Smarter Science Better Buildings
Western Development Museum – Moose Jaw

(Answer Key for the Student Package)

Students will work their way through the Museum building and exhibits, answering questions provided and discussing what they see.

ENTER THE MUSEUM GALLERIES

Stop as you enter the Museum galleries and look past the exhibits at the Museum building including the roof, doors, lights and walls. Do you notice what a big space it is?

The Moose Jaw WDM opened in 1976. The Museum was built to provide lots of space for cars, trains, planes, people and more.

Think about the size of the building. Pay attention to the doors, walls, heaters and lights as you go through the Museum as we will ask you more about them later.

MOVE TO RAILWAY STATION REPLICA

53 sq. metres (577 sq. feet) ERS Rating: 1 Energy Consumption: 449 GJ

In 1885, Canada was linked from coast to coast by the Canadian Pacific Railway. Every 12 km (eight miles) on the prairies, the railway built a siding complete with station, section houses and a name. These places would later become mail, market and supply centres for settlers farming within driving distance. In 1882, the CPR reached Moose Jaw, which became the divisional point for the railway. This railway station is a replica of a 1935 CPR station.

1. Estimate the thickness of the walls: ***7 – 10 cm (3 – 4 inches)***

2. Can you guess what the insulation in the walls might have been? ***It may have been straw, dirt or newspapers. Some buildings had no insulation at all.***

3. Where might cold air or water have leaked into this building? ***Through open doors and windows or around cracks in doors, windows & the roof.***

4. Why might it be harder for businesses to be energy efficient, compared to a home? ***Doors open frequently or may not be shut properly. Doors to loading bays may be open constantly allowing cold and damp inside.*** **Some businesses have large open spaces that are hard to keep heated.**

MOVE TO THE HODGE COAL TRUCK

Most homes and small businesses today are heated by natural gas. However, there are homes that are heated by wood, electricity and oil. Large buildings such as schools and apartment buildings may be heated using boilers, instead of furnaces, that heat buildings using water and steam. Do you know what kind of fuel you use to heat your home?

Estimated efficiency of furnaces over time:

Heat Source/Year	Fuel Source	% Efficiency
Wood stove/ 1880-1910	Wood	<30%
Furnace/ 1920- 1940	Coal	30-40%
Furnace/ 1950-1970	Oil/Natural Gas	90%
Furnace: ENERGY STAR/2010	Natural Gas	95-98%

1. From 1920-1940, many buildings were heated by coal. How was coal hauled to homes and businesses? ***By truck or horse & wagon***

2. Think about how home heating fuel is transported to homes and businesses today? Do you think heating fuel is transported the same as it was 100 years ago in Saskatchewan? How do you think we move heating fuel today? ***Some heating fuel is transported the same as in the past by train or truck. Today heating fuel can be transported by train, tanker trunk or pipeline. Pipelines can be above or below ground.***

3. When people used coal to heat their homes they needed a large space to store the coal. Do you need a place to store heating fuel in your house? Why or why not? ***If your home is heated by natural gas or with a boiler (using heated water to create steam), you do not need storage as this fuel is piped into your home. If you use wood, then you need a place to store firewood in your basement or a wood shed.***

MUSEUM EXTERIOR DOORS

1. Located near the Railway Station are some of the Museum's exterior doors. Let's take a closer look at them.

2. Without opening the door, do you feel air coming in around the door? ***If you feel air then the door is not sealing properly so heat is escaping & cool air is coming in.***

3. Is daylight visible around the door?
If you feel air then the door is not sealing properly so heat is escaping & cool air is coming in.

4. In the winter, frost can collect on and around doors. This happens if there is air or moisture leaking in around the door. What can be done in a home, business or school to help stop air from leaking around doors? ***Put weather stripping around the door (& windows too) to stop heat loss. Put a door snake (cloth tube) along the bottom of the door.***

MOVE TO AUTO REPAIRS BUILDING

In the early years of automobiles, there were few garages. Cars were sold by farm machinery dealers who didn't always know a lot about them. Between 1910 and 1920, automobiles became more common in Saskatchewan and more garages and repair shops were opened.

This garage was built by museum staff using photographs to guide them.

