Government of
Northwest Territories

LESSON # 3:

Developing a Model Green Home

INTRODUCTION

In Canada we take electricity and heat for our houses for granted. However, in many parts of the world electricity is still a luxury. We can learn a lot from innovative methods used in developing countries to capture heat energy and produce small scale electrical grids. People over the centuries have learned to design their homes to take advantage of the surrounding natural resources to heat and light their homes. Most of their designs are simple and can be applied to new situations or different locations. Taking advantage of the suns energy or gravity and falling water can provide an almost unlimited source of energy to meet local needs. Necessity is the mother of invention and green energy can provide many opportunities for innovative solutions to meeting your energy needs.

This activity uses a Science, Technology, Engineering and Mathematics (STEM) multidisciplinary approach the curricular outcomes and can be mapped back to Experiential Science 10-20-30 outcomes as detailed in the curriculum map. Further outcomes in Mathematics, ELA, Social Studies, Northern Studies and CTS multimedia can also be incorporated to increase the trans-disciplinary connections for students. This creates a real-world learning environment where they must use a variety of skills, knowledge and competencies to create and design new and novel approaches to presenting materials. The activity goal can be framed in the context of developing affordable green housing that is carbon-neutral and uses alternative forms of renewable energy to heat and power the house. This could include initiative to designing and implement strategies and policies to use local resources to efficiently produce, sustainable and reliable green energy while reducing their carbon foot-print. The focus should be on creating a model to demonstrate modes of electrical generation and heating of homes and how alternative forms of energy, from indigenous and western technologies, can be used to supplant the reliance on fossil fuels for electrical energy and heat generation.

Ideally students would see themselves in the role of advocates as well as the influencers and the decision makers of the future. This is an opportunity for them to design a world of their own making and show how their steps in green energy policies and strategies can mitigate or reduce GHGs and have a stable electrical grid.

LESSON PLAN #3: DEVELOPING A MODEL GREEN HOME

GOAL

Create a working model of an energy efficient green home that uses only renewable, carbon-neutral sources of energy, from a variety of sources to heat and power their model home.

KEYWORD SEARCH

Alternative energy, Carbon-neutral communities, Building carbon neutral homes, low pressure hydro, alternative energy policies for home owners, alternative energy projects developing countries, Passive and Active solar homes.

TIME

Budget 1-2 hours for group work and 1 hour for presentations. Additional time may be required for in class group work.

CURRICULUM CONNECTION

Experiential Science 10, Unit 4 Resource Management and Population Dynamics
General Learning Outcome:

- Students will gain an understanding of the basic processes to ensure sustainable resources.

Specific learning Outcome:

- Students will gain an understanding of the foundations of a sustainable future, economics and ethics by: Investigating the uses of renewable resources in the sub-Arctic and Arctic to reduce the ecological footprint with regard to: Renewable sources of energy, and cost effectiveness
- Researching and developing a media promotion campaign that would encourage people to gain an appreciation of the “Beauty of the Land” and the need to preserve it for future generations.

Experiential Science 20, Unit 4, Petrology and the Ocean Environment
General Learning Outcome:

- Students will gain a general understanding of the petroleum industry including the processes involved in manufacturing petroleum products, the environmental impact of this industry and the careers available related to the petroleum resource industry.

Specific Learning Outcome:

- Students will gain an understanding of the environmental issues surrounding the petroleum resource industry by: Evaluating alternative renewable forms of energy (e.g. wind, geothermal, solar, biomass, heat pumps) by considering: i. Availability ii. Cost and efficiency iii. Environmental impact iv. Other relevant “cultural” considerations

Experiential Science 30, Unit 4, Freshwater Resource Management (STSE)

General Learning Outcome

- Students will investigate governance and ethics related to freshwater resources.

Specific Learning Outcomes:

- Students will understand the foundations of a sustainable future, economics and ethics by: Investigating the renewable resources that can be managed by humans including: Describing and illustrating how the freshwater resources of the region (local watershed) are used and managed by people.
- Developing a management program that would ensure that freshwater is available for future generations.
- Describing and plotting the location of dam sites and the affected watershed.
- Researching and presenting findings, to a mock board of inquiry, on the impact of dam construction and their effect on the environment and on traditional lifestyles / subsistence living.
- Investigating and evaluating the economic, ethical and long-term implications of various water management boards' decisions.

Associated Curricular Connections:

- Language Arts: public speaking, presentation skills, literature research, technical writing, interpreting information from a variety of genre.
- Social Studies & Northern Studies: Citizenship, Traditional Knowledge, self-efficacy, networking and teamwork.

Materials And Methods

As students are building a working model of an energy efficient, carbon-neutral home that is self-sustaining, they will require construction materials for their model. However, you should encourage students to use recycled and repurposed materials such as, boxboard and cardboard for structure, clear plastic for windows, glass and plastic containers, used paper etc. to build their model home. They will also need such materials as, pencils, markers, construction paper, box cutters, straws, scissors, tape glue etc., to affix and add detail to their construction project.

Part A

1. Introduce the concept of what homes look like around the world. Include a wide variety of new and old house designs from developed and developing countries that use the natural surroundings to provide energy. (See 'Green Homes from Around the World' PPT presentation attached)

2. Students can use this information as an opportunity to make a list of the ideas they may want to use in the design of their carbon-neutral house.

3. Students, in small working groups, can brainstorm how they want to design their model house and what technologies they want to use in making their house carbon-neutral. Note: not all components of the model house have to be functioning i.e. students can make a representation of a photovoltaic cell but it does not have to operate. Direct students to Lesson #3 student handout for assignment overview and rubric, as well as Lesson #3 Alternative Energy Backgrounders

PART B

1. Once students have designed their carbon-neutral home on paper they can begin construction of the scaled model using the recycled materials.

2. As many students will use passive solar heating, the model can be tested by placing it in direct sunlight near a window. A thermometer can be used to measure the increase in temperature, which the students can record and later use to evaluate their design.

3. For each modelled application of green technology students should develop a short narrative on how this green technology works, why it is carbon-neutral and how it can be used to supplant the use of fossil fuels.

4. Students can then present their work to classmates or at science fairs or other public events.

INQUIRY QUESTIONS

- How can you make a carbon-neutral home?
- Can a home rely on green energy alone?
- What does an energy self-reliant house mean?
- How can I reduce GHGs by changing my energy use behaviour at home?

SHARING THE MESSAGE

Students can use their social media skills to present their carbon-neutral, self-reliant home to friends, family and the community. This is a good way of introducing them to the power of social media for constructive change and getting people to think about why we must plan for innovative housing designs to meet our future energy needs.

