Sustainability Study

Misery Bay Visitors Centre and Sifferd Cottage

Misery Bay Provincial Park,
Manitoulin Island, Ontario, Canada

Ted Kesik and William O'Brien
May 17, 2011

UNIVERSITY OF TORONTO
JOHN H. DANIELS FACULTY OF ARCHITECTURE, LANDSCAPE, AND DESIGN
Daniels

Sustainability Study

Misery Bay Visitors Centre and Sifferd Cottage

Misery Bay Provincial Park, Manitoulin Island, Ontario, Canada

Prepared for *Friends of Misery Bay* by *Ted Kesik, University of Toronto and William O'Brien, Concordia University* through funding made available by the *Jeffrey Cook Charitable Trust*.

Misery Bay Provincial Park is a 760-hectare nature reserve located on the south shore of Manitoulin Island, a 10-minute drive west of Evansville. The park and facilities, which are managed by Ontario Parks and operated by Friends of Misery Bay, are subject to and bound by the Provincial Parks and Conservation Reserves Act, Class Environmental Assessment and the Parks Management Plan. Misery Bay Provincial Park offers 4 hiking trails about 2, 3, 4, and 5 kilometres each in length, which feature mixed woodland, old beach ridges, and rare alvars (flat limestone bedrock with no soil). A visitors centre opened to the public in 2002 houses information on the unique and rare aspects of this park. Three additional trails about one kilometer each in length are located on the west side of Misery Bay and accessed by Little Lake Huron Road and Rocky Trail. The Sifferd Cottage, constructed by Calvin and Eunice Sifferd, who initiated the conversion of their vacation retreat property into a nature reserve during the 1970s, is located on the west shore of Misery Bay. This study focuses on the sustainability of these two constructed facilities and their relationship to the present and foreseeable uses of this remarkable and unique ecosystem.

This study is funded by the *Jeffrey Cook Charitable Trust* and conducted on behalf of the Friends of Misery Bay. The views expressed herein are those of the authors and do not necessarily represent the views of the *Jeffrey Cook Charitable Trust*, *Friends of Misery Bay*, *Ontario Parks*, or any other individual or organization involved with this study.

Acknowledgements
The authors of this report wish to acknowledge the collegial support and cooperation provided by Thomas Moore (Friends of Misery Bay), Ryan L. Gardner (Ontario Parks) Klaus and Marjut Dunker (Project Architects), and Rick Gagnon (Two-West Wind and Solar).

Table of Contents

Executive Summary

This study, funded by the Jeffrey Cook Charitable Trust, is premised on providing the Friends of Misery Bay, Ontario Parks and all stakeholders with a comprehensive sustainability plan. Renewable energy is a key factor in this sustainability plan and underpins all present and future aspects of the facility operations. It is not possible to separate the allocation of financial and human resources needed to operate and maintain the renewable energy system from the operation and maintenance of the entire park facilities. Future sustainable development scenarios will be largely determined by the energy needed to power and service the Misery Bay Visitors Centre and Sifferd Cottage, and the ability to fundraise will be affected by the sustainability of the facilities and how this compares with similar ecological parks in northeastern North America.

It is unlikely a sustainable future for Misery Bay Provincial Park is achievable without the engagement of succeeding generations. It will be difficult to attract volunteers and to collect sufficient users fees if there is no interest among the upcoming generation. The importance of digital media and social networking as means of connecting the Misery Bay support community, researchers and users cannot be underestimated. To achieve a sustainable future there is only one alternative scenario - to expand the entire support network without increasing the ecological footprint of the facilities. How and when this evolution proceeds will be determined by the stakeholders subject to all policies and regulations governing Ontario Parks.

Investing in environmentally responsible facilities and expanding the use of the park through promotion and fundraising will require a master plan that engages all stakeholders. Media relations and broadcasting are critical to raising awareness and stimulating interest. Accordingly, the Visitors Centre and the Sifferd Cottage become destinations in themselves hosting functions that generate revenues and increase the visibility of the park.