1. List the materials that were used to build this garage? Where would local builders get these materials? ***If there were trees then you could get your own lumber but there weren't many trees if you lived in southern SK. You would purchase lumber that would be brought in by train from another province or, if you were lucky, northern SK.***

2. Estimate the thickness of this building's walls: ***7 – 10 cm (3 – 4 inches)***

3. Notice the stove. What fuel was used to heat this building? ***Coal.***

4. What provided light for this building? ***A kerosene oil lantern & sunlight through windows. This building also has electricity so it has electric lights.***

4. How many panes of glass are in the windows? ***One***

5. Find two of the places where heat would escape from this building:

   1. ***Around open doors (both man & garage doors) or around gaps when the doors are closed.***
   2. ***Around windows. Through gaps in the wood siding.***

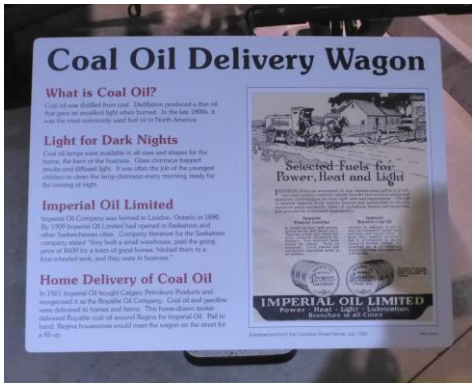
6. List three things in this building that did not use electricity in the early 1900s, but today require electricity:
   1. ***Cash register/till (today's equivalent – computerized till with debit/credit machine)***
   2. ***Kerosene lamp (today's equivalent - electric lighting)***
   3. ***Clocks (today's equivalent - electronic clocks), Typewriter (today's equivalent - computer)***

7. Stop and listen while standing in front of the Auto Repair Shop. Do you hear the Museum's heating system and can you feel heat? Can you see where the Museum's heaters are located (look up)? _____
Do you know what type of heat it is? ***Heat from a boiler that uses heated water to create steam. The heat created is then circulated by a fan.***
Is this similar to how your school is heated? ***Most schools are heated in a similar way but it can vary between schools. Many large buildings are heated using a boiler.***

9. It is hard for businesses in large buildings, like museums, to heat their buildings efficiently. Do you have any suggestions that would help make it easier to heat (or cool) a large building. ***Students can use their imaginations here. Some suggestions are: To re-insulate the roof and walls to help keep heat in & cold out. Ensure there is good weather stripping around doors and windows. Do not leave doors and windows open in cool or damp weather. Ensure that heating systems are running efficiently. This may include upgrading old systems. Using wind turbines and solar power to generate power to run heating appliances.***

MOVE TO COAL OIL DELIVERY WAGON

Coal was used to heat homes and businesses from around 1910 – 1940.



1. What is coal oil? ***Coal oil is distilled from coal. Distillation produced a thin oil that gave excellent light when burned.***
2. What was coal oil used for? ***Stoves, heaters, lamps, automobiles, tractors***
3. Is coal oil a renewable resource? ***No***
4. How did homes get coal oil? ***By horse-drawn tanker (wagon)***

Our homes, schools and businesses are only one part of living sustainably. Let's explore other ways that we can live sustainably.

MOVE TO 1929 STREETCAR

In the early twentieth century in Saskatchewan, hardly anyone owned a car. Just like today, booming cities needed public transit.

1. How is using public transit good for the environment? ***Less cars on the road creating fumes & less fuel used means cleaner air. Emissions from cars can cause greenhouse gases that, unnaturally, heat the planet.***

2. What powered the 1929 Streetcar? ***Electricity provides power through overhead lines.***

3. Why did streetcars go out of fashion? ***Streetcars were replaced by cheaper, rubber-tired buses and trolleys that were not restricted to rails.***

4. Cities like Los Angeles and Atlanta have considered a return to streetcars in recent years. Why do you think they may be considering this? ***Streetcars will mean less cars in congested downtown areas. Electric streetcars do not require gasoline so they do not produce emissions harmful to people and the environment. They are also quieter. These cities will also use them to entice tourists to their communities.***

MOVE TO 1951 TROLLEY COACH

1. What powered the 1951 Trolley? ***Electricity. Trolleys had an electric motor which got power from an overhead line (like a streetcar).***

2. What are two advantage trolleys had over streetcars?
   1. ***Trolleys weren't restricted to rails and could pick up passengers at the curb.***
   2. ***Trolleys had rubber tires that made them quieter than streetcars.***

3. What replaced trolley cars? ***Diesel-powered (gasoline) buses.***

MOVE TO *100 Years of Saskatchewan History* exhibit - Weather Module

In Saskatchewan we have all kinds of weather, from very hot to very cold. Today, we are lucky to have electricity in our homes that provides power for furnaces to keep us warm in the winter. Electricity also powers air conditioners and fans to keep us cool in the summer. How did they keep warm or cool before we had electricity? Prior to 1949, only about one percent of Saskatchewan's farms had electricity. A few communities had electricity but it was considered a luxury enjoyed by city dwellers. In the 1950s and 1960s, electricity came to many rural areas. Let's take a look at the weather display.