ENRICHMENT ACTIVITIES/FAST FINISHERS

As this activity uses a scaled model real scaled technology such as photovoltaic cells, micro wind turbines and passive solar water tanks etc. could be added to the model. This would provide students with a working model that could be placed in direct sunlight to concretely demonstrate the viability of the concept of creating a self-reliant energy home.

STUDENT HANDOUTS

- Lesson #3 Alternative Energy backgrounders
    - Hydroelectricity
    - Solar Electricity
    - Solar Heating
    - Wind Power
    - Biomass
    - Geothermal Power
    - Residential Heat Recovery
    - Conservation
    - Efficient Energy Technologies.
    - Renewable Energy in the North
    - NWT Energy Inventory
- Green Homes from Around the World PPT
- Lesson #3 Student Handout

EVALUATION

As students will have to create a model as well as a presentation, the rubric attached to the student assignment will evaluate the green component narrative write ups, The scaled model/design as well as the presentation. Feel free to elaborate or integrate other criteria. The curriculum map provides point of articulation for addressing the front end matter as well as specific learning outcomes. The integration of Mathematics, Art, Language Arts, CTS and Social Science outcomes could also be included in the rubric design.

ALTERNATIVE ENERGY BACKGROUNDERS: STRATEGIES FOR GREEN ENERGY

A. HYDROELECTRICITY:

Hydroelectric power has been used in the NWT since the early 1940's to provide and support cheap energy for home and industrial uses. The NWT has some the best underdeveloped hydroelectric power in all of Canada.

In the NWT there are considerable challenges to making hydroelectric power reach its potential. Because of the small economic scale of small community closed grids (no external sources of power) and remote locations, considerations such as construction costs, lack of capital investment, environmental, socio-economic impacts as well as the public desire for cheap energy can limit possible options for alternative forms of energy production. Also, there are long standing community concerns about developing local hydro potential, which when coupled with the logistics of acquiring power from sources further away from a community, can lead to complex discussion. However, for the most part the general public is not fully aware of the new technologies and developmental processes that can make hydro projects environmentally sound and produce clean cheap energy without GHG's.

The GNWT is committed to building a sustainable and reliable hydropower (macro and micro projects) legacy and is looking at many options to produce clean, sustainable energy. Current process for hydro development focuses on high pressure dams, which can cost a lot and impact the local environments and river system. However, there are increasingly more options for low-pressure hydro projects that have minimal environmental impact and do not require dams or large changes in elevation to work. This means that micro-hydro projects could be developed that could be closer to a community and only require a small amount of the water to be diverted without the need for the construction of a costly head pond or changes to the river bottom.

Below is a map indicating current and potential hydro projects to generate clean, reliable electrical energy. (NOTE: Graphic designer place in high-resolution image from source GNWT Energy Division)

Use the map as a starting point to investigate the potential use of hydropower for your community. Locate the current and potential hydro projects near your community and think about how you could access this energy as part of your community energy plan. Keep in mind that not all water resources are the same. Some rivers, because of their geography, are better suited for hydropower development but may be far from a town. This results in additional construction costs as access into the site can be limited and expensive transmission lines would have to be put in place. However, keep in mind that the energy is "free" and clean once the hydro project is in place, which adds to the cost benefit of hydro power.


LEGEND
EXISTING HYDRO
PROPOSED HYDRO
LOCATION MAP
HYDRO
Lower Ramparts
Colville Lake
Fort Good Hope
Norman Wells
Norman Wells
Upper Bracket
Head of Rapids
Tulita
Johnson River
Wrigley
Fort Simpson
Fort Simpson
Nahanni Butte
Jean Marie River
Trout Lake
Kakisa
Hay River
Enterprise
Fort Providence
Mills Lake
Great Slave Lake
Yellowknife
Dettah
Rae Edzo
Gamètì
Wekweètì
La Martre Falls
Lower Rapids
Snare Rapids
Snare Falls
Snare Cascade
Snare Forks
Blemon Rapids
Anderson Falls
Vee Canyon
Mosquito Canyon
Dead Moose
Artillery Lake
Nonacho Lake
Nonacho
Fort Resolution
Tsu Lake
Three Bears Rapids
Benna Thy
Nonda Rapids
Natalkai Falls
Elsie Falls
Twin Gorges II
Twin Gorges I
Fort Smith

Use this information and the internet keyword search to find more information on the NWT hydro potential for your community.

Keyword Search: NWT hydro potential, future sites NWT hydro, alternative hydro projects, small scale hydro projects, creating off-grid hydro, innovations in small scale hydro.

Use the section below for your research notes and citations.

Research Notes & Citations:

B. Solar Electricity

Solar panel technology, or photovoltaic cells, is becoming more available and efficient at converting the suns rays into electrical energy. In many cases solar technology, in the north, can outperform its rated capacity due to snow reflection, a cooler operating climate and prolonged summer sun. In the early days of alternative energy many northerners started using solar technology as a source of renewable energy for off-grid camps and homes. Since then solar power has expanded from single dwellings to solar farms which supply electricity to a community. This provides people with the quality of life they want without increasing their greenhouse gas emissions and having to rely on fossil fuels for electrical generation.

However, the seasonal availability of the sun can shorten photovoltaic daily output in the winter, when the demand for electricity is the highest. Yet solar energy is still a viable source of energy, which can off-set the demand for electricity during the sunny months of spring and summer. This allows many standalone small community generators to install hybrid systems where solar power offsets diesel consumption when the sun shines. Further, if solar power tied into other sources of alternative energy, the system can use the alternative energy first, thereby reducing need of the diesel generator and use of fossil fuels. Also, in hydro communities every time alternative forms of energy are produced and used first it can allow the head pond to fill with water during the summer. This allows the stored potential energy of the water to be used during the high demand periods, especially in the winter. With an integrated electrical system, whether it be an open or closed grid, allows the operators to use renewable sources of energy first and supplement with diesel power as a last resort thereby reducing overall greenhouse gas emissions. Ideally this saves thousand and even millions of dollars annually on the purchase of diesel fuel, while increasing northerners' own self-reliance on secure energy that is not influenced by rapid fluctuations in global energy supplies.

Below is a map indicating the current solar power generating capacity. (Source NT Energy pg 8, A vision for the NWT Power System Plan.)

Find your community on the map. Does your community use solar power to generate electricity? What is its capacity? How does this system reduce greenhouse gases? How would you use solar technology in your community energy plan?

Figure 3 – Existing Solar Generation in the NWT

Use your internet keyword search to find more information on the solar energy / photovoltaic cells as a potential source of energy for your community.

Keyword Search: NWT Solar power, photovoltaic power, off-grid photovoltaic cells, solar hybrid power generation, solar energy systems, NWT Power System Plan

Use the section below for your research notes and citations.

