Sustainable Living Technologies

7531 Deer Park Road, Castlegar, British Columbia, V1N 4V8
sustain_ability@telus.net 250-354-3428

Building A Sustainable Living Infrastructure

What better place to start building energy consciousness into your lifestyle than in your home design plans? Think beyond monthly utility bills – beyond depending on large-scale grid electricity, ongoing fossil fuel depletion and high heating costs. Imagine instead a home built to harmonize with the cycles of the sun, designed to gently absorb the natural energies freely offered by the Universe.

Solar, water or wind powered electricity, solar hot water, radiant floors, and composting toilets are just some of the technologies available to pave your path toward living sustainably and with responsibility toward the planet. Integrating these technologies at the design stage of your home is what will bridge your concurring ideals of beauty, efficiency, self-empowerment and economic value.

Consciously designing your home's energy infrastructure is an iterative process that marries your personal values with the landscape you have chosen and the technologies available. Sustainable Living Technologies has developed an alternative energy engineering process that asks the right questions and offers the appropriate information to enable you to make wise and long-lasting choices.

We start by informing you about the current technologies available and giving you ideas about how other people are using them. Then we ask questions about your landscape, your home construction plans and your lifestyle. Together we discern which technologies make sense for you. These we integrate into your home design at a detailed level, such that your home is built with an alternative energy infrastructure in mind. The required components are pre-engineered, pre-wired or plumbed and assembled on mounting boards, and delivered with your home to simplify installation.

As we move toward greater consciousness our level of responsibility in all areas of our lives increases. Luckily we are not alone. We gives you the support of experts in the field who have similar mindsets, who realize that every action we take today creates the reality of our tomorrow. May we help you find your unique point of contribution on the spectrum of alternative living choices today.

The Alternative Energy Spectrum

The conventional home uses an oil or gas furnace for heat and the utility companies for all the electricity and water that we want. Habitually we have used these resources flagrantly and thoughtlessly because they are financially affordable. Only recently have some manufacturers started designing energy efficiency into their appliances. The goal has been convenience at the cost of the planet, and our biggest exercise in energy efficiency involved turning down the thermostat at night.

At the other end of the spectrum, off-grid enthusiasts have gone to extremes to reduce their ecological footprint. Some have spent months or years self-designing a composite of heating, water and electrical systems that take time every day to manage. Chopping wood, tending water lines and conserving solar power on a dark winter's day are some of the challenges for the do-it-yourselfer, and typically he or she thrives on it.

There is a middle way. Energy efficiency can be an exercise in consciousness without being a chore. Yes, we have to build redundancy into our systems, but it can be integrated seamlessly such that we are aware of the impact of changes in seasons or in our behaviour but the shift of control between systems is automated. For example, a solar user can depend on the grid in the evenings and then witness the meter spin backwards on a sunny day, selling power back to the utility. Or, after a controller has taken the daytime heat from solar tubes on the roof to pre-heat the hot tub water in the winter, a flick of a switch can bring the temperature up to 100+ degrees just before you jump in.

Integrating your alternative energy strategy into the design of your home avoids retrofitting new ideas into a conventional building plan. The utility room placement and size fits the heating systems, supports for solar panels can be built into the roof, portions of a south wall can be built big enough for a solar air heating panel, extra insulation can replace the need for air conditioning, and more.

Studies indicate that for every dollar of energy you save in your home, the value of your home increases by $20.00. You can gain these energy savings, reduce your ecological footprint, take responsibility for your own power, increase your level of conscious awareness and provide for our children's future all at the same time.

At some point we may have a single box the size of a suitcase that powers every energy need that we have in our home for the cost of a telephone. Until that time, we have the fun of applying ingenuity and creativity to proven technology to develop a sustainable energy infrastructure that generates goodness on all levels.

Sustainable Technologies Overview

1. Electricity

Natural electricity can be derived from the sun, wind or water. Water, or micro-hydro systems, generally provide the most consistent and cost effective wattage but not everyone has access to a hillside creek on their land. Solar power is clean, simple to install and as maintenance-free as you can get (no moving parts) but usually requires energy conservation during winter months. Wind power requires coastal, mountain top or prairie-style winds which in most places are not consistent; it is best used as a complement to a solar system.

These are three different ways to generate electricity. All three share the technology required to store, convert and distribute electricity. Batteries are used to store the DC power. A controller makes sure the batteries don't overcharge. An inverter changes the DC power to regular household AC power, and a series of components like a meter, a disconnect switch, a lightening protector and combiner/junction boxes ensure the safety and facilitate the management of the system. Most people use a gas, diesel or propane generator to back their system up and to support the occasional use of high-powered tools. The generator can also charge the batteries, usually through a charger built into the inverter.

