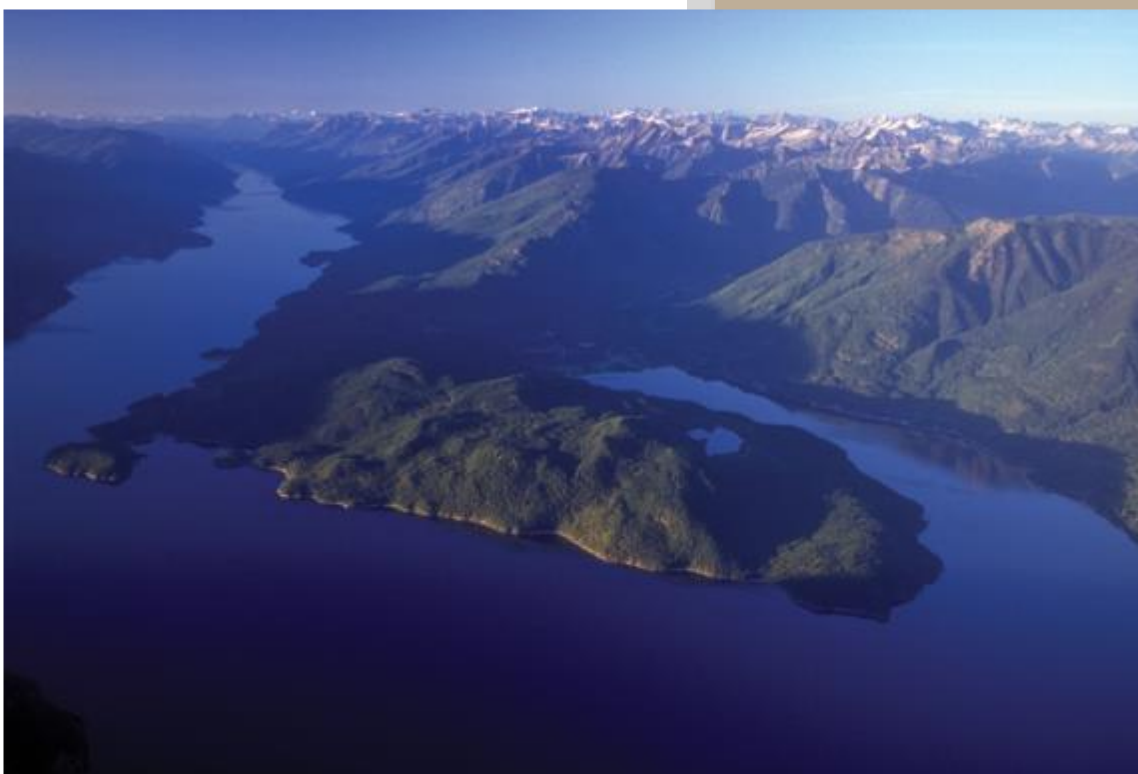
Rural Alternative Energy & Resiliency



Yasodhara Ashram and the Kootenay Lake Eastshore

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ABSTRACT

This report was assembled with generous support from:

The Rural Development Institute
Teck Service Internship
Yasodhara Ashram and Retreat Centre
(Jayne Boys as mentor)
Selkirk College Renewable Energy Certification Program
and the Eastshore Communities of Kootenay Lake (locally referred to as "the Eastshore")

Energy resilience is an issue of major local concern in many areas of rural BC. The Eastshore is one of many examples of a community vulnerable to frequent outages in BC. This report looked at alternative forms of energy and heat generation to supplement grid energy, in effect diversifying and strengthening our provincial grid. Means of storing and substituting community generated energy for grid energy during outages were also looked at.

This report is a compilation of information from research and methodology laid out in the project plan, and was guided by informal interviews with Riondel residents and meetings with Yasodhara Ashram groups.

1.0 Mandate and Background

The Eastshore region is geographically remote, and as a result of its location at the far end of a single phase line on the Fortis utility grid, is prone to frequent and extended power outages. Economy on the Eastshore is driven by small business and outages are a disruption to the local economy, closing businesses and shaping the livelihoods and lifestyles of people who live here.

The aim of this project is to address the issue of energy resilience on the Eastshore of Kootenay Lake by looking at both community and household level options for distributed generation. The focus is on alternative and renewable sources of energy. Suitable solutions were identified through a combination of research and community engagement including meetings and tours. In addition to this report, an informational booklet was published for the use of local householders and communities.

YASODHARA BUILDING LEGEND	
Buddha Loka	Residence with basement workshop and wood stove. 1600sqft.
Krishna Kutir	Timber framed split level farmhouse circa 1970, with tin roof. 1500sqft.
Mandala House	Multi-use public building with classrooms, office space and kitchen, with concrete sides and roof. 10,000sqft.
Many Mansions	10 bedroom lakeside timber residence with asphalt roof and concrete ground floor. 2100sqft.
Parvati House	3 bedroom timber lakeside cottage, with asphalt roof. 1200sqft

1.1 Outcomes

Outcomes were chosen to guide progress.

A. **Desired Outcome**: Assemble guide of prototypical solar photovoltaics and a small hydro system that could be replicated within the Eastshore limitations of income and access.
   Implementation: Documented solar PV system scenarios in all sizes. See Booklet.
B. **Desired Outcome**: Produce a user-friendly report and template for Eastshore residents addressing how to work with energy conservation and renewable energy technologies.
   Implementation:
   i. See Booklet
   ii. The first step in becoming energy resilient is wiser energy use. A point of use monitor was acquired at the Ashram to measure and track electrical consumption of individual appliances.
   iii. Through the evaluation of energy use and conservation strategies, buildings were identified as being incorrectly metered for residential use rather than commercial use. Savings from switching status are potential contributions towards future energy initiatives.
   iv. Looking at the whole Eastshore community, however, there is a question about the applicability of the current pricing regime, given the shortage of viable alternatives. (Unlike, say, Vancouver, residents here do not have the opportunity of an easy switch to natural gas.)
   v. Rainwater catchment systems reduce need for electrical pumping and ensure that some water is always available in outages.
   vi. A stand-alone (off-grid) photovoltaic was investigated for provision of electricity to the Yasodhara garden.
C. **Desired Outcome**: Prepare and offer workshop or presentation to Eastshore residents on energy conservation and renewable energy technology.
   Implementation:
   i. The Eastshore Energy Resilience discussion was held by Community Connections at Gray Creek Hall in October and included a presentation of the findings from this report.
   ii. Renewable energy (RE) technology tours were advertised and offered at Yasodhara during the Strawberry Social and 50th Anniversary Celebration. These tours covered technology in use as well as options and potential for further energy diversification. Local people attended and were encouraged to query the tour and think about applications of RE technology at their own homes.
   iii. Presentations were made to the Ashram's Renewable Energy Hub and to the Ashram's Land and Infrastructure Planning committee. These focused on options for energy conservation and resilience through diversification of energy through renewable sources.

1. 2 Methodology

The following tasks were chosen to support exploration and scoping of the options available for greater energy independence, looking specifically at renewable energy systems. Yasodhara Ashram hosted the project. A number of its buildings and outdoor spaces were used as representative of the area for different aspects of this pilot study (See Legend, page 2).