Research Notes & Citations:

C. Solar Heating

In the North the spring and summer sun is long and intense, which is an opportunity to take advantage of passive solar energy to heat airspace and water. With the use of simple collection panels and tubes, filled with water, the suns energy can be captured by the water and used to heat homes and preheat hot water. These systems produce no greenhouse gasses and can save a great deal of money by acting as a supplemental heat source thereby reducing the use of fossil fuels for space and hot water heating. The sun's energy is free for the taking and can off-set your energy bills by hundreds of dollars annually.

Any time hot water needs to be heated, whether it be for domestic hot water or summer community swimming pools, solar powered hot water collection panels can significantly offset the use of fossil fuels by as much as 50%. Over an entire summer this is a huge savings on the purchase of fossil fuel while reducing greenhouse gas emissions significantly.

Solar heating has such huge cost-free benefits that governments, corporations and private citizens are designing buildings and houses to take advantage of this free source of heat. With the development of new technologies, materials and designs people are seeing huge reductions in their energy costs of fossil fuels. This has two major benefits: 1. Less fossil fuels are used therefore lower GHG emissions and 2. You are accessing free renewable energy that has no GHG emissions.

Use the internet keyword search to find more information on the potential applications of solar heat for use in your community.

Keyword Search: NWT solar power, passive and active solar heating, energy efficient home design solar heating, solar farm technology, solar energy house designs.

Use the section below for your research notes and citations.

Research Notes & Citations:

D. Wind Power

Northern Canada has significant wind power resources and in many remote arctic areas wind generated electrical power can be a reliable source of energy. Unlike solar, which works best in the spring and summer months, wind is a constant source of energy that is available all year long. Wind turbines have become more common in many countries as they can tie the electricity generated from these wind turbines into the main electrical grid. However in northern Canada, most small communities have a closed electrical grid that is not connected to other sources of electricity. This can leave a community vulnerable to discontinuous electricity and the need to supplement with diesel fuel generators.

New technologies and control systems allow for hybrid wind/diesel generators to operate based on the wind turbines ability to generate electricity and the additional demand supplemented with the diesel generator. In other words when the wind is turning the wind turbine and producing lots of electricity, the control systems powers back the diesel generator thereby using less fossil fuel. As the wind dies down or the demand increases the diesel generator can power back up to take more of the load and the community has a seamless source of reliable energy. In areas that have significant wind potential large-scale wind turbines could produce more than half of the electrical needs of a community. Although this technology is very reliable and proven, it does have its challenges in that wind turbines are very large, cold temperatures can affect their operation, they require specially trained personnel for maintenance and operation, as well as large cranes to hoist the towers. This can raise the cost of installation, however the offset in diesel fuel savings and reduction in greenhouse gas emissions can be significant. Keep in mind that once the wind turbine is in place, the wind is a free and sustainable source of energy.

Use the internet keyword search to find more information on the potential use of wind power for your community.

Keyword Search: Wind power NWT, wind energy, wind farms, renewable wind energy, hybrid wind energy, best practices wind power, advances in wind turbine

Use the section below for your research notes and citations.

Research Notes & Citations:

E. BIOMASS

For centuries people in northern Canada and around the world have used biomass (wood) to heat their homes and cook their food, as firewood has been a reliable carbon neutral source of energy. Today's biomass technologies have taken us from inefficient old fashion wood stoves to high tech pellet boilers that can heat large spaces such as schools and public buildings. Buildings that were once heated by fossil fuels can now be heated with renewable wood pellets. In the north this is an emergent technology but one that is quickly gaining favour as a reliable and inexpensive heating source. Since the north, within the tree line, has large forested areas and quantities of firewood, biomass can be used to heat homes and hot water. However, at the moment, wood pellets are manufactured outside of the NWT and we have to rely on transporting pellets by transport truck from southern Canada. As this creates a supply chain it could leave people vulnerable to interruptions in wood pellet supplies.

As with any new or renewed approach, there are emergent entrepreneurs in the NWT that are actively engaging in producing wood pellets. This would make northern communities more independent and have access to a secure supply of wood pellets with a much shorter supply chain. This would employ local people and provide a carbon neutral source of heat that could reduce the reliance on fossil fuel for heat and electrical energy.

Use the internet keyword search to find more information on the use of biomass as a potential source of heat for your community.

Keyword Search: Biomass alternative energy, Biomass NWT, NWT Biomass energy strategy, Arctic Energy Alliance biomass, best practices biomass energy

Use the section below for your research notes and citations.

Research Notes & Citations:

F. Geothermal Power

Geothermal energy is energy, in the form of heat, that is taken from the earth. There are few places on earth where there is sufficient geothermal power to produce conventional electricity using high-pressure steam. These high-grade geothermal resources, such as those found in Iceland, can provide an almost endless supply of clean electricity, space heating and hot water to large sectors of their population. However, these high-grade geothermal areas are limited to a few "hot spots" around the world. Yet, low-grade geothermal resources, (lower temperature) like those found in southwestern NWT, are more widely distributed globally and can be used to offset local heating costs. By using low-grade geothermal energy to heat buildings and homes can have many benefits to a community's energy plan. For example, if geothermal heat is used to heat spaces and hot water the need to generate electricity or use fossil fuels for heating is decreased. Accessing this source of heat can have unseen benefits for communities that access hydro power as they can store unused water in the head pond and use it during periods of high demand. The combination of renewable energy resources enables us to access carbon neutral energy which further reduces our dependence on fossil fuels and reduces greenhouse gas emissions. Remember that for every litre of diesel fuel that we do not burn, there are 2.6 kg less CO_2 going into the atmosphere and contributing to greenhouse gases.

Use the internet keyword search to find more information on the geothermal heat potential for your community.

Keyword Search: NWT geothermal map, NWT geothermal inventory, geothermal energy, alternative geothermal projects, uses of geothermal energy, geothermal technology

Use the section below for your research notes and citations.

Research Notes & Citations:

G. Residential Heat Recovery

Communities that rely heavily or solely on diesel fuel to generate electricity are often referred to as "thermal communities". They are called this because the diesel generators and diesel fuel used to produce electricity is quite inefficient as only one-third of the potential energy of the fuel is converted into electricity. The other two-thirds of the energy (heat) goes into the generators cooling system and exhaust as heat and greenhouse gases. However, engineers have developed new technologies to capture some of this waste heat to heat water to redistribute the heat to nearby buildings, there by off-setting the need for fuel oil. This increases the over all efficiency of the diesel generator as the waste heat is now used to heat buildings. Although this is a good use of waste heat energy the diesel generating process consumes large quantities of diesel fuel and produces large quantities of greenhouse gasses which increases the rate of climate change.

Heat recover just increases the efficiency of energy exchange but it still results in the combustion of fossil fuels and the production of greenhouses gases.

Use your internet keyword search to find more information on the potential for residential heat recovery in your community.

