	Grow drought tolerant plants	Other:

5. ***Shorter Showers:*** if a showerhead has flow of 6 litres/minute, calculate the amount of water used for a five-minute shower, compared to a 20 minute shower.

6 litres/minute x 5 minutes = **30 litres**
6 litres/minute x 20 minutes = **120 litres**

How much water do you save by taking the shorter shower?

90 litres of water are saved with a shorter shower.

Solar

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. What parts of Canada have the highest ***annual photovoltaic potential***? What part of Saskatchewan has the highest potential?

The parts of Canada with the highest annual photovoltaic potential are the southern parts of the prairie provinces, Alberta, Saskatchewan, and Manitoba.

The southern region of Saskatchewan, south of Prince Albert, has the highest potential overall for photovoltaic potential.

2. Try the ***solar panel*** display. What difference do the clouds make to how much the meter moves? Why?

The clouds block sunlight and reduce the amount of power that the solar panels can produce.

3. ***Innovative designs:***

a. LightLeaf panels – where would you use these panels?

These panels are flexible and lightweight. They are best used for things that move. These panels are molded to fit the surfaces of boats, campers, and other vehicles.

b. Mitrex building integrated panels – what makes these solar panels innovative?

The solar cells are like the filling in a sandwich with a structure of lightweight honeycomb backing on one side and protective tempered glass on the other. The honeycomb backing provides structure and a cooling effect that helps to increase the solar panel efficiency.

These solar panels can become siding material – which allows buildings to be converted into solar power plants!

4. The ***Pesâkâstêw Solar Project*** powers 2,500 homes and eliminates more and 15,000tC02e/year. List the benefits of this project for the two First Nations involved. **(Student Choice)**

The benefits of this project for the two First Nations Involved:

- Reduce the energy costs in the communities by powering homes with renewable energy.
- Provide jobs and technical training in each community.
- Creates a revenue (money) source for the two First Nations communities.
- Offers the potential for expanding solar energy production and future opportunities for constructing more facilities like this.

5. If your home uses 7500 kWh/yr and the average panel produces 400 kWh/yr, how many panels will you need to produce enough electricity for your home? If you live in Saskatoon, check MyHEAT Solar to see the solar potential of your address.

$\frac{7500}{400}$ = 19 panels (18.75, rounded up)

Retrofits

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. Compare the ***EnerGuide® ratings*** of the historical and modern houses. What factors helped the older homes use less energy? What factors help the modern homes use less energy?

In the older homes:
- Smaller houses use less energy.
- Small windows lose less energy.

In the modern homes:
- Better insulation reduces heat loss.
- Better constructed windows and walls mean fewer air leaks.

2. Put your hands on the ***window display***. Which types of glass allow more heat to escape? Which window keeps more heat in? Explain how the window's design and construction contribute to heat loss and retention.

You can feel that the clear 3 pane window allows more heat to escape.

- **Insulated window frames reduce heat loss** and condensation.
- Triple glazing – three panes of glass that have **air or gas-filled spaces to reduce heat loss.**
- Air-tight design – the **joins between the panes reduce air leakage** into and out of the home.
- Low-e Glass – Special coatings reflect radiant heat, keeping heat inside in winter and outside in summer.
- Window Gas Fills **- Inert gases between the panes reduce heat loss by convection.**

Note, that heat lost through windows can account for up to 15% of a heating bill.

3. Try out the home retrofit samples like **weather stripping, pipe and wall plate insulation**. Which would be useful in your home and where would you use them? **(Student Choice)**

- Weather stripping – can be used to seal air leaks around doors and windows.
- Pipe insulation – can be used to insulate hot water pipes to reduce heat loss.
- Plate insulation – reduces air leaks into and out of the home from outlets on exterior walls.
- Other ideas students suggest.

4. What are some of the benefits the Prairie South SD achieved by putting new windows and lighting in these Moose Jaw ***heritage schools?***

Some of the benefits achieved by the Prairie South School Division are:

- The well-sealed and efficient windows feel warmer in winter and reduce drafts, which reduces energy use. They also allow summer ventilation. All of this creates more comfortable spaces.
- The LED gym lights improve brightness and reduce energy use.

The things that aren't specifically named are:

- Reduction in energy use and cost.
- Overall, more comfortable buildings.

5. ***Real Retrofit:*** The 2018 Energy Retrofits of the **1970s Split-Level** home will reduce the home's energy use by about 40% or 70GJ/year. Calculate the reduction in greenhouse gas emissions from making this retrofit to the home. Use this calculation:

70GJ/year x 50kgCO_2/GJ = **3500** kgCO_2/year reduction

Smarter Science Better Buildings

WDM Saskatoon Exhibits Visit Guiding Questions – Pages 7 - 13

Use the map on page 13 to help locate these exhibits.

Move to the *A Saskatchewan Story* exhibit
First Nations' Log House, circa 1880

16 m^2 (172 sq feet) Energy Consumption 135 GJ / year

Notice the log house in this diorama. In parkland areas with bush and bluffs, houses were often built of logs. Trees were cut down, branches taken off and the bark stripped. Logs were etched at the corners to fit snugly as log upon log was stacked to make the walls. Spaces between the logs were filled with a plaster mixture of clay, straw and water.