The first option for moving forward a sustainable future is by government funding alone. Ontario Parks and the Ministry of Natural Resources may wish to promote nearly carbon-neutral facilities situated on a world-class ecosystem as the future of new park developments across Ontario. The second option is to partner with the Great Lakes university sector to secure research funding that will contribute to the necessary investments needed to carry out a robust program of scientific study, internships and dissemination. A third option is to aggressively fundraise among the private sector and conservation advocacy organizations for donations in support of the enhancement of Misery Bay facilities and operations. Finally, all of these options can be pursued together so that no single stakeholder is excessively burdened.

The key findings of this study in regards to the Visitors Centre include:

- The Visitors Centre is entering its 10th season of operation and the overall condition is very good. The wood siding is in need of refinishing, several of the glazing units have experienced seal failures and require replacement, and proper ramps are required at the lower level door and battery/mechanical room. These items may be considered to fall within normal maintenance and repair requirements.
- The storage garage/shed is also in good condition and only requires to be cleaned out of remnant materials, and obsolete equipment so that it can take on more effective future use. Installation of PV powered interior and exterior lighting is recommended.
- The present system of photovoltaic (PV) panels and batteries is more than adequate for the current and reasonably foreseeable usage.
- The intervention/investment with the greatest impact on the ecological footprint of the facility is to trim trees to the south of the Visitors Centre and improve passive solar performance. This intervention results in the largest reduction in non-renewable energy demand of any option.

- Wind turbine is relatively expensive (only a 3 kW unit was modeled) and a much larger capacity would be needed to entirely meet heating demands throughout the entire winter. However, the wind turbine, as a supplement, has the potential to eliminate the propane boiler if the objective is ensure the building, including battery storage area, remains above freezing temperatures. It also contributes to the diversity of renewable energy generation thereby extending the reliability of the energy system.
- Installation of a wind turbine is preferable to solar thermal panels as this provides redundancy, additional capacity and the potential for space heating sufficient to maintain the building above freezing (i.e., heated battery room).
- Solar thermal is helpful in summer months for domestic hot water but is less effective in winter months without massive amounts of thermal storage. Solar thermal panels are only justifiable if there is an increased demand for domestic hot water during the current operating schedule (i.e., showering facilities - presently there are no bathing facilities at the Visitors Centre).[1]
- It is advisable to replace inefficient equipment (computers, monitors, etc.) and lighting (high intensity halogen fixtures with internal transformers) and encourage conservation through feedback and education. An energy dashboard is an available option for displaying the amount of power being demanded and the amount of energy consumed. This technology has been found to be effective in modifying users' energy consumption behaviour and also has educational benefits.

In relation to the Sifferd Cottage, this study concluded:

- Some minor roof repair is necessary and the flashings checked and possibly redone, especially around chimneys
- A small roof over the battery storage entrance should be built to shelter the door from rain.
- The concrete floor condenses in wet weather (cold concrete slab) and lifts the vinyl tiles. Improved venting of the building would help control and removal of condensation. Wood flooring would be less susceptible to condensation.
- Exterior siding should be cleaned and re-stained; also at places the surrounding ground has risen due to accumulation of detritus and covers the siding board. The ground around the building should be removed to at minimum 4" below wood siding boards and cleaned seasonally.
- Railings for stairs leading to the upper level are missing and railings for stairs leading to the mezzanine, as well as mezzanine guards do not comply with Code requirements. The attic loft must be cleared of clutter to afford safe egress.
- Aside from the deficiencies noted, the Sifferd Cottage is highly suitable for housing researchers and affords comfortable accommodations during summer months and generous cooking facilities. Potable water and sanitation facilities are essential services before the building can be occupied, as well as the provision of smoke alarms on each level of the building.
- A modest PV energy system is adequate for most foreseeable uses of this facility from May 1 to October 31, except for brief periods there may be a minor shortage of energy in September and October.
- While not explicitly modeled, this system has sufficient capacity to also run a UV-sterilizer during the summer months.[2]
- Under the scenario where the propane powered equipment remains and insufficient funding is available in the short term to purchase and install a complete PV system, there are stand-alone solutions for composting toilets and portable solar-powered charging devices. This technology would restrict the Sifferd Cottage to day use only, but would comply with environmental, health and safety regulations.