Keyword Search: Heat recovery systems, electrical energy heat recover, thermal communities NWT heat recovery

Use the section below for your research notes and citations.

Research Notes & Citations:

H. Conservation and Efficient Energy Technologies

As the population increases so does the demand of energy, but in many cases the infrastructure to produce energy can be limited. This is why conservation, innovation and the use of new energy efficient technologies have to be part of any community based energy plan. Whether you are on or off the grid or in an open or closed electrical grid using energy wisely is key to energy security, sustainability and self-reliance.

Conservation can mean many things from retrofitting homes and the work place to using alternate sources of green energy to installing energy efficient appliances, lighting and heating technology. All of these steps contribute to reducing our ecological footprint and help us move to a carbon neutral society with limited greenhouse gas emissions. These actions not only helps the environment but they also makes things cost less to operate while providing a high quality of life and comfort.

Governments at all levels, including the GNWT, have implemented energy conservation policies and efficiency programs to help make homes, buildings and business more efficient and lessen their reliance on fossil fuels by fostering alternative energy use. This includes setting building standards that exceed National Building Codes, redesigning northern house and retrofitting older ones to be more efficient to take advantage of free source of energy such as solar and geothermal. The GNWT has also put in place incentive programs and rebates for people who buy energy efficient appliances or use green technologies for heating or lighting their homes and businesses. All of these incentives, large or small add up to reduce our greenhouse emissions as a society.

Further the GWNT supports the Arctic Energy Alliance and not-for profit agency that helps ordinary people and business convert and or utilize green conservation technologies. Organizations such as the Arctic Energy Alliance provide many services and programs, such as energy audits, financial and technical support and guidance in developing energy action plans.

Use the internet keyword search to find more information on conversation and use of new efficient technologies for your community energy plan.

Keyword Search: Energy conservation technologies, changing energy consumption behaviour, building a green energy future, carbon neutral housing, alternative energy housing.

Use the section below for your research notes and citations.

Research Notes & Citations:

BACKGROUNDER: RENEWABLE ENERGY FOR THE NORTH

Providing energy to meet the needs of northern homes, businesses and industries is no easy task. In a modern society everyone wants energy that is reliable, sustainable and inexpensive but in the NWT this can be difficult to attain due to a small population and a large number of remote communities that cannot access a large multi-source electrical grid. This means that most communities have to rely on expensive, carbon intense thermal power to generate electricity.

Fossil fuels still provide a large percentage of heat and power for the NWT. The reliance on fossil fuels put northerners at an economic disadvantage due to oil's high cost, fluctuations in the global energy markets and supplies chain disruption, which increase our energy vulnerability. Plus the use of fossil fuels also contributes to greenhouse gasses, which compounds the effects of global climate change.

Governments around the world acknowledge they have a role to play in mitigating GHG emissions to lessen the impact of climate change. Currently, the GNWT has developed a cyclical approach of frameworks, action plans and policies that are revisited and revised to combat climate change and reduce our reliance on fossil fuels. These action plans are a proactive step in creating policies and programs to enable people to reduce their GHG emissions and lessen the community's reliance of diesel power for electrical generation and fuel oil for heating. The long term goal is to create a multi-dimensional electrical infrastructure that employs a variety of cost-effective sources of green energy. This creates an electrical system that is more reliable, sustainable and reduces GHG emissions.

For example actions with in the NWT Energy Priorities Framework includes:

1. Educating and empowering people to manage their own energy consumption through energy conservation awareness and efficiencies of new technologies and behavioural practices.
2. Researching and investing in alternative sources of energy and applications of new technologies.
3. Public Works and Services (PWS) along with the NWT housing Corporation are improving the energy efficiency and performance of buildings and public housing.

All of these actions are attainable and can be done now. By focusing on proven technologies, that can reduce reliance on fossil fuels for power generation and heating, gives people a solution for the 'now' and provides opportunities to carefully plan for future large scale projects. This would include longer term plans like the NWT Biomass Energy Strategy and the NWT hydro Strategy. Both seek to supplant fossil fuels, one by using local renewable wood products and the other using NWT water resources to generate heat and electricity that is near carbon neutral, renewable, sustainable and reliable. Strategies and programs to off-set GHG emissions and access green energy technology are on-going and expanding every year. For the most current listing of GNWT initiatives and strategies to combat climate change and alternative energy projects use the keyword search GNWT, ENR, PWS, AEA NTPC, climate change, alternative energy. This will give you online access to the most current projects, policies and data that you can use for your projects.

Also, the GNWT funds a number of programs delivered by the Arctic Energy Alliance to assist local people with reducing the high cost of energy and shifting peoples' perceptions and access to renewable resources. Three such programs are:

- Energy Efficiency Incentive Program (EEIP),
- Energy Conservation Program and the
- Alternative Energy Technologies Program (AETP).

These programs are administered through the Arctic Energy Alliance, a not for profit organization supported by the GNWT. AEA's role is to provide supports through financial incentives, program and educational supports, to individual residents, businesses and the community programs on energy efficiencies and alternative energy programs. AEA is continually expanding their list of incentives and program supports which are outlined on their website, www.aea.nt.ca. Visit their site for helpful information on green energy.

The intent of these energy programs, policies and strategies is to make northerners aware that they have an active role to play in mitigating greenhouse gases and using our local energy wisely. Since we live in such a remote cold environment the NWT tends to have one of the highest per capital carbon footprint of peoples in Canada. Making conscious efforts to reduce our use of fossil fuels, no matter how small, will be a positive step forward. Remember that for ever litre of diesel fuel we burn 2.6 kilograms of CO2 is produced. If all 45,000 people in the NWT reduced their consumption by just one litre that would be 117,000 kgs less CO2 entering the atmosphere. Expanding these habits and ways of knowing how to use our energy wisely we can greatly reduce our GHG emissions as a territory.

So you might ask, "why should I care about green energy alternatives"? The answer quite simple is the Arctic and in particular Canada's Arctic, is experiencing some of the most rapid and intense climate change on the planet. Although global temperatures have increased by 1-2oC, the NWT Arctic along the Mackenzie River corridor is experiencing a positive 5-7oC degree changes in temperature with some estimates set even higher. This will have an impact on all aspects of northern living, from where we get food to travelling on the land to turning on the lights or dealing with bizarre weather. Any way you look at it there will be a need for secure and reliable power and we must prepare for a future less reliant on oil for fuel.

These unprecedented shifts in warming throughout the NWT are changing permafrost ranges (depth and area) as well reducing annual surface ice thicknesses on lake, oceans and rivers. This is having a significant impact on infrastructure and is making traditional ice road resupplies to remote communities more challenging and predictably less reliable. With many small remote communities relying on ice road delivery of diesel fuel for electrical generation the need to secure local reliable sources of energy increases with each passing year.