Method	Action
Complete a residential and community energy audit (consider the needs and interests of the Eastshore community for independent energy production)	Informal interviews took place with community members and Ashram groups. Renewable energy tours of the Ashram were used as opportunities to consult on needs. Eastshore Resilience Discussion was hosted by Community Connections and identified key concerns for future. See: *Section 1.1 C*
Perform a cost benefit analysis of various energy conservation strategies and provide recommendations on how to improve energy resilience.	See: *Section 1.1 A. Outcomes to date* *Section 2.6 Conclusions* *Section 2.7 Recommendation (III) Conservation* *Figure 2.Alternative Heat and Power Cost-Benefit*
Evaluate applications and limitations for solar photovoltaic cells and hydro generators on the Eastshore.	See: *Section 1.1 A. Outcomes to date* *Section 2.8 Recommendations* *Figures 6, 7, 10, 11, 12, and 13*
Assess when and where their installations make economic and/or environmental sense, estimate the cost of system installation.	See: *Section 1.1 A. Outcomes to Date* *Section 2.3 Photovoltaic* *Section 2.6 Conclusions* *Annex 3. Figure 2. Energy Sources Summary*
Assess the Eastshore quantitatively for solar photovoltaic cells and small hydro systems.	See: *Section 2.3 Photovoltaic* *Section 2.2 Micro Hydroelectric*
Design and build prototype solar PV and small hydro system that could be replicated within the Eastshore limitations of income and access.	The hydro option showed poor results. A different site would improve outcome. See: *Section 2.2 Micro Hydroelectric* Options for small off grid garden or Parvati rooftop PV as prototypes were investigated. See: *Section 2.3 Photovoltaic* *Figure 15. Passive Solar Water Heating* *Figure 16. Off Grid PV for Garden* *Figure 17. Rainwater Catchment*

SECTION 2: FINDINGS

2.0 Wind Resource: Least Feasible in the Kootenays

Mountain ranges are not generally good places for wind turbines owing to surface roughness (trees) which cause friction, and the topography of mountain ranges which slows wind and causes turbulence. The exception is wind turbines on mountain tops which can be worthwhile considering, particularly when the mountaintop is already accessible by road and within reach of either energy storage facilities (batteries), or a point of connection to the utility grid (more likely).

Wind speed data has been gathered through a pole mounted anemometer since 2011 in the Yasodhara Ashram garden. This showed that wind speed is sufficient to begin spinning a mini turbine (rated at 2.5 m/s) approximately 10% of the time[1]. During the time the turbine is moving, there is little to say it would produce enough energy to offset its own capital cost, in this location, within the foreseeable future.

However, if there were community interest, the anemometer could be relocated to collect a sample years' worth of data at a hilltop location such as at the Peak of Bluebell Mountain.

2.1 Biomass: Feasible with Quickest Payback

Wood Pellet heat is a financially sound option for those willing to keep up on maintenance[2], with most household pellet boilers and stoves expected to pay themselves off in savings within 4-10 years. It is worthwhile noting that while stoves are space heaters primarily and most effective with large rooms and open floor plans, boilers are integrated into whole home heating systems and can be installed in the place of oil or electric boilers with moderate simplicity. With a boiler, the manner by which heat is distributed within the home or building does not need to be modified necessarily. Pellet boilers can heat by means of radiant floors, baseboard radiators and any other hydronic circulation heating systems.

On the subject of carbon neutrality and sustainability, pellets are made from compressed wood waste, have low moisture content, and 3-4 times the energy contained in the equivalent weight of cordwood. Pacific Carbon Trust identifies wood pellets as a by-product of the forestry industry; they rate pellets as a carbon neutral source of heat, without accounting for shipping. Shipping of pellets can be offset through purchase of carbon credits if desired. In this area future consideration could be given to acquiring a small scale pellet compressor to have assurance of price stability and long-term supply.

Boilers can also be obtained which have the capability of burning wood chips needing less processing, or a flex-fuel wood chip/pellet burner. These flex-fuel boilers suffer a slight loss of efficiency, and the transition between fuels requires componentry being switched out which implies some mechanical know-how.

Stoves, pellets and expert consultation are all available at the Grey Creek Store.

Further reading:
Section 2.4 What Can an Eastshore Household do?
Figure 2. Alternative Heat and Power Cost-Benefit

[1] Wind data showed ability to turn a standard wind turbine 2% of the time.
[2] Maintenance of pellet boiler includes weekly cleaning of ash tray and auger, and regular hopper refills.

2.2 Micro Hydroelectric: Consistent, Long Term Power

A hydroelectric facility will generate electricity dependably, day and night, unlike solar or wind. This is one of the most reliable sources of energy when a suitable site is available[3]; it is also one of the most capital cost intensive. The capacity of a facility is determined by the flow of water available through a yearly cycle. Only a percentage of water may be diverted from any creek or river in order to protect ecosystem health. This ratio is determined by an environmental assessment.

The Eastshore has exceptional potential for micro hydro as a result of the vertical drop (also referred to as head) available. Riondel has two creeks which provide drinking water to the town. Indian Creek is a year-round fish bearing creek, which makes environmental approval of a new structure more complicated. However, the existing pipe supplying water could be looked at and assessed as candidate for the integration of a turbine, without affecting the towns' water supply. Hendrix Creek is not recognized as a fish bearing creek and could be a source for hydro-electric generation as well. Further hydrological surveys would be needed to determine capacity and generation.

At Yasodhara Ashram an experimental weir installed on Krishna Creek in 2012 was read daily over the past year. During spring and fall, flow shows terrific potential; however during the summer and parts of winter the creek all but dries up. Considering the high capital cost of installing a hydro turbine and given that a turbine on Krishna Creek would generate energy only part of the year, the monitoring project has been retired.

2.3 Photovoltaic: An Uprising, Needs Political Initiatives

Photovoltaic (PV) solar panels have made enormous advances in efficiency and come down in price significantly over the past 10 years. Unfortunately, accessibility to this promising technology is still largely dependent upon grants and subsidies. Without these, the PV industry in BC has struggled to establish itself. The consequence is while technologically feasible and common in other parts of the world, it is seldom financially feasible for a household in BC to generate electricity with PV[4]. Municipalities and groups of people have more options for leveraging funding.

Off-grid applications are a slightly different story. The BC Sustainable Energy Association advises that if you are looking at spending more than $20,000 on power lines to have your home connected to the grid, that you consider PV combined with other forms of renewable energy first (BCSEA, 2013).

Further reading:
Figure 4.Pay-back time on Investment
Figure 5. *Cost per KWH over 10 Years*
Figure 14.*Solar Direct Water/ Sewage Pumping*

Home Sized PV

Parvati House was among buildings assessed for photovoltaic at the Ashram. It is presently the first choice of location for PV at Yasodhara given several key features: proximity to an electrical panel at Mandala House,

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[3] Suitable site: creek or river persists year round, is not habitat for fish or at risk species, is deep, has significant vertical drop between intake and turbine locations, and is accessible by road. Formal hydrological assessment typically takes at least one year.

[4] The exception is if panels are bought wholesale online and the homeowner is qualified to install them.

a large accessible roof, and a south facing aspect. However assessment with the Pathfinder[5] found that 11-12 trees were blocking winter light and needed removal before installing an array which could be productive year-round. Winter light was an unfamiliar discovery in this context and many were surprised to realize the implications of low-to-the-horizon winter sunlight.

Further reading:
Figure 8. *and Figure 9. PV assessment at Parvati House*

Riondel Community Centre PV

The Riondel Community Centre, as a publicly owned building, is uniquely positioned to receive funding for joint energy conservation and renewable energy generation funds. The building is also a great candidate for solar owing to a clear south aspect with unusually little shading on account of its location adjacent to Riondel's play fields.

Further reading:
Figure 13. Riondel Community Centre Rooftop PV Assessment

2.4 What Can an Eastshore Household do?

Parvati House at Yasodhara Ashram is a 3 bedroom home comparable to other year-round or summer cottages on the Eastshore; it is currently being renovated and is planned primarily for short term retreats.

Of all the options for conservation and energy efficiency, the most sensible by far in this situation was insulating exterior walls as well as the floor and roof to the maximum level achievable in the space available.

Heating:

Heating was a primary consideration. Among the possibilities weighed for Parvati were a geo-exchange extension from a nearby supply, an air source heat pump, condensing boiler, wood pellet fired boiler, or electric baseboard:

Geo-exchange extension

A Geo-exchange extension is an attractive option if infrastructure is already in place and nearby, as it is at Yasodhara's main building, Mandala House. Upon review of this option however, it was discovered that an extension from the geo-exchange system at Mandala House would require digging a 50 ft long trench through bedrock, which would be costly and highly disruptive.

To install geo-exchange from scratch is generally out of reach financially on a residential level, although prices continue to drop as the technology is used more widely. Notably, geo-exchange is used increasingly often for school heating, as horizontal ground loops are convenient to lay under playing fields during construction. The BC Ministry of Agriculture has also published a feasibility study for geo-exchange in agri-food operations. (2011, retrieved online: www.bcac.bc.ca/sites/bcac.localhost/files/Geoexchange%20in%20Agriculture%20Study.pdf).