- The deep cycle battery bank is the heart of the system. We recommend sealed batteries because they require zero maintenance. The flooded kind are cheaper and slightly more efficient, but are subject to spillage, gassing and need to be maintained with regular watering and equalization.
- Special MPPT controllers are available for solar systems that boost solar output by as much as 20%. In wind and water power systems, a load diversion controller is required to divert excess power to a heating element. You may have excess power for space or water heating!
- Less expensive inverters are still available in a modified sine wave technology. However because of the sophisticated electronic controls built into today's appliances and tools, we suggest a pure sine wave inverter. If you are selling power back to the grid, a special inverter is required that supports 220 volt power and that manages disconnection from the grid if the grid fails.
- A meter is crucial to monitor the input, output and usage of your system. If you are selling power back to the grid, you will also need a bi-directional meter, usually purchased from your local power company.

With the careful measuring and diagramming we are known for, we plan and pre-assemble much of the installation. The controller, inverter, safety disconnect and meter come pre-wired and mounted on a board to put on your wall, such that installation is as easy as hooking in your input wire (from solar panels, wind or water turbines), your

generator wire, your AC output wire and AC input from the grid if applicable. We will provide detailed drawings and instructions for you or your electrician to follow.

Installing the solar panels, wind turbine or water turbine requires some on-site effort.

- Mounting kits make solar panels simple to install on the ground or on the roof.
- Wind turbines can be noisy so a roof mount is avoided. With guyed tower kits, ground installation can be completed in a day.
- Micro-hydro systems require a fair amount of customization to your site. A large part of the install involves running pipe from the intake site to the turbine and back to the creek to discharge. The turbine needs to be housed to protect it from the weather.

In most cases, wire needs to be run underground to the battery bank. Batteries need to be kept inside to avoid freezing. Sealed batteries should be protected in a cupboard, on a shelf or in a container. Flooded batteries need to be in a sealed and vented container.

Sizing your system is crucial because an oversized system can perform as poorly as an undersized one. Sizing starts with filling out our load audit form, in which you detail what appliances you use and how often. We also need to understand your general lifestyle needs and the landscape you are working with. Our focus is on engineering a solid infrastructure that meets your current needs and will support your changing needs over time.

Pricing

Here is some general information on price and function to help you start detailing the system you need. However keep in mind that solar panels are in such high demand these days that sourcing enough for a large system can take months, and prices are on the rise.

While a starter solar power system can be had for under $1000 (with one 64-watt solar panel), it will only power a DC light or two and a radio. DC appliances are expensive and not commonly available, and so most people get an inverter to support their regular AC appliances.

Adding an inverter and jumping up to two 120-watt panels can be done for about $7,000. This would satisfy most appliance needs for someone who conserves a lot, or who just uses the system on weekends (allowing the batteries to recharge during the week.)

A system to run most low-power appliances conservatively every day would require four 120-watt panels at a cost of about $12,000. To add in a fridge or freezer, jump up to 170 watts per panel for a package cost of $17,000. A workshop or other high usage requirement could bring you up to eight panels and $26,000, and a system with no usage limits can be $40,000 or more.

For those with access to grid-tied electricity, generating enough power to sell back to the grid is an attractive option. Batteries are used to store energy only as a backup if the grid goes down. The size of these systems depend on how much in excess of personal needs is desired, and has ranged from $20,000 to $60,000!

Micro hydro systems can vary greatly in complexity and in price. A basic turbine producing up to 800 watts continuous power can be had for $1,800 but putting all the components in place (penstock, battery bank, inverter, power board, etc.) can take you up to $12,000 or more. If your system can generate several kilowatts continuously, you may be able to use straight AC power and skip the inverter and battery bank altogether.

Adding a small 400 watt wind turbine to an existing solar system can be done for about $1200, however higher performing systems can take you up to $5,000 or more. Bear in mind that a wind turbine should be at least 33 feet (10 meters) above any object within a 330 foot (100 meter) radius. To be a good wind site, the wind has to be uncomfortably strong much of the time.

2. Hot Water

Several technologies are available for using the sun to heat hot water for your personal use, for your hot tub or swimming pool, and for your radiant floors. While solar can generally provide 100% of your needs in the summer, it will only pre-heat in the winter and needs a backup system, which could be an on-demand tankless water heater, a boiler, or an electric, gas or propane hot water tank.