The uncertainty and negative impact of fossil fuels on the environment is causing society to pause and think about where our energy comes from. Anytime there is a shift in thinking it takes time for people to engage in the new train of thought, including the need to invest in clean energy. As all forms of alternative green energy cost money it is important to strategically invest funding into projects that provide a good return on investment while providing a reliable, sustainable source of energy. Focusing on readily available renewables such as hydro and wood provide an opportunity for our society to make some changes that will have an immediate noticeable positive impact. The key to success is about using the resources that are close at hand so not all community energy plans will look alike or appear equal. This is why we must look at each community for the local potential sources of energy that exist whether it be hydro, biomass, wind, solar, geothermal and even tidal and wave energy. Community based energy

plans will have to investigate the potential sources of local energy as well as create a strategic plan for their long-term energy needs.

Community based, targeted energy plans and energy awareness can provide a community with the tools and voice to become self-reliant green energy producers while reducing their carbon footprint.

In the NWT most homes are still heated with petroleum-based fuel oil, especially in the remote communities. However, there are a significant number of homes, in the tree line, that do use firewood as a supplemental heat source, which is a good first step in displacing the use of fossil fuels. This self-reliant practice has kept people comfortable throughout the generations. So what is old is new again as wood provides a carbon neutral source of heat. This coupled with more hydro, solar, wind and geothermal expansion could lead to less dependence on fossil fuels while providing clean renewable energy.

Although these alternate energy programs cost money the cost of doing nothing would set everyone up for failure with even high costs for energy and leave us vulnerable to global uncertainties in the energy market. By individuals and communities working together to do create climate change mitigation and alternate energy plans, over time, we will construct a reliable, secure and sustainable alternative energy system for the NWT. This will require people to think outside the box and use this as an opportunity to try out new technologies for green energy. Through trial and error learning we will learn new strategies and create opportunities for green energy that protects the environment and land for future generations.

To find the most recent literature on the effects of climate change and renewable energy in the arctic use the keyword search NASA climate change, Arctic Canada climate change, NWT Climate Change Strategy, Alternative source of energy combat climate change. These sites will provide useful project information for you when working on your energy projects.

NWT Energy Inventory

The GWNT and energy providers have studied the range of various renewable resources in the NWT to develop a renewable energy inventory. This inventory provides people with real-world data on hydro, wind, solar, biomass, geothermal and other potential sources of energy for electricity and heating in our arctic and sub-arctic environment.

The cost of energy in the NWT is significantly higher than in southern Canada because of economy of scales and having an electrical grid that is open so distributors can optimally manage the highs and low in energy demand. This results in competitive economies, which can force the cost of energy down. For example, in areas where nuclear and hydro produce the majority of the electricity electrical rates can be ten to fifteen cents a kilowatt-hour. Unfortunately for many remote NWT communities that rely on diesel power for electricity there is no cheap electrical grid to tap into and the cost of electrical production can exceed two dollars a kilowatt hour. Find out the cost of electricity in your community, how does it compare to other NWT communities and countries around the world?

These remote communities are considered to be on a closed grid, as they have no access to other sources of electricity through transmission lines. Closed electrical grids that are stand-alone diesel generators must be designed to handle the peek demands of the community therefore they are over designed and use significantly more fossil fuel to create electricity as they are running at full capacity all the time. However, with the use of renewable energy and new hybrid diesel engines we can reduce the use of diesel. Supplementing the closed grid with renewable forms of energy, coupled with conservation methods, teaching people to be aware of energy consumption and using their electrical energy wisely can help reduce greenhouse gas emissions and reduce our overall reliance of fossil fuels. To find out more on the NWT Energy Inventory use the keyword search NWT Energy Inventory, NWT hydro potential, NWT solar potential, NWT geothermal potential, NWT wind potential.

Engaging individuals and communities through new policy changes, and those on the way, will encourage entrepreneurs and corporations to become energy producers. Through net metering programs people can become energy produces, where renewable forms of energy that they produce are merged within the existing grid help to build a broader network of energy sources. Policies and programs work hand in hand to help bring down the cost of setting up alternative forms of renewable energy infrastructure as interested individuals and groups can pool their resources to install and maintain their system.

This means that as more people become aware of their personal energy consumption and energy use behaviour throughout the day, they can strategically plan when to use the energy when it is most effective. By changing ones daily habits and activities, with energy usage, it will allow us to use energy strategically to have a reliable and sustainable green energy. This will lessen our dependence on fossil fuels and make northerners more independent energy uses. To find out more about energy smart behavioural changes use the keyword search energy behaviour changes, smart energy, carbon neutral houses, zero carbon housing, energy conservation behaviour.

Group Members_____

DEVELOPING YOUR MODEL GREEN HOME: LESSON #3 CREATING A MODEL GREEN HOME

PART A: RESEARCH

1. Find some inspiration about model green homes from around the world by checking out the *Green homes from around the world* ppt or doing the following keyword search:

PART B: DESIGN

2. In Small working groups, brainstorm how you would like to design your model house and what technologies you will use to make your home carbon neutral. Note: not all components of the model house have to be functioning i.e. you can make a representation of a photovoltaic cell but it does not have to operate.

PART C: CONSTRUCTION

3. Once you have designed your carbon neutral home on paper you will begin construction of the scaled model. *NOTE* your model home should be using a variety of recycled materials. You may choose to use passive solar heating, Your model can be tested by placing it in direct sunlight near a window. A thermometer can be used to measure the increase in temperature, which the you can record and later use to evaluate their design
4. For each modelled application of green technology, develop a short narrative on how this green technology works, why it is carbon-neutral and how it can be used to supplant the use of fossil fuels.

PART D: PRESENTATION

5. In your Groups, you may be asked to present your model green home to the class.

SEE RUBRIC ATTACHED FOR THE STANDARDS YOU SHOULD BE AIMING TO MEET

Group Members_____

	100%-85%	85%-70%	70%-65%	65%-50%
Green Component Narratives	Clearly and thoroughly provides information on a variety of examples of how the various components of a green home would function Many creative and innovative strategies are included in the narratives	Provides many examples of green technologies that could be implemented explains where they would be implemented in the community and the energy savings associated.	Provides few examples of green technologies and provides vague examples of how these technologies would be implemented	fails to provide sufficient examples of green technologies provides little information about how these green technologies could be implemented
Scaled Model and Design	The scaled model and design show a lot of thought Almost completely or completely fabricated from recycled materials Outstanding Original and creative content, Making the implementation of the green technology highly feasible	The scale model and design shows thought scaled model and design show good use creativity and originality With some minor changes the implementation of the green technology would be possible	Scale Model lacks organization and information little evidence of creativity or originality Major changes would be required in order to implement the green technology	Little attempt to make Scale Model eye catching Design is lacking key components Project is sloppy in appearance The implementation of the green technology would be impossible