[5] Solar Pathfinder. Has a reflective plastic dome to display a panoramic view of surrounding area, in combination with sun path diagrams specific to the latitude of the site, allowing diagraming shade at any time of the year.

Wood Pellet (Biomass) Boiler

For Parvati the pellet boiler was decided against as the necessity of refilling the hopper with pellets wouldn't be favorable to guests' privacy. In many households however a wood pellet boiler could be a very attractive option. Yasodhara has several other buildings which are ideal candidates for biomass heat, notably Buddha Loka/the workshop, and Krishna Kutir. Biomass boilers are simple to install in place of other boilers and cost from $1000 - $10,000 depending on use, size of building heated and additional functions desired such a flexible fuel capability.

> Further reading:
> *Figure 2. Alternative Heat and Power* Cost-Benefit
> *Section 2.1 Biomass: Feasible with Quickest Payback*

Instant Heat Boiler, and Air Source Heat Pump

The instant heat condensing boiler and air-source heat pump were both financially and environmentally attractive options but were not possible on account of a shortage of trained installers available for site visits within Parvati renovation's timeframe. An instant heat boiler would have been a good option, especially given grants offered to assist, had natural gas been available.

(Fortis BC has offered an excellent rebate program for residential installation of air-source heat pumps and commercial installation of condensing boilers. Condensing boilers however must be natural gas in order to qualify. This is not currently available on the Eastshore.)

The electric tank-less water heater was decided against on performance grounds. Parvati will be furnished with two tub/shower bathrooms; the tank-less heater was considered a gamble, and possibly insufficient to cope with the load. An electric tank-less heater would be a great option in a one or one-and-a-half bathroom house.

Electric Baseboard

Electric baseboard carries with it the benefits of low cost installation, readily available installers, and the convenience of familiar equipment. This, combined with site-specific factors of a high standard of insulation at Parvati, which would forecast lower heat requirements, and the prediction of minimal winter usage of the building, made electric baseboard heat an appealing option for Parvati.

Solar Thermal

Solar thermal deserves a mention here despite not being investigated for Parvati. These panels generate heat, not electricity, and have the advantage of employing ambient air temperature, rather than direct solar radiation as solar PV panels do. Hence solar thermal panels are less severely affected by shading, although their performance is optimized in full sun conditions.

A back-of-the-envelope quote given to Yasodhara Ashram for solar thermal panels estimated that for $10,000 an area the size of Many Mansions and the Temple combined (roughly 4000sqft) could have half its heat requirement met by solar thermal panels year-round (quote received August 2013). This approximates to a pay-off period of less than 6 years.

> Further reading:
> *Figure 2. Alternative Heat and Power* Cost-Benefit

2.5 What can the Eastshore Community do?

Community energy involves taking greater responsibility for energy consumption by inviting both the compromises (environmental and otherwise) as well as the benefits (economic and social) into the local system. When there are power outages, businesses close, food spoils, and even households have to have their own generators. For a comparison of emergency needs to energy resources, See *Figure 1*.

A local energy generation scheme (such as PV or micro hydro), when combined with a battery back-up, would provide energy to save food in cold storage and allow businesses to stay open during outages. Generation and storage (batteries) can be installed at the same time or one following a trial period of the other. This means that alternative energy can be explored for generating power (such as hydro or PV), and an energy storage bank for outages can be installed at the same time to compliment, or follow later on.

The Eastshore community has a distinct advantage on account of the relationships built here through other collaborative-thinking enterprises and local activism, such as Community Connections, Food Roots, the building and financing of Crawford Bay School, and the weekly summer Farmers Market to name a few.

Energy could go forward as a subcommittee in an established group. In this format, as a community venture, energy projects can be eligible for grants and low interest loans from a variety of sources. Securing these funds is a matter of doing groundwork and planning ahead of time to be ready with proposals when funding is announced.

Further reading:
Figure 6. Funding for Communities and Municipalities
Figure 3. Options for Power during Outage
Figure 7. *Community Energy*
Figure 14. *Solar Water and Sewage Pumping*

Figure 1.

<table>
<tr><th colspan="5">Needs in Emergency / Alternative Supply Sources</th></tr>
<tr><th></th><th>Solar PV</th><th>Wood Pellet</th><th>Micro Hydro</th><th>Gas Generator</th></tr>
<tr><td>Water and Sewage Pumping</td><td>DC-direct PV to pump: refills reservoir in daylight, even in outage. No need for batteries</td><td>No</td><td>Yes</td><td rowspan="4">Yes to all. Traditional outage option. Need to have propane.</td></tr>
<tr><td>Heat</td><td>No</td><td>Yes. Can use pellets or chips with flexible boilers - increases resiliance</td><td>With enough electricity produced can provide electric heat.</td></tr>
<tr><td>Light and Electricity</td><td>Need batteries - more expensive than generator</td><td>No</td><td>Yes</td></tr>
<tr><td>Community Relief Centre</td><td>Potential to provide during long term outage</td><td>Needs a source of electricity for controls</td><td>Would need batteries to use power during outage</td></tr>
</table>

2.6 Conclusions

These findings support the claim that hydro, solar and biomass technologies can be feasible here on the Eastshore. Projections differ when looking from individual to community options, and between technologies. This reflects the truth that these installations, while able to be generalized in a report such as this, will always rely on technical details specific to site, location and access, for true feasibility.

For individual households, the broad statement that can be made is that biomass (wood pellet) heating will pay off its capital cost relatively quickly, then become cheaper than electric or oil heat. Photovoltaics are effective, although initially costly. Then again, with calculations adjusted for projected rising cost of electricity from the utility (Fortis) PV's are able to generate an income and pay themselves off within their lifetime. PV, if nothing else, should be watched as price continues to drop.

For groups, community managed micro-hydro and/or photovoltaic installations are completely viable for energy production. When combined with community support, funding and ownership, these projects and the communities backing them will benefit from a host of outside funding options including clean energy grants and innovative start up grants.

See: *Figure 6. Community Funding*

One of the unique limitations to energy efficiency on the Eastshore is the absence of natural gas, which has a number of financial installation incentives and energy efficient appliances out now. The absence of natural gas makes the case for renewable energy better, particularly when looking outside for funding.

All of these technologies are widely used and proven in other parts of the world, particularly in Europe. However, in Canada, most technologies require a good dose of creative drive and innovative thinking simply because they are less widely recognized. Establishing a foundation with questions like, "How much energy does the home or community use and where?" and, "where is energy lost?" provides a launching point for investigation into alternatives.

2.7 Recommendations for Yasodhara Ashram

Some measures can and need to be taken immediately to ensure functioning in an outage. A combination of generators, batteries, and heating upgrades in strategic locations are the recommended first steps.

I. Yasodhara Ashram Water Supply: Water is crucial. Current responses to fire and power outage emergencies at the Ashram are labour intensive and reliant on old, noisy technology. Either PV's or new generators would perform well in their place. Ashram pumps are in shaded locations less conducive to PV installation and so generators are recommended.
Recommend: Invest in an automatic ignition generator to power effluent and lake pumps during outage.
Cost: water pump backup: $4979 = $2399 for generator plus $2580 electrical installation
Cost: effluent pump backup: $3959 = $2099 for generator plus $1860 electrical installation

See: Figure 3: Options for Power during Outage
Annex 5. Gen 3-4. Lake and Effluent Pump Quote

II. Mandala House Backup:

There is a need for essential supply to the freezer and fridge, as well as lights during outage. An uninterrupted power supply system (UPS) capable of powering Mandala House would supply instantaneous essential energy in outage. This could be expanded on to include a diverse blend of battery, photovoltaic, and propane (tractor mounted) generation.
Recommend: A battery UPS providing 11 hours backup and the foundation for growth of a system independent of the grid and fossil fuels.
Cost: $13,820. ($8400 materials, $1000 installation, $4920 wiring, minus $500 Ominica consulting fee rebate)

See: Figure 3: Options for Power during Outage. "Batteries Line 2 - $8400 Ominica"
Annex 5: Battery 1: Ominica Solar

III. Yasodhara Ashram Conservation:

Conservation is the most cost effective way to reduce grid energy use. The Ashram can track electrical usage with the kill-a-watt monitor.
Recommend: Designate one person to manage energy. This person takes readings at outlets and moves monitor weekly, mapping energy load within sub sections of Ashram. Keep track of usage by outlet, taking note of what is plugged in. A power bar can be plugged into the kill-a-watt for heavier use areas. This information can be used to compare devices at the Ashram amongst themselves and against energy star rated appliances, as well as analysed to make recommendations: adjusting usage, turning off phantom loads, and replacement with energy efficient models where upgraded energy savings are significant.
Cost: Human Resources; replacement appliances.