1. What are some ways that Saskatchewan people coped with extremely warm weather? ***Using fans and hats to keep cool. If you had electricity, you could use an electric fan. Going for a swim.***

2. What are some ways to cope with extremely cold weather? ***Using items like bed warmers, foot warmers and water bottles under blankets or next to the body. Extra blankets or warm, wool mittens, toques and scarves.***

3. How would you heat the things that kept you warm? ***Hot water is put inside water bottles and foot/bed warmers. The water would be heated on a stove using coal or wood to create heat.***

Workstation Guiding Questions – Answer Key

BUILDING MATERIALS

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

1. Why is it important to consider the whole **life cycle of building materials**? Describe how this information could affect how we choose products?

   The energy and resources that go into making materials contribute to how sustainable they are. Knowing about how a product is made from raw materials through manufacturing, transportation and what happens to a product at the end of life, helps us decide whether this is a product we want to use, or one that we should avoid. Example: concrete is made locally, but uses a lot of energy in production. Materials that are recycled or are recyclable when they are at the end of life, are better for the environment. No product is perfect, we need to make informed choices.

2. How do materials that have a high **R value** increase the energy efficiency of a building?

   R value refers to the ability to resist heat loss. High R value means that less heat will be lost from the building.

3. Name one **social, environmental or economic benefit** of building an energy efficient home.

   Student choice. Social benefits include that the home is comfortable, affordable, low voc products improve air quality, construction jobs are good jobs, etc. environmental benefits include that the house has a small footprint, uses resources responsibly, reduces waste and harm to surroundings, supports new energy efficient technologies. Economic benefits include that the cost of products is paid back over time by energy savings, supports new energy efficient technologies and companies, local, well paid construction jobs.

4. Check (✓) **sustainable building materials**, and for one item, explain why you chose it.

Vinyl flooring	Polyurethane insulation ✓	Concrete board siding ✓
Reclaimed or FSC wood ✓	Granite countertops	Triple pane windows ✓
Metal roofing ✓	Straw bale insulation ✓	Other:

Item:_____

Why I would choose it: students might name durability, recyclable at end of life, renewable source of materials or local vs. material coming from a great distance

5. In **Saved from the Landfill**, 67,436 tonnes of material kept out of the landfill equalled 95% of the weight. What was the weight of the material that went to landfill (5%)?

   $\frac{67{,}436 \text{ tonnes}}{95} = \frac{x}{5} = 3549 \text{ tonnes}$

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?

   Students compare ratings in display. Smaller houses use less energy. Small windows lose less energy. Better insulation and windows, fewer air leaks help the new ones use less.

2. Test the **window display**. Which types of glass allow more heat to escape? Which kinds keep more heat in and how does their construction contribute to this?

   Window with HP coating loses less heat than clear 3 pane window. Display shows a number of factors that reduce heat loss- durable materials, multiple panes, coatings, inert gas, warm edge spacers, air tight.

3. Do you have a **programmable thermostat** in your home? Program this one to the suggested setting and then consider doing the same thing in your home. How would it help you save energy?

   Yes or no, or I don't know. It helps to save energy by remembering to turn down the heat for you. The programmed thermostat will reduce or increase heat on the schedule you program.

4. Try out the home retrofit samples like **weather stripping, pipe and wall place insulation**. Which retrofits would be useful in your home and where would you use them?

   Student choices.

5. Insulating the basement/foundation of the **1970s Split-Level** home will reduce the home's energy use by 25 GJ/year. Calculate the reduction in greenhouse gas emissions from making this retrofit to the home. Use this calculation:

   25GJ/year x 50kgCO2/GJ = ___1250____ kgCO2/year reduction

SOLAR

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

1. Explain **convection, conduction**, and **radiation**. Hint: They are part of the radiant floor heating and solar evacuated tube panels.