[1] The demand for hot water at the Visitors Centre was reported as being virtually non-existent since routine housekeeping can be performed with cold water detergents.
[2] UV sterilizers have not been viewed as approved methods of ensuring potable water quality in the past at Ontario Parks. However, they do provide a factor of safety in the event water labeled as non-potable is accidentally ingested.

The following recommendations are submitted for consideration by the stakeholders:

- There is a need to establish a working group that will forge a comprehensive master plan and a coherent set of sustainability strategies for the future of Misery Bay Provincial Park.
- In the very short term, it is important to carry out the required maintenance and repair cited in this study in order to conserve the existing facilities. This will enable medium and long term planning to proceed without compromising the hard work and resources embodied in the existing facilities.
- The Sifferd Cottage is an untapped resource that can be made available to the scientific research community in some form of use with relatively low initial expenditures. This facility is critical to a longer term mission of research and dissemination that will foster fundraising opportunities.
- Means of engaging the upcoming generation in the support and operation of the park must be explored and promoted.
- Ontario Parks should consider using Misery Bay Provincial Park to pilot a program of expanding services without increasing its ecological footprint. There are several widely accepted methods available to measure ecological footprint and Ontario Parks has access to all of the data needed for annual assessments. This will serve to inform future practices, policies and programs related to the Ontario parks system.
- Conservation is the key to sustainability. Natural conservation through energy efficiency improvements in lighting and equipment, and future improvements in the cost and efficiency of renewable energy technologies, will inevitably lead to a lowering of the carbon footprint. This should be coupled to an ongoing promotion of energy and resource conservation at this exemplary facility.
- For reasons of safety and security, the continuous operation of a WiFi system and a security camera are recommended. Telecommunications would enable email and text messaging beyond current seasonal satellite internet communications and the live cam link would animate the park web site.
- Media relations and public outreach are key to the long term viability of Misery Bay Provincial Park. Raising public awareness of its existence, promoting use of the park to educational institutions, and partnering with stakeholders to host high profile events are among the strategies needed to compete for the funding of Canada's nature reserves.
- The open and transparent sharing of information and discussions among stakeholders is the most effective means of bringing the best ideas to the table. It is important to establish a regular protocol for information exchange and dialogue so that this process can be properly planned, scheduled and conducted.

Background

This study was undertaken by the research team of Ted Kesik and William O'Brien, as a result of funding made available to Professor Kesik at the Daniels Faculty of Architecture, Landscape and Design, University of Toronto by the Jeffrey Cook Charitable Trust. The funding stems from an interest by the Friends of Misery Bay to enhance the sustainability of the Misery Bay Provincial Park, in particular, the Misery Bay Visitors Centre and the historical Sifferd Cottage. Specifically, the Friends of Misery Bay are advocating to enhance the reliability and efficiency of renewable energy generation to promote a lower carbon footprint, a more usable facility, and to enable expanded future uses.

Friends of Misery Bay is a registered non-profit charity devoted to supporting the Misery Bay Provincial Park in its mandates of protection (especially of its rare alvar habitats), research and education. Since agreement for the establishment of the park in the late 1970's, up to the regulated protection of Misery Bay under Ontario's Provincial Parks Act in 1989, through to the present, a group of devoted volunteers has helped manage and operate this natural asset. The Friends of Misery Bay was instrumental in advocating the construction of a low carbon Visitors Centre that opened to the public in 2002, and was responsible for obtaining funding through the Jeffrey Cook Charitable Trust for the commissioning of this study.

According to the Ontario Ministry of Natural Resources web site, Ontario Parks deliver Ontario's parks and protected areas program, including provincial parks operations, development and implementation of legislation, regulation, policies and guidelines for protected areas, policy leadership on conservation reserves; compliance monitoring, auditing, and public reporting.