IV. Yasodhara Heating and Conservation: Three points

A) The very best way to improve overall heating efficiency is to upgrade insulation wherever possible.
Recommend for entire Ashram: Take advantage of any opportunity to upgrade insulation in buildings.

B) Buddha Loca and Krishna Kutir are both electrically heated and relatively easy retrofits for wood pellet heating. Some modifications would need to be made, for instance Buddha Loca would need ducting installed in upstairs rooms to circulate heat. These modifications may be worthwhile in terms of energy savings and increased resiliency.
Recommend for Buddha Loca and Krishna Kutir: 1) Consultation with biomass professionals for quotes and system designs specific to Ashram buildings.
See Figure 2. Alternative Heat and Power Cost-Benefit.

C) The Ashram could also look into a combined wood pellet / solar thermal heating system for Many Mansions and the Temple as a more energy efficient (thus resilient to change) approach to heating these buildings.
Recommend for Many Mansions and Temple: Further research into a solar thermal and wood pellet combined system for the Temple and Many Mansions.
See Figure 2. Alternative Heat and Power Cost-Benefit.

2.8 Recommendations for Big Picture Resilience

Big picture resilience includes technology which may be more costly and require planning ahead, such as the collaboration between neighbors required to organize and apply for grants in order to use biomass or PV's on a community scale.

Eastshore Community Energy Connections: Establish a committee of residents interested in moving energy discussions forward and developing a plan for increased resilience. One of the first steps for a coalition like this could be developing a "community energy plan" (also known by the acronym CEP) This would be similar to a municipal plan, but focused on energy and used to engage local residents in discussion and move ideas into the community. A CEP starts with itemized local present energy use. Next step is planning for conservation and reduction of use, and lastly, the implementation phase: making the transition to renewable sources.

Grant spotting: Preparing for the implementation phase of a CEP. Yasodhara Ashram, as a not-for-profit entity, and the Riondel Community Centre as a municipal building, can qualify for grants and loans to install energy offsetting and storage technology and become emergency hubs as well as educational centres for the community. In the case of either Yasodhara or the community centre this might be structured, for example, as a co-operatively owned venture, further inviting public involvement.

See Figure 6. Community Funding

Micro Hydro: Hendrix or Indian Creek could be assessed for flow and suitability of a turbine on intake pipes. Any other creek could be fitted with a weir to monitor seasonal fluctuation. Monitoring and assessment of waterways other than Krishna Creek was not within the means of this project. A micro-grant could be applied for to cover costs of monitoring (installing weir). Yasodhara could offer their weir for relocation to one of these creeks.

Yasodhara Ashram: Mandala House could be proposed as an Emergency Relief Service Centre for the Eastshore region between Crawford Bay and Riondel. In the event of a major outage or disaster it is halfway between these small towns and accessible by road or water. In the proposal, infrastructure needed would include an uninterrupted supply battery backup system (UPS) capable of powering Mandala House for 24-48 hours in combination with a photovoltaic panel array to replenish energy in the batteries. The propane boiler would be used for heat. There are large stores of food and floor space for upwards of 300 people to sleep. The benefit to having a grant supported UPS would be to allow a buffer of automated resilience between the community and the grid, allowing flexibility to attend to immediate needs within the Ashram or Eastshore community.

Further Reading:
Figure 3. Options for Power during Outage
Figure 6. Community Funding
Figure 7.*Community Energy*

SECTION 3. APPENDIX

3.0 Annex

Technical Contacts.

Cory Peck, Ominica solar. Nelson BC. http://ominecasolar.com/.
Solar PV panels.

Darren C Anderson. Solar electric light fund (SELF). Vancouver BC. darren@self.org.
Solar PV including off-grid.

Adam James, Spectrum thermal. Trail BC. getadam@shaw.ca.
Solar thermal panels, geo-exchange expansion.

Kevin Pegg, Energy alternatives. Telkwa BC. http://www.EnergyAlternatives.ca. "Cabin lights kit," off-grid for garden.

Northern outdoor energy systems. Prince George BC. http://northernoutdoorenergy.com/. Wood Pellet boiler quotes for various sized buildings.

Gord Bullen, Advanced wood heat. Blind Bay BC. http://www.woodheating.ca/index.htm. Pellet boilers for temple.

Jason Organ, EB horseman & son. Cranbrook BC. http://ebhorsman.com/. Battery back-up for Mandala House.

Zac McCormick, McCormick heating. Nelson BC. Heating advisor for Parvati.

Lance Ogden. Canadian sheet metal. Creston BC. Air source heat and cooling for Parvati.

3.1 Tables and Slides

Figure 2. Alternative Heat and Power Cost-Benefit

Installation Type/ Name	Energy produced / method	Potential usage/ locations	Capital Cost of Suitable Unit(s)	Capacity/ output per annum	Running Cost (if any)	Current Cost per annum	Annual Savings	Installation Cost	Notes
Geothermal extension	Radiant heat from MH	Parvati	$2,600	11,000 kw heat	$0	$990	$990	require digging 4 ft deep 50 ft long trench through bedrock $10,000?	Disruptive installation
Photovoltaic (PV) Solar Panels	Electricity from solar light, fed into grid	Garden off-grid	$6,000	620 kW	$0	$56	$56	0	*See Figure 16.* Could consider buying a small system similar to this on E-Bay & self installing.
		Parvati small	$13,110	2920 kW	$0	$263	$263	included	*See Figure 8. also annex 5. Figure 1.* Panels also have resale value.
		Parvati whole roof	$32,650	8760 kW	$0	$788	$788	included	*See Figure 9. also annex 5. Figure 2.* Panels also have resale value.
	PV panels and Batteries storage of electricity for outages.	Small PV array on Parvati and small battery bank for outages	$21,510	2920kW	$0	$263	$263	$5,920	Quote from Ominica. Batteries alone ($8400) supply 11 hrs backup on 2 kW draw. Plus panels "Parvati small" ($13,110) charging simultaniously.
		Large Pasture PV array and battery backup for long-term resilience	$180,000	Supply 60kWh avg per day : 21,900kW pa	$0	$2,190	$2,190	Batteries need a heated place. New building likely.	This is my estimate based on avg price per kW. Corys prices often below avg. This scenario, and pricing, are still in process.
pellet stoves	heat for water heating systems	Temple	$6,700	24,200	$746	$2,178	$1,431	$5,000	Assume price $150/ton of Pellets. 900 outdoor pellet from northern outdoor. Have electrical as backup
		Temple & MM Combined	$8,850	43,400	$1,338	$3,906	$2,567	$8,000	1100 pellet from North Outdoor. Underground lines to each building
		BL / Shop (Indoor Flex-fuel unit)	$9,120	17,000	$524	$1,530	$1,005	$5,000	Flexfuel 30. Indoor cordwood or pellet. 300lb hopper & tank $750
		KK	$6,700	19,500	$601	$1,755	$1,153	$2,000	Same boiler as proposed for Temple
Solar Thermal Panels	Heat for water heating system	Temple/ MM	$10,000	23,870	$0	$3,906	$2,148	$1,000	BOE quote from Adam - heat around half
Solar Coil	Passive water warming	Garden Wash Station	$0	$0	$0	$0	$0	$0 - handyperson project	*See Figure 15.* Ashram already has PEX pipe. Would cost approx $500 otherwise.
Rainwater Capture	Avoid use of electrical pump	Various. Near ornamental gardens.	$0	$0	$0	$0	$0	$0 - handyperson project	*See Figure 17.* Depending on intended use of captured water, can use recycled (free) car wash barrels, or buy food grade barrels ($100+ ea)