Group Members_____

Presentation	Demonstrates full knowledge by answering all class questions with explanations and elaborations Provides clear purpose and subject; pertinent examples, facts, and/or statistics; supports conclusions/ideas with evidence Demonstrates strong enthusiasm for the subject Significantly increases audience understanding and knowledge of the topic, convinces the audience of the important of the subject	Demonstrates knowledge by answering class questions without elaborations Uses pertinent examples facts and statistics Shows some enthusiasm for the subject Raises audience understanding and awareness of most points	Demonstrates little understanding and is only able to answer rudimentary questions Uses some pertinent examples facts and statistics Shows little enthusiasm for the subject Raises audience understanding of some points	Does not have a grasp of information and cannot answer questions about the subject Provides weak examples, facts and statistics which do not adequately support the subjects Includes thin data or evidence Shows no interest for the subject Fails to increase audience knowledge of topic
Comments	_____ _____ _____ _____ _____ _____			

LESSON #3 CREATING A MODEL GREEN HOME

GREEN HOMES FROM AROUND THE WORLD

DESIGNED BY RENOWNED ITALIAN ARCHITECT GIANCARLO ZEMA AND PRODUCED BY ECOFLOLIFE, THE WATERNEST 100 IS AN ECO-FRIENDLY FLOATING HOUSING UNIT. THE 100 SQUARE METER RESIDENTIAL UNITS ARE MADE OF UP TO 98% RECYCLED MATERIALS; INCLUDING THE LAMINATE TIMBER AND ALUMINUM HULL. SKYLIGHTS, BALCONIES AND LARGE WINDOWS ENCIRCLE THE DWELLING, ALLOWING FOR EFFICIENT LIGHTING AND BEAUTIFUL WATERFRONT VIEWS. 60 SQM OF PHOTOVOLTAIC PANELS EMBEDDED IN THE ROOFTOP PROVIDE UP TO 4 KWP OF INTERNAL ELECTRICITY. A SOPHISTICATED SYSTEM OF NATURAL MICRO-VENTILATION AND AIR CONDITIONING CLASSIFIES IT AS A LOW-CONSUMPTION RESIDENTIAL HABITAT.

THE WATERNEST ITALY

FOR MORE INFORMATION CHECK OUT
HTTP://WWW.ECOFLOLIFE.COM/

FOR MORE INFORMATION CHECK OUT
HTTP://EXPLORESRILANKA.LK/2012/07/GREEN-HOMES-OF-OUR-PAST/

WADDLE AND DAUB HOME IN SRI LANKA

THIS TRADITIONAL RURAL HOME IS MADE OF CLAY EARTH WALLS AND THATCHED ROOF, IS BOTH ECO FRIENDLY AND IDEALLY SUITED TO THE LOCAL CLIMATE. THE USE OF CLAY AND THATCHED ROOF IS IDEALLY SUITED TO THE HOT TROPICAL CLIMATE OF SRI LANKA. WHEN THE WEATHER IS COOL AND HUMID, ESPECIALLY AT NIGHT, THE POROSITY OF THE CLAY ABSORBS MOISTURE AND DURING THE DAY, WHEN IT IS WARM, THE MOISTURE IS EXPELLED. SO THE WALLS OF THESE HOUSES LITERARY BREATHE, ACTING AS A NATURAL “AIR CONDITIONER”, WHICH PREVENTS HEAT FROM CROSSING THE WALLS.

FOR MORE INFORMATION CHECK OUT
HTTPS://WWW.INSTRUCTABLES.COM/ID/NEW-INNOVATION-IN-CONSTRUCTION-USING-WASTE-PLASTIC/

P.E.T. BOTTLE HOME IN HONDURAS

THIS GREEN HOME IN HONDURAS FEATURES A SOD ROOF AS WELL AS ‘BRICKS’ MADE OUT OF BOTTLES FILED WITH SAND. WHEN YOU MAKE A CLAY BRICK, THE TIME AND ENERGY USED RIGHT FROM MIXING THE CLAY TO BAKING IT IN THE KILN AND TAKING INTO ACCOUNT THE FIREWOOD USED FOR THAT, YOU WILL SEE THAT THE BOTTLE BRICK IS FAR MORE ENERGY-EFFICIENT. THE TECHNOLOGY ALSO REDUCES THE CARBON EMISSION THAT HAPPENS DURING THE BAKING OF AN ORDINARY BRICK. PET BOTTLE CAN LAST AS LONG AS 300 YEARS (UNDOUBTEDLY LONGER THAN THE CEMENT USED TO BIND THE BOTTLES TOGETHER IN THE WALLS!).

GEODESIC DOME HOME IN NORWAY

THE SOLAR-POWERED, THREE-STORY, FIVE-BEDROOM HOME FEATURES AN IRRIGATED OUTDOOR GARDEN UNDER THE 25-FOOT-HIGH DOME THAT ALLOWS THE FAMILY TO GROW A VARIETY OF FRUITS AND VEGETABLES FOR FIVE MONTHS LONGER THAN USUAL -- AS THERE IS NOT MUCH SUN HERE FOR THREE MONTHS OUT OF THE YEAR. THE 49-FOOT-WIDE DOME, BUILT BY SOLARDOME, HAS 360 PANELS OF 6-MILLIMETRE THICK SINGLE-PANED GLASS THAT IS DESIGNED TO WITHSTAND THE HIGH WINDS AND HEAVY SNOW LOADS THAT ARE TYPICAL OF THIS REGION. THE RECYCLED ALUMINUM FRAME HAS A STRUCTURAL LIFESPAN OF 100 YEARS AND IS LOW-MAINTENANCE; ITS DOMED SHAPE TRANSLATES TO A 30 PERCENT MATERIAL SAVINGS COMPARED TO A CONVENTIONAL ORTHOGONAL BUILDING. THERE ARE 11 OPERABLE WINDOWS IN THE DOME TO ALLOW FOR VENTILATION. THERE IS ALSO A ROOFTOP TERRACE THAT THE FAMILY CAN USE. THE FAMILY COMPOSTS, AND GREYWATER IS REUSED TO WATER THEIR PLANTS.