Dr. Ted Kesik, P.Eng., the principal investigator in this study, was originally involved with the design of the Visitors Centre starting in 1998 with architects Klaus and Marjut Dunker, who championed a low energy building with a minimal environmental footprint. It is important to note this facility is off-grid and therefore relies primarily on renewable energy generation to meet its needs. With the increasing popularity of the facility, electrical energy security has become an issue with demands sometimes exceeding generation capacity. This issue is among the main concerns of this study, however, there was also an interest expressed by FOMB to see if the propane system could be entirely eliminated and to have the supplemental heating delivered by solar-thermal panels and/or a wind turbine.

Running parallel to the Visitors Centre is the need to assess the energy demands of the Sifferd Cottage in anticipation of its summer season use by academic researchers studying this unique alvar and wetland fen ecosystems. The Friends of Misery Bay are deeply interested in promoting ongoing environmental research but one of the barriers is the establishment of a proper research station that can appropriately house professors and their students, as well as teams of research scientists.

Ontario Parks has cooperated in this undertaking of a meaningful study with a view to sustaining the protection, operation and maintenance of Misery Bay Provincial Park in accordance with their mandate under the Ontario Ministry of Natural Resources. Their review and comment on this study was both welcomed and encouraged, and they have provided valuable input to the study process. They will always be a key stakeholder along with the public they serve, however, it is important to note that Ontario Parks is not committed to any of recommendations stemming from this study. They remain among many considerations that will be taken into account as part of the comprehensive park management process.

As such, this study serves as a vehicle for a wider dialogue about the future sustainability of Misery Bay Provincial Park and attempts to provide a framework for future interventions and investments that will ensure this natural legacy remains vital and accessible for the benefit of future generations.

Brief History of Misery Bay Provincial Park[3]

Misery Bay is located on Manitoulin Island, the world's largest freshwater island. A great wedge of land that separates the waters of Lake Huron from the North Channel, the island, lying off the north shore of Lake Huron, is a familiar part of the Great Lake topography. Misery Bay Provincial Park is located along remote stretches of Lake Huron shoreline at Misery Bay. It lies 35 kilometers west of Gore Bay.

Misery Bay Provincial Park is part of the townships of Burpee and Mills and Robinson where flora, fauna and glacial features are among the rarest of their kind in the province. This reserve spans Manitoulin Island at one of its "Narrows" where East and West Manitoulin are united by a slim natural land bridge no wider than a mile across in places. This natural causeway is unmatched for special geological features such as wide expanses of spreading flat dolostone rock with its exposed fossil records. The proximity of two great bodies of water, and the deposits of sand, silt and sediment, that over the ages gradually converted a reef between two land masses into a rich land bridge, have all contributed to produce a wonderful growth environment for special flora and fauna. They thrive here at The Narrows among its wealth of sandy bays, open farmlands, island-spanning wooded green corridors, and generous wetlands. Misery Bay shares that richness of features in The Narrows.

"As a park, nature reserve class, Misery Bay Provincial Park is managed for the protection of representative natural features while affording opportunities for the appreciation of its natural heritage, today and for future generations." To this end, the Friends of Misery Bay (FOMB) in cooperation with Ontario Parks, are in the process of developing viewing opportunities for the outdoor enthusiast. An exciting system of carefully selected hiking trails and a boardwalk (which needs to be extended further into the wetland) wind through less fragile areas of this unique natural environment. For winter enjoyment these same trails become a snowy wonderland.