Figure 3. Options for Power during Outage

Installation Type/ Name Produced/Method	Potential usage/ locations	Capital Cost of Suitable Unit(s)	Capacity/ output pa	Running Cost (if any)	Annual Saving	Installation Cost	Adjusted Cost	Notes
Batteries *None of these quotes include PV Panels. All **can** be attached to PV .*	Mandela House UPS (uninterrupted power system)	$9384 EB.Horsman	4 hrs backup at 1kW draw	charging from grid $.10 kWh	have power during outage	installed by supplier + $4920 electrical	$14,304	*See annex 5. Battery 1.* Quote from EB horsman in Cranbrook. Can be plugged into generator.
		$8400 Ominica	11 hrs backup at 2kW draw.	charging from grid $.10 kWh	have power during outage	$1000 installation + $4920 electrical	$13,820	Recommended in *AE Report, sec. 2.7, II. Also see annex 5. Battery2.* Quote from Cory, Ominica Solar. Can be plugged into generator to recharge in extended outage.
		$22,000 (ballpark)	24 hours power before needs charging	charging from grid $.10 kWh	No direct income from battery. Power for Mandala House during outage - fridge, freezer, some lights, some office and kitchen outlets. Propane boiler is used for heat.	Turlocks: $4920 + installation $1k	$27,920	**50 - 100 batteries under MH** (quantity depends on type of battery, price stays about the same regardless)
		$80,000 (ballpark minimum)	2-3 days power before needs charging	charging from grid $.10 kWh	have lots of power, capacity to cope for several days in an extreme winter crisis & help neighbours.	Turlocks: $4920 + installation $2k	$86,920	**200-400 batteries under Mandala House** (quantity depends on type of battery)
Generator Electricity from propane	MH fully functioning	$9,800	22kW per hour	propane	can power fridge and freezer, capacity to cope in an extreme winter crisis	$4,920	$14,720	*See Annex 5. Gen 2.* Home Depot quote
	Lake pump option 1	$2,399	15kW (to run both lake pumps simultaniously in case of fire)	gasoline	have water and sewage during outage	$2,580	$4,979	*See Annex 5. Gen 3-5.* **Will need two generators. For effluent: one 10kW. For lake: one 10 or 15kW.** Home Depot Quotes. Installation quotes from Turlock.
	Lake pump and/or Effluent pump option 2	$2,099	10kW	gasoline	have water and sewage during outage	$1,860	$3,959	
	MM/ tractor attachment	$5-9k	9-20kW depending on model	fuel for tractor	place for residents in winter, capability to keep other buildings from deteriorating in a severe event	0	$5-9k	could be moved elsewhere as necessary, longer term options for MM include solar thermal & pellet stove
	Root Cellar	$595	2.2kW	gasoline	save food in fridge/ freezer during outage	0	$595	Home depot. Hyundai 2200W Inverter generator. Quiet, elec ignition(?) fuel efficient
		$249	1.2kW	gasoline	save food in fridge/ freezer during outage	0	$249	Home Depot. Powermate 1200Watt Portable Generator Manual Start, probably loud

Figure 4.[6]

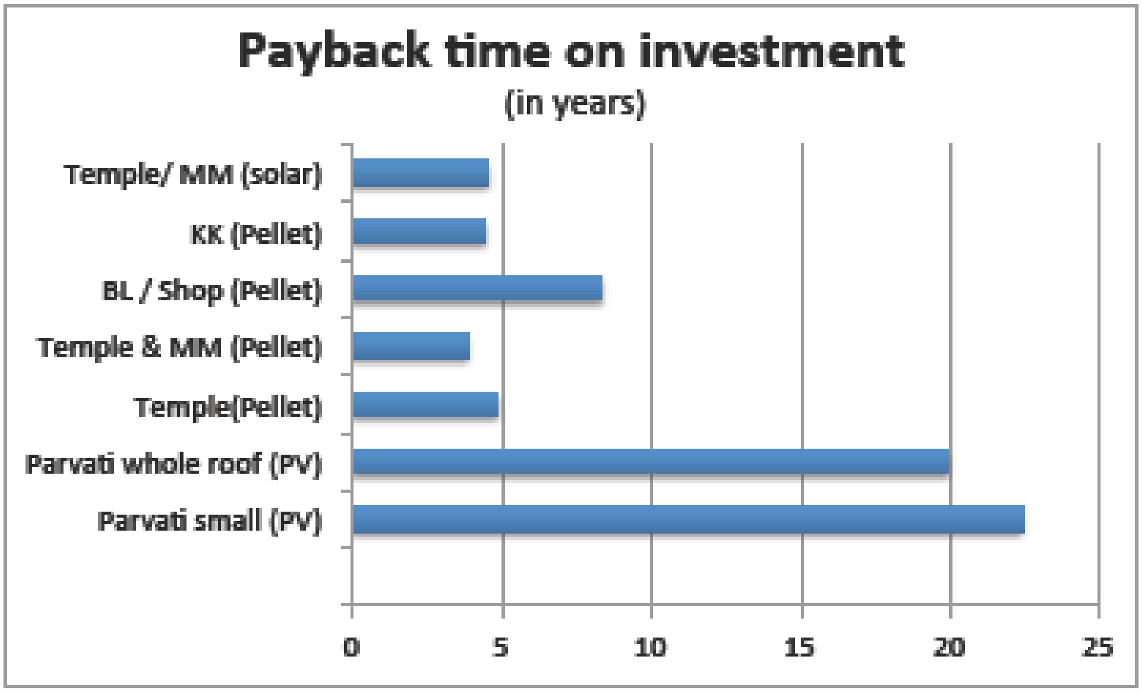
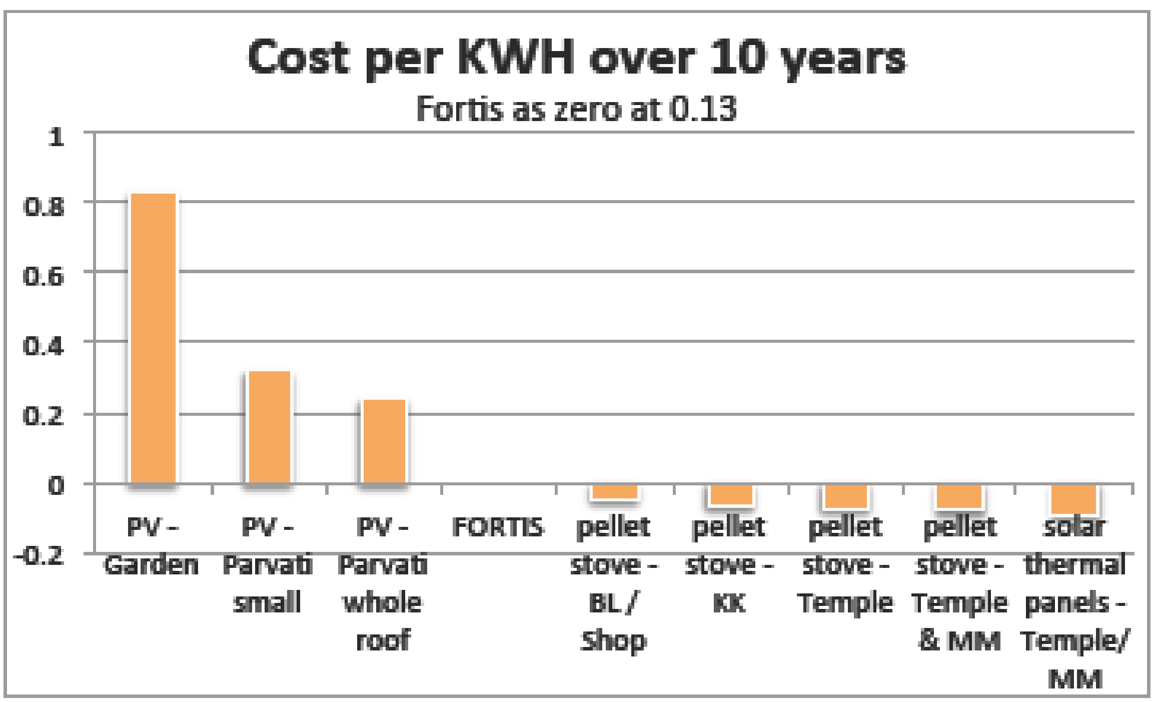


Figure 5.