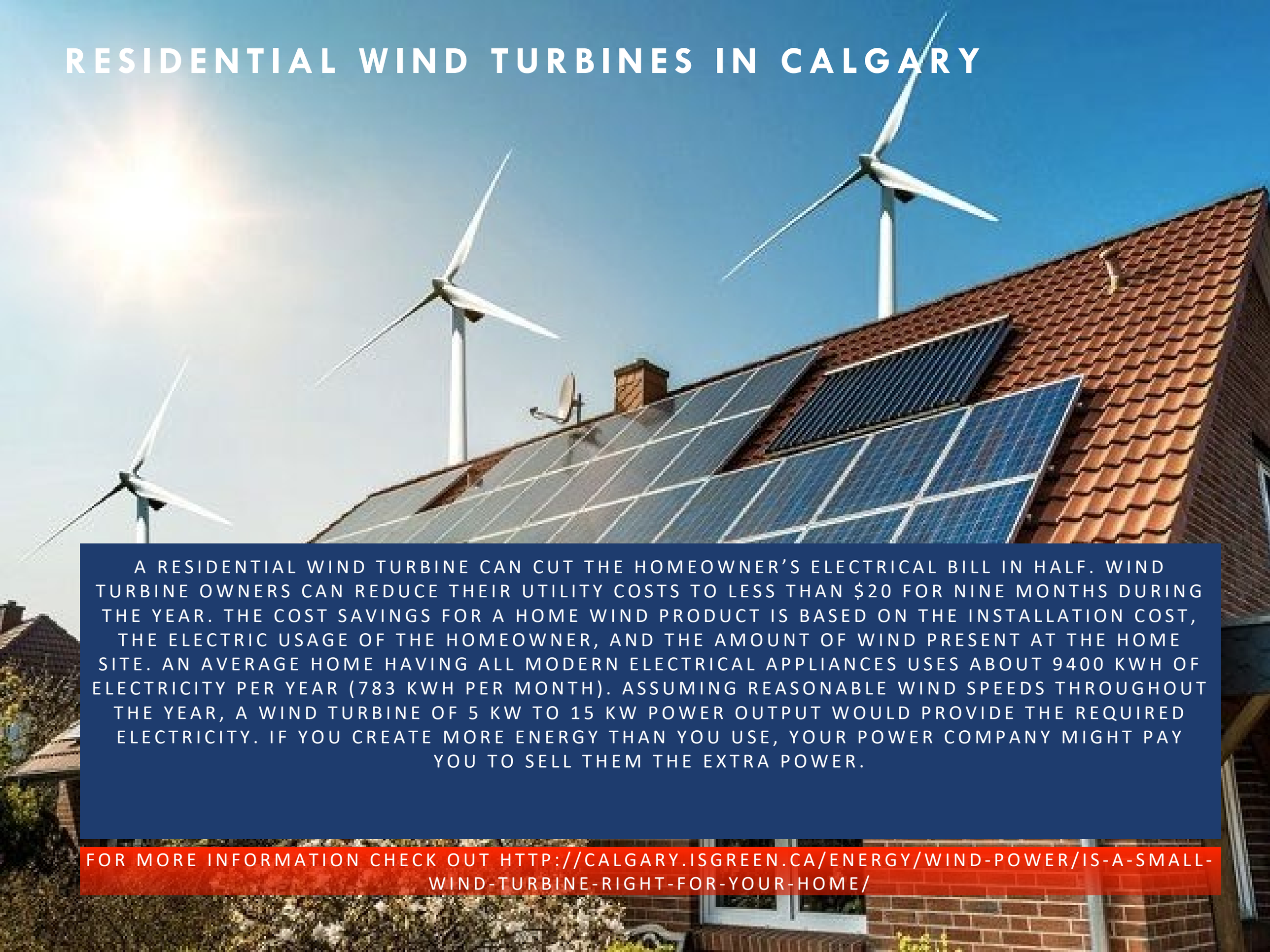
FOR MORE INFORMATION CHECK OUT HTTPS://WWW.TREEHUGGER.COM/GREEN-ARCHITECTURE/FAMILY-COB-HOUSE-UNDER-GEODESIC-DOME-HJERTEFOLGERS.HTML

AN EARTHSHIP IN ALBERTA

IT GENERATES ELECTRICITY ON-SITE WITH SOLAR PANELS AND BATTERIES. DRINKING WATER IS CAUGHT BY THE METAL ROOF AND COLLECTED IN FOUR CISTERNS CAPABLE OF STORING 5,800 GALLONS OF WATER. THAT WATER IS TREATED AND FILTERED DOWN TO FIVE MICRONS TO MAKE IT READY TO DRINK. GREYWATER FROM THE SHOWERS AND BATHROOM SINKS IS USED TO WATER A PLANTER IN THE GREENHOUSE THAT IS ALREADY PRODUCING A BUMPER CROP OF TOMATOES. THAT GREYWATER IS PUMPED BACK INTO THE HOUSE AND USED TO FLUSH THE TOILETS. SIMPLE EARTH TUBES AND CEILING VENTS IN THE GREENHOUSE KEEP THE HOUSE COOL IN THE SUMMER. PASSIVE SOLAR DESIGN, THERMAL MASS, LOTS OF INSULATION AND SOUTHERN ALBERTA'S GLORIOUS BOUNTY OF SUNLIGHT KEEP THE HOUSE WARM IN THE WINTER.

FOR MORE INFORMATION CHECK OUT
http://www.greenenergyfutures.ca/episode/82-how-we-built-our-own-earthship-radically-sustainable-grid-home-prairie

RESIDENTIAL WIND TURBINES IN CALGARY



A RESIDENTIAL WIND TURBINE CAN CUT THE HOMEOWNER'S ELECTRICAL BILL IN HALF. WIND TURBINE OWNERS CAN REDUCE THEIR UTILITY COSTS TO LESS THAN $20 FOR NINE MONTHS DURING THE YEAR. THE COST SAVINGS FOR A HOME WIND PRODUCT IS BASED ON THE INSTALLATION COST, THE ELECTRIC USAGE OF THE HOMEOWNER, AND THE AMOUNT OF WIND PRESENT AT THE HOME SITE. AN AVERAGE HOME HAVING ALL MODERN ELECTRICAL APPLIANCES USES ABOUT 9400 KWH OF ELECTRICITY PER YEAR (783 KWH PER MONTH). ASSUMING REASONABLE WIND SPEEDS THROUGHOUT THE YEAR, A WIND TURBINE OF 5 KW TO 15 KW POWER OUTPUT WOULD PROVIDE THE REQUIRED ELECTRICITY. IF YOU CREATE MORE ENERGY THAN YOU USE, YOUR POWER COMPANY MIGHT PAY YOU TO SELL THEM THE EXTRA POWER.