A Visitors Centre, entrance road, and parking areas on the east side of the bay, constructed by the Friends of Misery Bay with the assistance of the membership and volunteers, and support of Ontario Parks, enhances the nature reserve. Funded by both governments and numerous individuals, this unique "green concept" building is open during the summer months. Misery Bay Provincial Park is located on an ancient flat rock sea bottom. This unique feature, known as an alvar, presents unusual geological viewing opportunities for the visitors' enjoyment. It is this feature that makes Misery Bay a world class park. The Great Lakes Basin has the only alvars found in North America, and most of the alvars found in the world. Manitoulin Island is located on the northern rim of this large land feature. "The Manitoulin cluster of alvars are the most significant alvars found anywhere in the world."[4]

Of special interest to some will be the relict remains of inland beaches left on the rocks at Misery Bay Provincial Park by the retreat of three different great prehistoric lakes. The Visitors Centre building is constructed on one of the most recent of these relict shorelines (Lake Nipissing). The habitat here also supports its own unique flora that early records tell us attracted visitors to the area during pioneer days.

Manitoulin is noted for its many migrant and resident birds, and Misery Bay lives up to that reputation. Birders will find a variety of birding environments and staging areas during migration. Butterflies are numerous in the park, as are turtles. Visitors might be fortunate enough to glimpse a variety of such other wild creatures as otter, fishers, fox, coyote, bears and other mammals. Friends of Misery Bay have produced a trio of checklists to enhance the visitors' enjoyment of the nature reserve. Checklists of the flora, the birds and the butterflies of the bay area have been compiled after a number of years of careful study and research by several dedicated FOMB naturalists, and may be purchased at the Centre.

Misery Bay Provincial Park is now listed as an operating park and hosts a number of special events in addition to its regular operations. There is a strong interest by the academic and scientific research communities to further study this unique ecosystem and to monitor its sustainability in view of impending climate change.

---

[3] This brief history is based on the writings of Doreen Bailey, former Chair, Friends of Misery Bay, and excerpted from http://www.miserybay.org/about.htm.

[4] *Conserving Great Lakes Alvars: Final Technical Report of the International Alvar Conservation Initiative*. The Nature Conservancy Great Lakes Program, March 1999. http://www.epa.gov/ecopage/shore/alvars/alvar.pdf

Misery Bay Provincial Park - Significant Dates

Before 1870's & 1880's—Land around the Bay was largely burned over, beginning in the 1700's and again during the Survey of 1879; sometimes inhabited and certainly used by Native Americans for fishing and hunting and trading with settlers or others (as in sail boats) in Misery Bay, particularly from what is now called "The Landing."[15]

1880's—Used for "beaver" or marsh hay and pasturing, hunting, fishing, etc., by the James D. Ainslie family, eventually purchased by Ainslies; Edwin (Ned) Saunders, late in life, started a turkey farm on the east side of the bay (perhaps near Curly William's camp, now the shelter recently gifted by George Whyte).[16]

1959—Purchase by Cal and Eunice Sifferd from Bernard Ainslie of the first of several Misery Bay properties which were later turned over to Nature Conservancy of Canada as the core of the Park.[1]

1972—John Harvey, chair of the Nature Reserve Committee of the Federation of Ontario Naturalists was looking on Manitoulin Is., and other places, for natural areas worthy of protection. He considered Christina Bay, but it belonged to the Ontario Paper Co. and turned out to be too expensive to acquire.[2]

1975—John Harvey, FON, hired University of Western Ontario graduate student Stewart Hilts to search for other important sites that should be protected on the Island. He chose the Sifferd property around Misery Bay and began discussions with them about acquisition. The Sifferds already had such an idea. Mr. Hilts wrote an “Ecological Description of Misery Bay,” recommending it as a valuable site for preservation. Sifferds signed an option to purchase with FON, through Hilts, for the purpose of setting the land aside as a nature reserve.[3]

1976—Correspondence among FON, Nature Conservancy Canada, the McLean Foundation, MNR,, and the Sifferds and Robertsons (bog and black spruce swamp area to the north) proceeded toward purchase and gifting of the land, plans for land use, and transfer of titles.[4]

1977—NCC completed arrangements to assume title to the Sifferd properties.[5]

1978—NCC/Sifferd agreement to purchase/gift Misery Bay property signed.[5]

1979—Nature Conservancy of Canada formally turned over title to the Misery Bay land to the Province of Ontario, to be managed as a nature reserve park.[6]

1979—NCC turned over title of the Robertson bog property to ON for the same use.[7]