[6] This assumes Fortis will get currently requested price increases and that electricity will rise in price by an average of 3% pa after that, giving an average 10 year rise of 13 cents per KWH and an average 20 year price of 17 cents. (Some people are already paying 12 cents for some of their electricity.)

Figure 6.

Funding for Communities and Municipalities

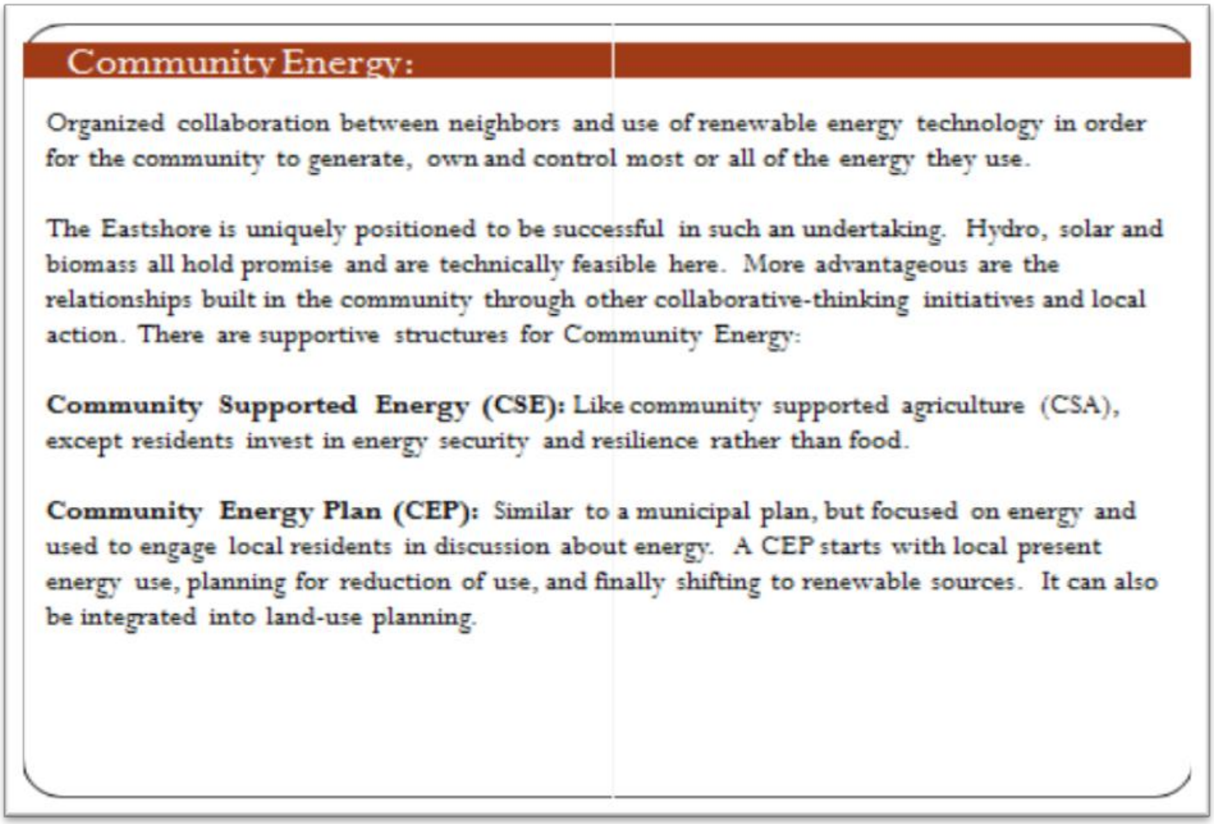
Energy projects aimed to benefit community (economically, socially, educationally or otherwise) have options for funding and financial aid. Some of these are as follows.

ICE – Innovative Clean Energy Fund.
Funded through provincial sales tax to support clean energy projects on community scale. Closed right now (September 2013).Expected to be replenished and opened to submissions in the next year or so.

Green Municipal Fund.
Supporting feasibility studies, plans, field tests and capital projects.
Energy Funding for municipal projects given project will reduce energy consumption by at least 30%. A minimum 20% of this must be from energy efficiency measures, rest can be from renewable energy technology.

Southern Interior Development Initiative Trust.
Accepting new applications starting 1 April, 2014. Community expected to have matching funds.
Priorities: Contribute towards economic stability of small communities through regional benefit, job creation and economic diversification

Figure 7



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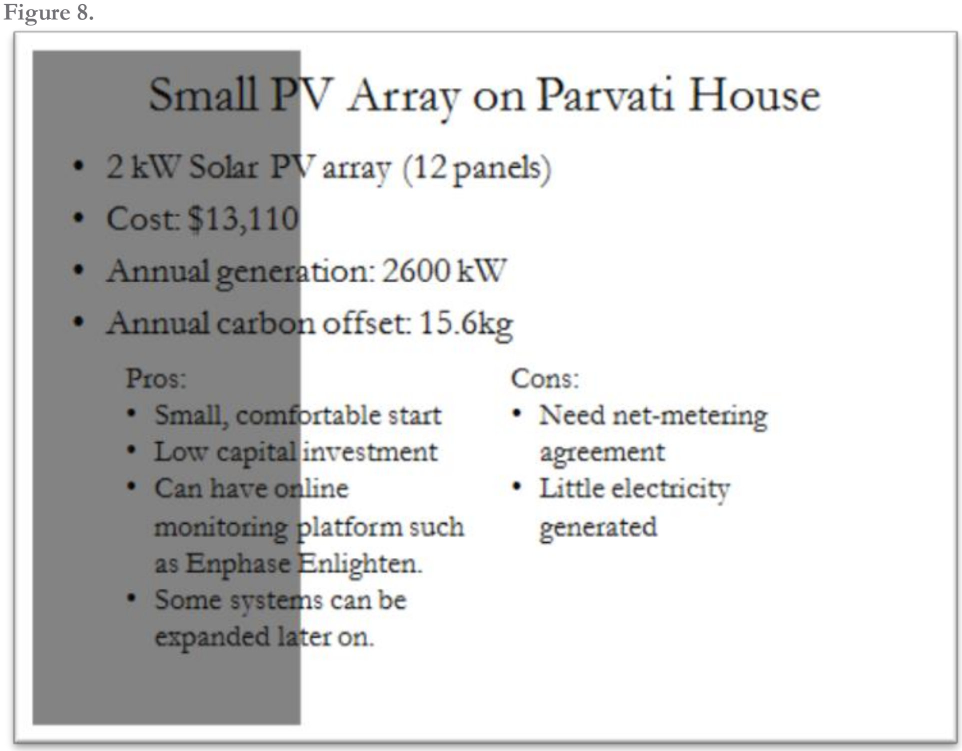

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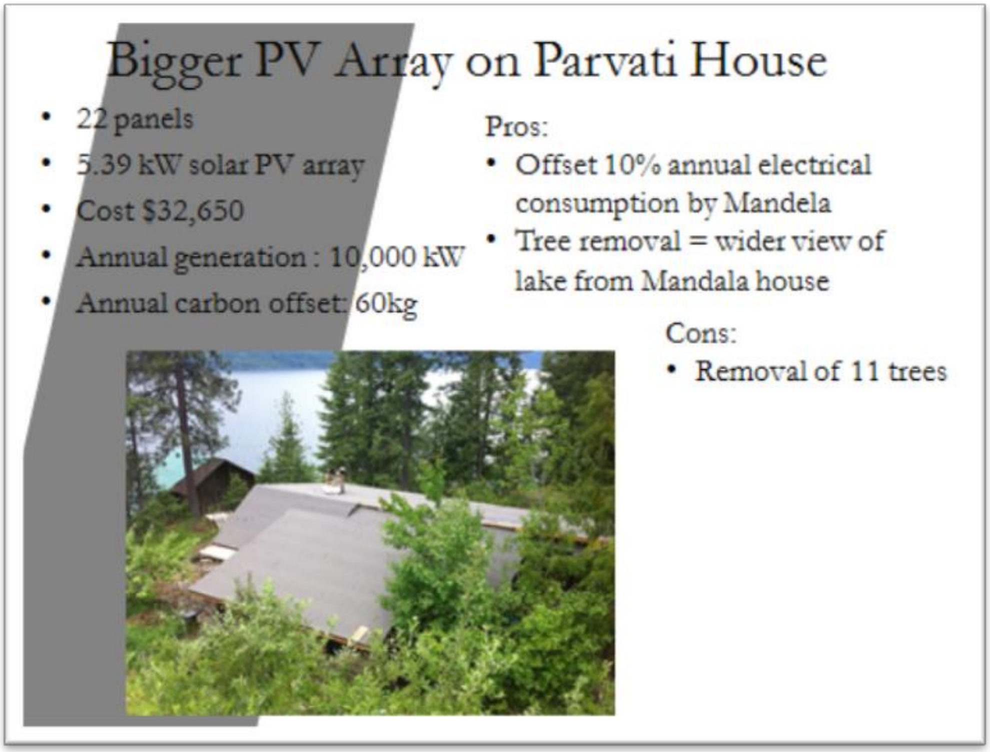


Figure 10.