FOR MORE INFORMATION CHECK OUT HTTP://CALGARY.ISGREEN.CA/ENERGY/WIND-POWER/IS-A-SMALL-WIND-TURBINE-RIGHT-FOR-YOUR-HOME/

FOR MORE INFORMATION CHECK OUT
HTTPS://INHABITAT.COM/NYC/HOF-HOUSE-BY-STUDIO-GRANADA-ARCHITECTS/

GEOTHERMALLY HEATED HOME IN ICELAND

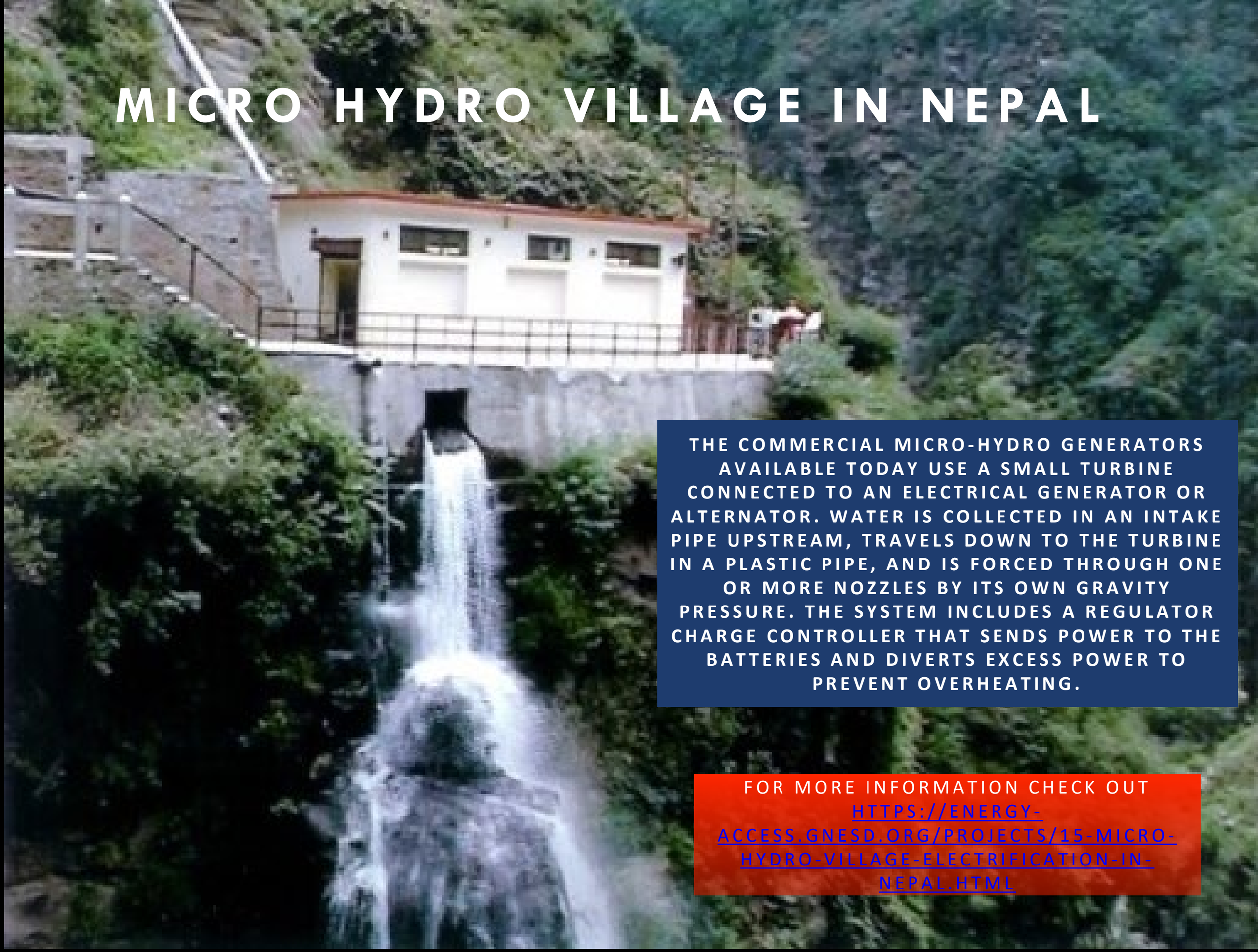
THE HOF HOUSE'S EXTERIOR CEDAR WALLS HUG THE MASSIVE CONCRETE STRUCTURAL WALLS AND WILL AGE GRACEFULLY WITH THE PASSING SEASONS. THE HEXAGONAL SHAPE FORMED BY SLICES OF THE SALVAGED BASALT PILLARS ARE REPEATED INSIDE, BRINGING A CONTINUITY OF DESIGN FROM THE OUTSIDE IN. GEOTHERMAL HEATING COMES UP FROM THE GROUND, WARMING THE STONE FLOORS AND PROVIDING HEAT AND ELECTRICITY THROUGHOUT THE HOUSE. THE REMAINING ENERGY NEEDS ARE SUFFICED BY HYDROELECTRIC POWER. THE WINDOWS ARE ORIENTED TO NOT ONLY CAPTURE THE SOUTHERN SUN, BUT ALSO TO CREATE A FRAME FOR THE MAGNIFICENT SURROUNDINGS OF THE CLIFF ISLANDS OF DRANGEY AND MÁLMEY AND THE HILLS OF ÞÓRÐARHÖFÐI.

STRAW BALE HOME IN BRITISH COLUMBIA

OUR HOUSE IS EXTREMELY COOL DURING THE SUMMER AND VERY WARM IN THE WINTER. STRAW, WHEN ENCASED IN EARTH PLASTER HAS A VERY HIGH R-VALUE. OTHER BUILDINGS CAN ACHIEVE THE SAME R-VALUE, BUT ONLY BY USING MORE EXPENSIVE MATERIALS AND A MORE MATERIAL-EXTENSIVE SYSTEM. IT HAS BEEN ESTIMATED THAT STRAW BALE BUILDINGS ARE ON AVERAGE 20% MORE EFFICIENT THAN STANDARD STICK-BUILT CONSTRUCTION.

FOR MORE INFORMATION CHECK OUT HTTPS://NATURECANADA.CA/NEWS/BLOG/STRAW-BALE-HOME/

MICRO HYDRO VILLAGE IN NEPAL



THE COMMERCIAL MICRO-HYDRO GENERATORS AVAILABLE TODAY USE A SMALL TURBINE CONNECTED TO AN ELECTRICAL GENERATOR OR ALTERNATOR. WATER IS COLLECTED IN AN INTAKE PIPE UPSTREAM, TRAVELS DOWN TO THE TURBINE IN A PLASTIC PIPE, AND IS FORCED THROUGH ONE OR MORE NOZZLES BY ITS OWN GRAVITY PRESSURE. THE SYSTEM INCLUDES A REGULATOR CHARGE CONTROLLER THAT SENDS POWER TO THE BATTERIES AND DIVERTS EXCESS POWER TO PREVENT OVERHEATING.

FOR MORE INFORMATION CHECK OUT HTTPS://ENERGY-ACCESS.GNESD.ORG/PROJECTS/15-MICRO-HYDRO-VILLAGE-ELECTRIFICATION-IN-NEPAL.HTML