1986—Draft of Concept Plan and Alternatives for Misery Bay published by MNR.[8]

1989—Misery Bay regulated for protection under Ontario’s Provincial Parks Act.[11]

1995—Feb., Misery Bay steering committee organized by Judith Jones.[9] Dec., FOMB incorporated, original signatories/directors were Judith Jones, Doreen Bailey, Bonnie Bailey, Gaynor Orford, Steve Hall, and Roy Campbell. D. Bailey acted as chair.[10]

1996—April; FOMB registered as a “not-for-profit” federal charity; April, management agreement with ON Parks (A. Penikett, Superintendent) signed; “Misery Bay Provincial Nature Reserve Management Plan” published by MNR; FOMB purchased $1,000,000 liability insurance policy.[11] June 15; first AGM; FOMB By-Laws adopted; elections of Doreen Bailey, chair, Bonnie Bailey, vice chair, Judith Jones, secretary, Gaynor Orford, treasurer, plus Heather Baines, Steve Hall, and Roy Campbell as directors.[12]

1998—June, boardwalk built; July, funding for Centre building acquired[13];municipal road started.

2002—Misery Bay Park Road and parking lot completed; June, ribbon cutting ceremony and official opening of new Centre building at AGM with address by John Harvey; July, Student summer staff.[14]

2003—Sifferd commemorative plaque unveiled by Eleanor Sifferd Moore.[15]

2006-7-Prof. interpretation consultants hired, L. Brown & A. Dalton.[17]

2009—Prof. organizational consultants hired, NOHFC, FedNor, LAMBAC grants, H. Cummings Assoc. [18]

2010—Prof. interpretation consultant D. Wilkes hired [19]

2011—Misery Bay Provincial Park status is changed to "Operating Park", Ryan L. Gardner, Park Superintendent.[20]

---

[1] Sifferd diaries; [2] Harvey 2002 AGM address; [3] Hilts & FON correspondence & Sifferd diaries; [4] Hilts correspondence & Sifferd diaries; [5] NCC/Sifferd contract & Sifferd files; [6] NCC/Prov. ON contract; [7] NCC/Prov. ON contract; [8] MNR draft publ.; [9] Feb. 1995, *Expositor*; [10] Art. Incorp.; [11] Reg. Agree., MNR publ., 1996 AGM min.; [12] 1996 AGM min.; [13] 1998 *Turtle Tracks*; [14] 2002 AGM min.; [15] 2003 AGM min.; [15] G. B. Abrey, 1879, Report and Field Notes, Survey of the Township of Burpee,…. & F. W. Major, 1934, Manitoulin, The Isle of the Ottawas; [16] C. & E. Sifferd, 1979, Elizabeth Bay letter book; [17] 2006 *Turtle Tracks*;[18] 2009 *Turtle Tracks*; [19] 2010 *Turtle Tracks*; [20] Ontario Parks Website.

Ecological Significance of Misery Bay Provincial Park

The Southern Manitoulin Island Coast is globally significant for its pristine Great Lakes shorelines and rare habitats, which support several species at risk, such as the Lakeside Daisy and Hill's Thistle. Recent analysis has shown the Manitoulin Island region to have the greatest richness of globally significant species and communities of any ecological district within the Canadian portion of the Great Lakes Basin. Manitoulin's intact, natural landscapes support an exceptional abundance of endemic, disjunct and globally-rare species and some of the best representative examples of ecological communities that are found nowhere else in the world, including globally significant alvar habitat.[5]

---

[5] Nature Conservancy of Canada.
http://www.natureconservancy.ca/site/PageServer?pagename=on_ncc_work_projects_manitoulincoast1

Current Operation and Usage of the Park[6]

Misery Bay Provincial Park has its trails open all year and visitors assume the full risk of their use. As of 2011 Ontario Parks has it listed as an operating park, day use only - no camping is permitted. The Visitors Centre building facilities are open during the summer months. The 2010 operating schedule was as follows: the Visitors Centre was staffed and open on Saturdays, Sundays, and holidays from 10:00 AM to 5:00 PM, May 22 through October 10, and daily during July and August, at the same hours. Attendance statistics for the park are summarized in Table 1.