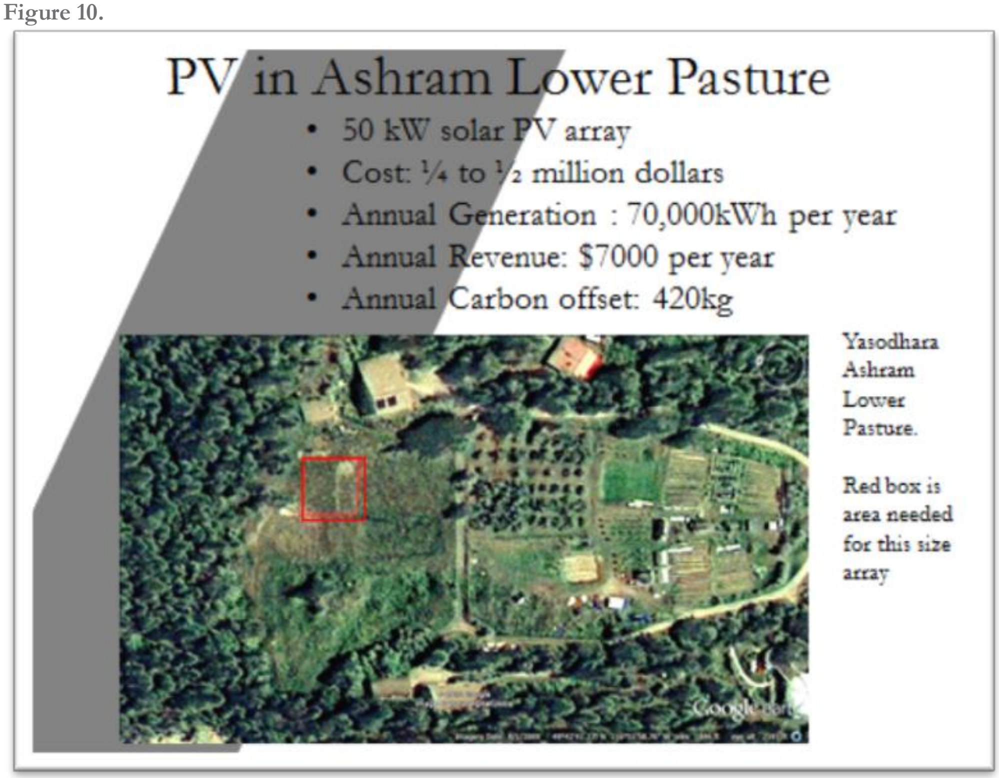


Figure 11.

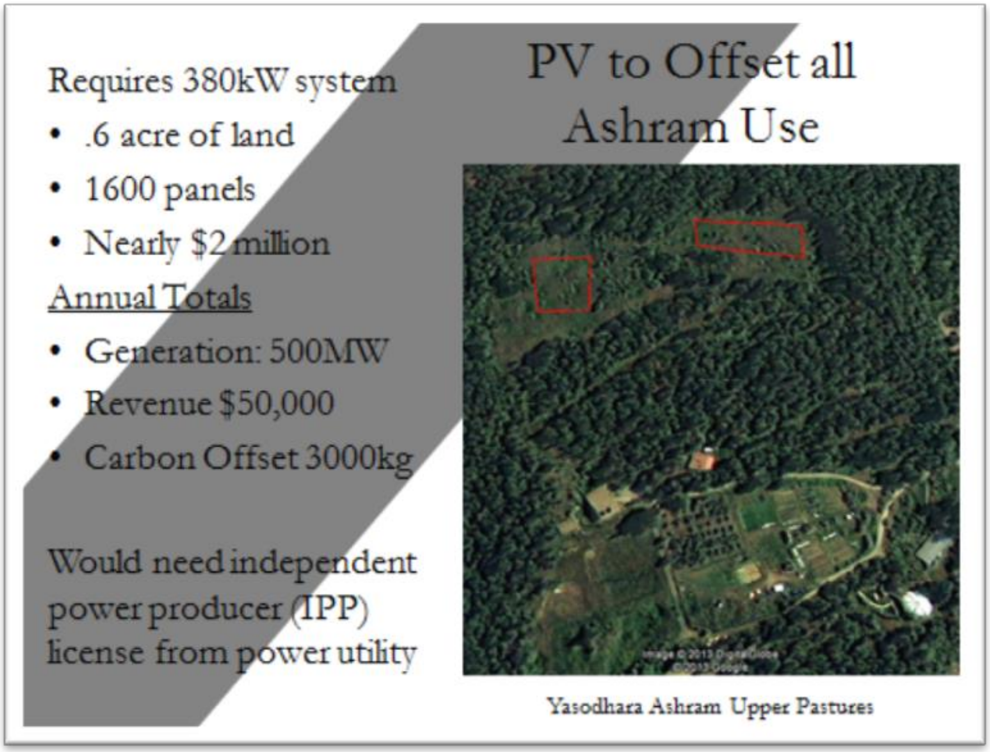


Figure 12.

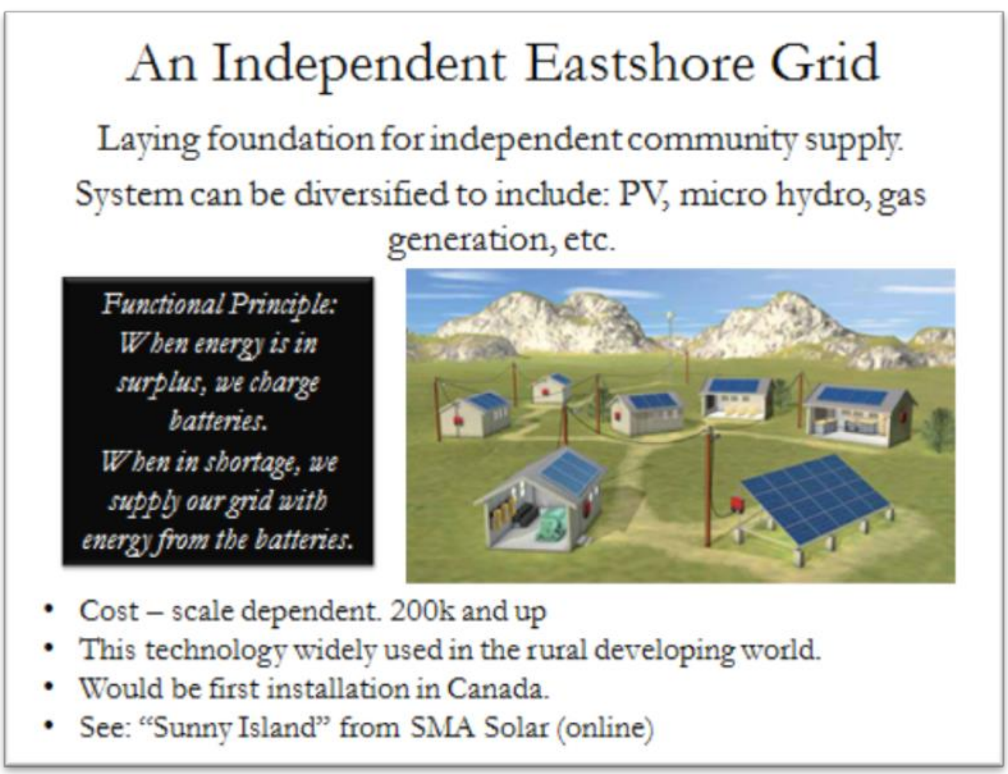


Figure 13.