   From Grade 7 Science text book:
   Conduction is: "The transfer of heat energy between substances that are in contact."
   Radiation is: "The transfer of heat energy in the form of radiant energy waves."
   Convection is: "The transfer of heat energy that happens when heated gas or liquid particles move from one location to another."

2. Check (✓) ways you could use **solar power** in your home or school. Student choice.

Use natural light from windows	Close curtains to keep summer heat out	Use solar panels for yard lighting
Use solar photovoltaic panels to make electricity at the cabin	Use solar thermal panels to heat pool water	Other:

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

   The clouds reduce the amount of power that the solar panel makes.

4. If your home uses 7500 kWh/yr and the average panel produces 300 kWh/yr, how many panels will you need to produce enough electricity for your home?

   $\frac{7500}{300}$ = 25 panels

5. List buildings in your neighbourhood whose roofs are large or face south, aren't shaded by trees or buildings, and could be used to hold solar panels.

   Student choices of buildings in their neighbourhood.

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 waste water flows inside copper pipe, cool fresh water is pumped up and passes warm water. Warmth is transferred to cool water by conduction.

2. Explain how a **grey water system** described here works to make use of rainwater.
   Rainwater is captured in a tank, filtered, chlorinated and pressurized for use in toilets or for watering outside, instead of fresh treated water being used for those purposes.

3. Look at ***Try This!*** Using a water efficient low flow showerhead, calculate the amount of water used for a 5 minute shower, compared to a 20 minute shower.

   6L/min x 5min = ___30_____ L 6L/min x 20min = ___120_____ L

   How much water do you save by shortening your shower this much? 120-30 = 90 L saved

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 washing machine with an ENERGY STAR® washing machine	Replace your old dishwasher with an ENERGY STAR® dishwasher
Fix a leaking toilet	Turn off the tap after washing your hands	Take a shorter shower
Collect rainwater	Grow drought tolerant plants	Other:

5. People in the UK (United Kingdom – England, Scotland, Wales & Northern Ireland) use half the water that we do in Canada. What do you think they are doing differently?
   Student ideas: take shorter showers? Water lawns less? Water saving technology in more homes? Wash clothes less often?

NET ZERO HOME

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

1. **LEED buildings** reach a high standard of energy efficiency. Why do you think **awareness and education** are included in the checklist?
   Letting people know about innovative ideas helps to spread those technologies and ideas around.

2. List the things that make up the **building envelope**. Why is it important for the envelope to be airtight and have good insulation?
   The wall, roof, windows and doors make up the building envelope. An airtight home doesn't let air leak in and out, wasting energy. Good insulation reduces heat loss through walls, roof and foundation.

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 joints in construction. Double wall construction surrounds wood and joins with insulation, stopping more of the heat loss.

4. $$Q = \frac{A \times \Delta T}{R}$$

   When you "turned down" the thermostat (ΔT), what happened to the power (Q), consumption of the house? Why?

   The power consumption went down. When the thermostat is lower, not as much energy is needed to keep the house at that temperature, compared to a higher temperature.

5. **"Warming of the climate system is unequivocal** [and] **Human influence on the climate system is clear."** – Intergovernmental Panel on Climate Change, Climate Change 2013. The Physical Science Basis, Summary for Policymakers

   a. What does "unequivocal" mean?
   b. What does "human influence on the climate system is clear" mean?

   Unequivocal means there is no doubt
   Human influence on the climate system is clear means that things that humans are doing (like driving cars and heating our homes) are affecting the climate system.

LIGHTING & APPLIANCES

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

1. The **average Saskatchewan home** uses a lot more electricity than the Vereco NET ZERO home. Name three ways the NET ZERO home uses less.
   Energy star lighting and appliances, smaller house, fewer lights, phantom power controls that can shut off electronics and lighting.

2. 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 the line
Use timers for lights and block heaters	Use a power bar	Unplug electronics
Buy ENERGY STAR® appliances	Reduce Air Conditioner use by setting the thermostat to 24ºC	Other:

3. 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.

4. Look at ***Try This!*** We use much more electricity than our parents and grandparents did. Name two modern appliances you could do without in order to use less electricity.
   Student ideas – special appliances, security systems, air purifiers, second or third computers or TV's, etc.

5. **Energy = Power x Time.** Explain what this equation means in terms of the kind of lights we use and how long they are on.
   Power is the amount of Watts a light uses. If we leave a light on for one hour, it will use less energy than if we leave it on for 6 hours. Good technology is a light bulb that doesn't use much power, good behavior is turning out the light when we don't need it.