Several solar thermal technologies are available but we prefer the highly efficient evacuator tube technology. Because they are round they collect heat earlier and later in the day. Because the tube operates like a vacuum, heat is not lost to the surrounding atmosphere and they work in the winter. Other technologies like flat plate collectors or batch tanks are slightly less expensive but a lot less effective over the course of the year. An entry level tube system that works via a heat exchange wand into a standard hot water tank and provides hot water for your domestic use starts at $4,500. Larger systems to support a hot tub, more heat in the winter or a radiant floor usually require a special purpose hot water tank (with built in coils for heat exchange) and can run $10-12,000.

Generally speaking a solar hot water system pays for itself in about 10 years. Given that it lasts 20 or 30 years or longer, it’s an excellent investment.

The extreme efficiency of gas or propane tankless hot water systems is starting to become known in our Western culture. In the East, it’s a standard and the idea of keeping tens of gallons of water constantly hot ‘just in case’ you want it seems absurd. With a tankless system, the water heats instantly as it passes through the heater, starting when you turn the tap on and ending when you turn it off. You only heat what you use, and you

never run out the way you can with a tank system. Plus, these units are known to last 20 years and more. Most standard tanks start to leak and need to be replaced in 5-10 years.

A tankless heater can operate alone, or a solar thermal system can be used to preheat the water in a standard tank before it passes into the tankless heater. One unit can support an entire household (6-7 gallons per minute, which for example would support two showers and a sink simultaneously) and costs $1,900. A starter or cabin unit, which restricts the flow and only supports one faucet at a time, costs $700. Other models fall within these two examples. Another option is to plug in an electric unit under one sink, at a cost of $375. Whole house electric units require a 200 amp service and are about $1,000.

These on-demand units are also a popular heat source for radiant floors, with or without a solar assist. One small wall-hanging tankless heater may be all you need to heat your hot water and your home! These heaters can also be stacked together for more output.

3. Space Heating

The first and best source for heating your home is passive solar. This means the orientation of your house and windows should be south, the angle of your roof should let in winter sun and shield from summer sun, your insulation should be as thick as possible, and, if possible, you should build into a hillside to use heat from below the frost line of the earth. Insulated concrete forms work great for this! Your windows should be of the highest R-value possible.

Many people are considering geothermal heat these days. This involves drilling down into the earth, or laying a field of pipe under the frost line, or a loop of pipe into the bottom of a lake to access the consistent heat of the earth (which is the yearly temperature average in your climate). Electricity is needed to pump glycol or antifreeze through these pipes, and to run a heat pump which boosts the earth temperature up to our comfort level. You don’t have to worry about your home freezing if you go away! However a wood stove or other heat source is often used to boost the temperature a little more if needed. Interestingly, we have found that taking heat from the earth on a consistent basis reduces the average earthen temperature over time. To counteract this, heat has to be pumped back in through the loop in the summer. Separate wells may be needed for the supply and return lines. Solar hot water is a good complement to a geothermal system.

Geothermal systems tend to be expensive for a single homeowner, although some with a long term view will go for it. Since they are very site specific and often require heavy equipment, these systems don’t lend themselves to pre-packaging and you are best sourcing the expertise locally.

Today, Europe utilizes radiant floor heat in well over half of its buildings. The benefits are palpable to anyone who has experienced a radiant floor home. Heat evenly radiates from the floor and into the objects in the room, staying in the living zone. In contrast, forced air heat rises into the ceiling area and does not evenly concentrate heat in the living zone or floor.

The design and installation of radiant floors is simple. Evenly space plastic PEX pipe over the floor and fill it with water. Circulate the water through a heat source with a pump. Attach the pump to a thermostat and controller so it can be managed at will. Some will prefer to use glycol (antifreeze) in a closed loop for an extra guarantee against freezing, but this may require a heat exchanger which costs in efficiency.

Larger and multifloor homes will separate the tubing into different zones so that the temperature of the main living area can be controlled separately from the basement or the bedrooms. In this case, a pump and thermostat/controller is required for each zone, and each zone is plumbed into a distribution manifold near the heat source.

The heat source can be varied, although most people use propane or natural gas because of its responsiveness compared to electric water elements. Boilers, on-demand tankless heaters, geo-thermal, wood furnaces, solar thermal or even hot springs have been used! All can keep the liquid flowing through the tubing at a steady temperature between 120 and 135 degrees.