1. Sometimes another natural resource was added to the plaster. What do you think was added? Manure

2. Estimate the thickness of the walls in cm: 15 cm (6 inches)

3. Where might air or water have leaked into this house? Under doors, around the window, through the floor, between the logs, through the roof.

4. Can you spot the woman carrying pails of water? If you had to haul all of the water you use for washing and drinking, would you use less than you do today? Why or why not?
Less water would be used because a person could only carry small amounts of water at one time. It is unlikely they could carry as much water per day as a person uses in their home today.

Move to the *A Saskatchewan Story* exhibit
Settlers' Sod House, circa 1905

32 m^2 (344 sq feet) Energy Consumption: 479 GJ / year

Inside, the house measures 3.7 metres (12 feet) by 6 metres (20 feet). Around the house is an outhouse (in the mural), a wood pile and a water well.

This house was built by Museum staff using photographs of sod houses to guide them. The sods were plowed from the edge of a slough. It took more than 350 sod blocks to build.

FYI….Did you know the nickname for a sod house is a "soddie"?

1. Where would settlers have gotten the sod for their houses? From the land where they are building their home.

2. Estimate the thickness of the sod house walls in cm: 75 cm (30 inches)

3. How does this thickness contribute to keeping the inside of the sod house comfortable? Thick walls insulate the home, keeping the winter cold from entering the house and by help to keep summer heat from getting in the house. Air may leak around the sod blocks but air does not leak through thick sod blocks unless they become cracked.

4. How was this home heated? Wood or coal stove

5. What provided light for this house? Sunlight through the windows or from an oil or kerosene lamp as there was no electricity.

6. How many panes of glass thick are the windows? One

7. Find two places heat would escape from this house: (Student choice) Answers may include:
   - Under or around the door
   - Unsealed windows
   - Cracks in the walls
   - Heat would conduce through single pane windows

8. How did the family living in this house do laundry? Hauled water and hand washed, dried on a clothesline (seen in the mural by the sod house).

9. Life in a sod house sometimes included unexpected guests burrowing into the walls to keep warm. Can you think of three of these potential guests? Which one would you least like to see beside your bed in the morning?

1) Insects
2) Mice
3) Snakes
4) Skunks

The worst would be **Students choice**.

Move to the *A Saskatchewan Story* exhibit – 1920s Fair Scene – Agricultural Fair Tent – Stationary Light Plant

Light plants consisted of three parts:
1) an energy source
2) an electric generator
3) a storage battery

Vocabulary: A **volt** measures how much "pressure" there is in an electric circuit. The higher the voltage, the more electrical current will flow.

1. How many volts did this plant produce? 32

2. What provided power for the light plant? Gas engine or wind charger-powered generator

3. What could the light plant provide power to? A broad range of 32-volt appliances - toasters, clothes irons, vacuum cleaners and even ceiling fans

Move to the *A Saskatchewan Story* exhibit – Eaton's Catalogue House – 1920s

1. Where were the building materials for this home ordered from? Eaton's Mail Order Catalogue

2. Why would they have to order building materials? Many settlers did not live near stores so they would order from a mail order catalogue. The materials were then shipped by train to the purchaser. (This is similar to ordering online today.)

Move to the *A Saskatchewan Story* exhibit
Eaton's Catalogue House – 1930s

181 m^2 (1948 sq feet) Energy Consumption: 759 GJ / year

This is the same home from the 1920s. Harsh weather conditions in the 1930s have taken a toll on its appearance.

Sometimes these homes were insulated with newspapers, horsehair or sawdust. Some of them had no insulation at all.

1. Look around, do you know what heats this house?
   A coal or oil-fired furnace (note the heat registers along the floor).

2. Look at the lighting. What was used?
   Incandescent lights and kerosene lamps.

3. How many panes of glass thick are the windows? One

4. Why are there newspapers along the window sills? To keep the dust from coming into the house from around the window.

5. What is the door made of? Wood
   Estimate its thickness in cm: 10 cm (4 inches)

6. Find two places heat would escape from the house:
   Student choice. Can include:
   - Under and around the door
   - Through wood construction
   - Around unsealed windows
   - Cracks in walls
   - Single pane glass windows

FYI…
Notice the hand pump in the kitchen for water.

The home's water came from a cistern or large container that collected rainwater for household use.

Move to the *A Saskatchewan Story* exhibit
Watch Rural Electrification in Action

FYI…
By the end of 1956, 40,000 of the province's farms (around 47 percent) were being served by power from the Saskatchewan Power Corporation.

Which home do you think would be the most comfortable in winter, the 1930s Eaton's House or the 1905 Sod House? Why?
Students answer based on what they've seen while touring the exhibits.

Move to the *Fuelled By Innovation* (Straw Gas Car) exhibit

1. What does the Straw Gas Car use for fuel? Straw
2. Where and when did the Straw Gas Car make its debut? August 15, 1918 in Saskatoon
3. In 1919, U of S research into straw as a fuel ended. Why? The process took too much straw, too much people power and too much time to be practical.
4. Sketch the straw gas car.
5. What crop is being used as part of a biodiesel mix to fuel Saskatoon buses today? Canola
6. What three reasons led the city to adopt a biodiesel blend for its entire bus fleet?
   - Increased fuel economy
   - Reduction in engine wear
   - Reduced greenhouse gas emissions

← Did you know that this crop was developed in SK?