Riondel Community Centre Rooftop PV

- The area highlighted is 15 x 20 meters, flat asphalt roof
- Roof is 12 ft. high, accessed by ladder
- South aspect is surrounded by play fields with very minimal shading.
- The highlighted area could support up to 250 panels, a 37.5kW photovoltaic array generating around 50,000kWh per year
  - Equivalent to what 3 average households use in a year.

- Electrical savings per annum = $4435
- BOE installed cost approx. $150,000
- This project would be eligible to apply for Innovative Clean Energy or Green Municipal grants.
  - See funding …

Figure 14.

DC-direct
Solar Pumping for Water or Sewage

- Solar direct pumping pumps water to reservoir during daytime as panels receive light.
- In ashram system, they would still have current electric pumps for backup.
- Easily expandable, if the pumps are not moving the volume of water required, simply add solar panels.
- Con: At the Ashram, would need to remove many trees to provide un-shaded space.

Start cost estimate: $5100

Figure 15.

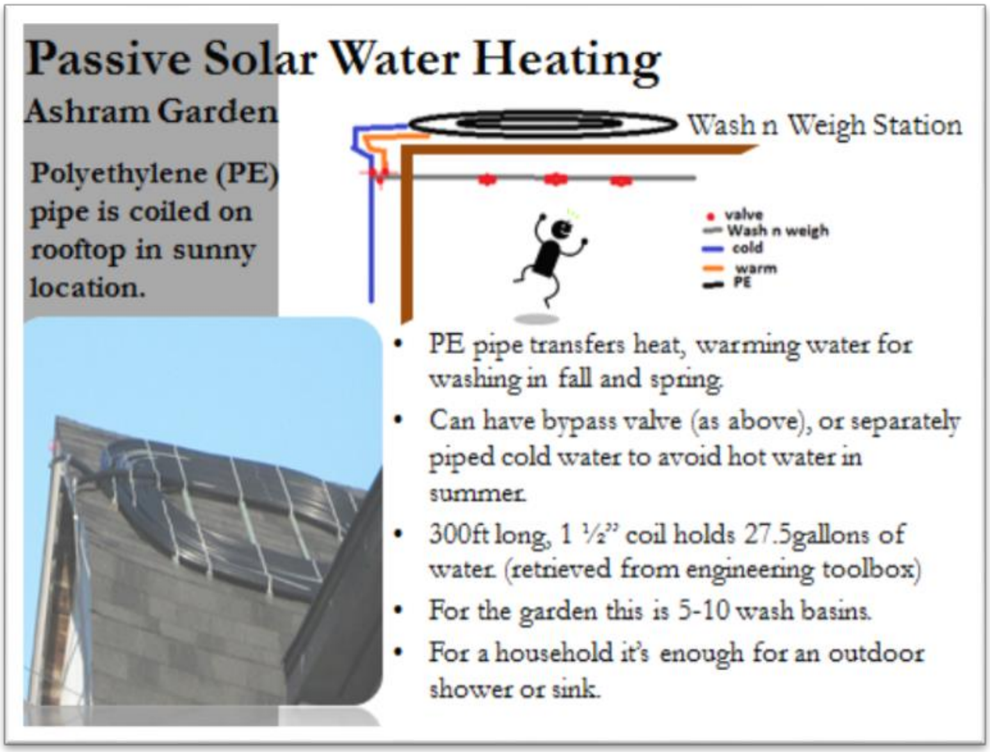


Figure 16.

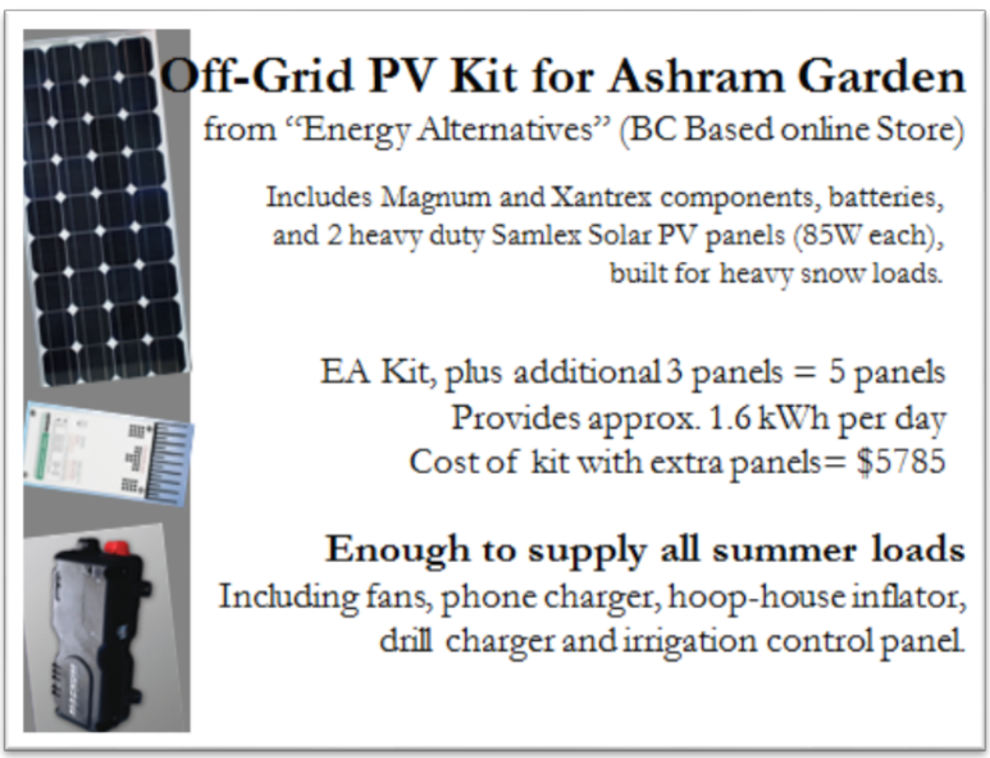
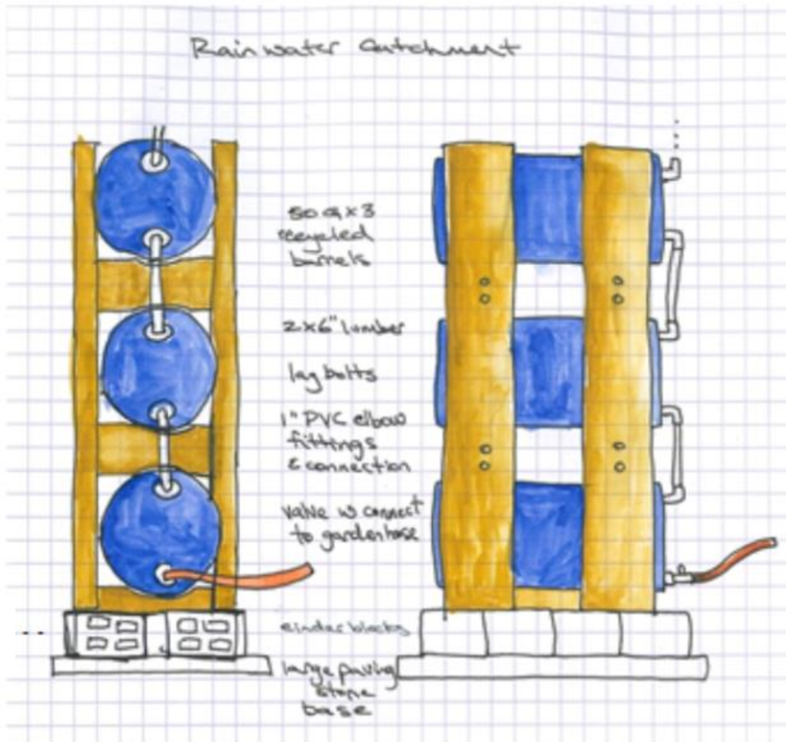


Figure 17.

3 x50 gallon barrels =

150gallons



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