Pricing a radiant floor system depends on the construction method preferred for your home. Tubing is inexpensive to staple into a concrete floor just before pouring, and can be had for about $.60 per square foot. To add the tubing into the joist of a second or third floor, it's best to use a combination of reflective foil beneath it to reflect the heat up and aluminum heat plates attached to it to diffuse the heat evenly. This can cost $2.00 per square foot or more, depending on the system chosen. A cement board on top adds a thermal mass to hold the heat. Ceramic tile is the best medium for the top layer because it holds the heat too. Hardwood is acceptable, but carpet can act as an insulator to keep the heat from rising and is the least preferred option. New carpets are available now that pass the heat upward more effectively.

The manifold, pumps, controllers and associated plumbing appropriate for your home can be pre-assembled on a board such that installation involves simply mounting the board and plumbing in the hot and cold water ports, and the supply and return lines.

Let's take an 800 square foot home with a basement as an example, with a slab-on-grade construction. The owner wants to control the temperature in each 800-square-foot floor separately, so there are two zones. A multi-temperature, multi-zone manifold comes pre-assembled with the pumps, thermostats, controllers, and expansion/purge kits necessary for a freeze-proof system. The PEX tubing is laid in

the basement floor prior to pouring the concrete slab. On the main floor, the tubing is laid within the floor joists with reflective foil beneath it and heat plates to evenly diffuse the heat. An on-demand tankless water heater can heat both the radiant floor and the domestic hot water. It is mounted on the wall and it's size is 25"(h) x 15"(w) x 11"(d). The shipped price of this complete space and water heating system is under $7,000. A solar assist for $4,000 - $12,000 would reduce, and in the summer eliminate, the ongoing cost of gas or propane,

Wood stoves are a perennial favourite heat source and can burn quite efficiently. What we are re-discovering, however, is that the most effective heating medium is not the wood itself but the stone or firebrick around the wood. We support the proven concept of the masonry stove, in which a basic firebox is surrounded by masonry to create a hearth that heats your home for 18-24 hours after the fire has burned out. A large number of small sticks of wood are used to create a very hot fire for the short time that's required to heat the stone mass. A minimum amount of wood is used, the hot burn is supremely efficient, and the hearth can be used for heating your hot water and cooking all day! These stoves come in kits for $5,000 - $7,000, ready to be finished with facing by your local mason. A masonry chimney is required as well. The total price will be close to double the price of the kit, but the system will last the life of the home. A built-in cooking oven stays at 350 degrees for 7-8 hours, and a stainless steel coil heats your hot water too!

Space heating with solar can complement your main heat source during the day. Their effectiveness is based on sun exposure rather than temperature, so they work in the winter. Solar thermal systems can transfer heat from the hot water to air via a heat exchanger. Alternatively, a 4' x 7' hot air solar panel is available to attach to a south facing wall with a light fan cycling the heat (and destratifying the air) from a small hole at the bottom to a small hole at the top. It costs about $2,500 and can produce about the same amount of heat as a 2000 watt ceramic space heater. Solar Wall is a new wall siding designed to collect heat and transfer it indoors, however it's been used mostly for industrial buildings so far.

4. Water Pumping

If you have the electricity available, a standard AC pump is the least expensive solution. Some off-grid people use their AC generator intermittently to fill up a reservoir above the house. However if no electricity is available, a solar-powered water pump is quite effective. A typical system includes one or more solar panels, an efficient 12 volt DC pump, a controller (with a float switch), and a "linear current booster" that allows the pump to run even if it's cloudy out. Since it only runs in the daytime, a reservoir is needed, ideally above the house to create pressure from gravity. To further boost the pressure to current standards, you can put a small pressure tank and another pump inside the house.

As long as it's daytime and the float switches show that the water source is not empty and the storage reservoir is not overflowing, the pump will run. The type of pump you need depends on the depth of your water source, how much lift is required, and how far away the source is from the use. Pricing ranges from several hundred dollars to a few thousand. To better determine your water pumping solution, please fill out our water pumping questionnaire.

3. **Composting Toilets**

Composting toilets are effective biological converters of human and household “waste,” saving money and energy for the planet. They start the regeneration of the Earth’s precious environment that is long overdue. They range from simple twin chamber designs through to advanced systems with rotating tynes, temperature and moisture probes and electronic control systems. Some high-end models so closely resemble a regular toilet that your friends may not notice the difference. The size and height is the same, and when you stand up a trap door automatically opens to let out the waste and closes again. A mixer kicks in to stir things up, (almost like a flush!) and a small fan dries out excess moisture. Some of these units require no drain, and may not require a septic! (See your local building inspector). These high-end units can cost $3,000 or more. Basic compact models for limited use start at about $1,300.

New technologies and products, as well as over 30 years experience is now setting the scene for a major expansion of composting toilets throughout the world.