2009 Misery Bay Park Visitors

The Visitors Centre was staffed from 10:00 AM to 5:00 PM by volunteers of the FOMB on weekends from Victoria Day weekend to Thanksgiving, and by grant-supported students every weekday in July and August, for a total of 102 days.

Visitors were counted with a clicker as they entered the Centre or were seen passing by outside. Those who entered were invited to sign a visitor book, but only 1,784 did so. A notebook for after-hour visitors, kept in the trail map box outside the Centre, was also signed by some hikers. It is impossible to get an absolute count of park visitors because of after-hour hikers and multiple entries into the park. Also, we have no record at all of visitors to the west side of Misery Bay which is accessed by another road. Trails are open all year, and are used by many in the off-season. Data for this 2009 report is based on in-season written records.

The total visitor count for 2009 was 4,484 (in 2008, the total was 3,065), an increase of nearly 47%. This dramatic rise in number of visitors may be due to our increased effort to communicate our weekly activity schedule by email to island lodging and camping sites, to businesses and to information centers. Also, our events calendar was listed on this FOMB website (www.miserybay.org). In addition, we had good publicity in local papers following events, and one radio interview on CBC 1, Sudbury.

2010 Misery Bay Park Visitors

Centre attendants counted 4,372 visitors at the Misery Bay Provincial Nature Reserve Park in 2010. Of these, 80% were Canadians, including 11% from Manitoulin Island, 63% from Ontario but off-island, and 6% from seven other provinces. Of the 20% non-Canadian visitors, 11% hailed from 21 U.S. states, and 9% from 15 other countries. These figures are similar to those from 2009, but the park was open fewer days: 93.

Special events were popular, including Tuesday naturalists' talks given by experts in their field, guided interpretive hikes and Kids Day. Daily counts were highest in July and August, with the highest single day count of 172 on Tuesday, August 17. The two most common questions from visitors were, "What are alvars?," and "How did Misery Bay get its name?" Many favorable written comments were noted by visitors about their Park experience, such as "well-marked trails," "friendly, helpful attendants," and "interesting displays" in new cabinets designed by FOMB Board member and former University of Michigan museum director Tom Moore, and built by David Smith, God's Country Wood Products, Gore Bay.

The Visitors Centre was open daily in July and August, and on weekends and holidays from Victoria Day weekend through Thanksgiving. It was staffed by Gore Bay university students Laura Bell and Emily Hayden, as well as Friends of Misery Bay volunteers.

NOTE: While road and trail access to the west side of Misery Bay remain open, the Sifferd Cottage is not operational and remains unavailable for use by the academic and scientific research community.

[6] As reported by Thomas Moore, Friends of Misery Bay.

Visitor Origins		2008	2009	2010
Ontario	- Manitoulin	12%	8%	11%
	- Other Areas	63%	68%	63%
Other Provinces (7 provinces)		3%	4%	6%
U. S. A. (23 states) [*21 states*]		9%	10%	*11%*
Other Countries (26) [*15*]		9%	10%	*9%*
(Ave. Daily Attendance: 2010 = 47.0; 2009=43.9; 2008=38.8; 2007=30.1; 2006=19.7; 2005=27.4)				

Table 1. Misery Bay Provincial Park visitor statistics, 2008-2010 based on visitor book entries.

Figure 1. New display cases beneath windows interpret the flora and fauna of the Misery Bay alvar ecotope. 2010.

Inventory and Condition Assessment of Existing Facilities

The discussions that follow are not intended to be exhaustive in scope, and will focus primarily on the buildings and their service infrastructure. The purpose of this section is to identify issues related to either the durability of the facilities (essential maintenance and repair) or the renewable energy systems needed to sustain operations. The discussion is broken down into the two main facilities at Misery Bay Provincial Park: the Visitors Centre; and the Sifferd Cottage.

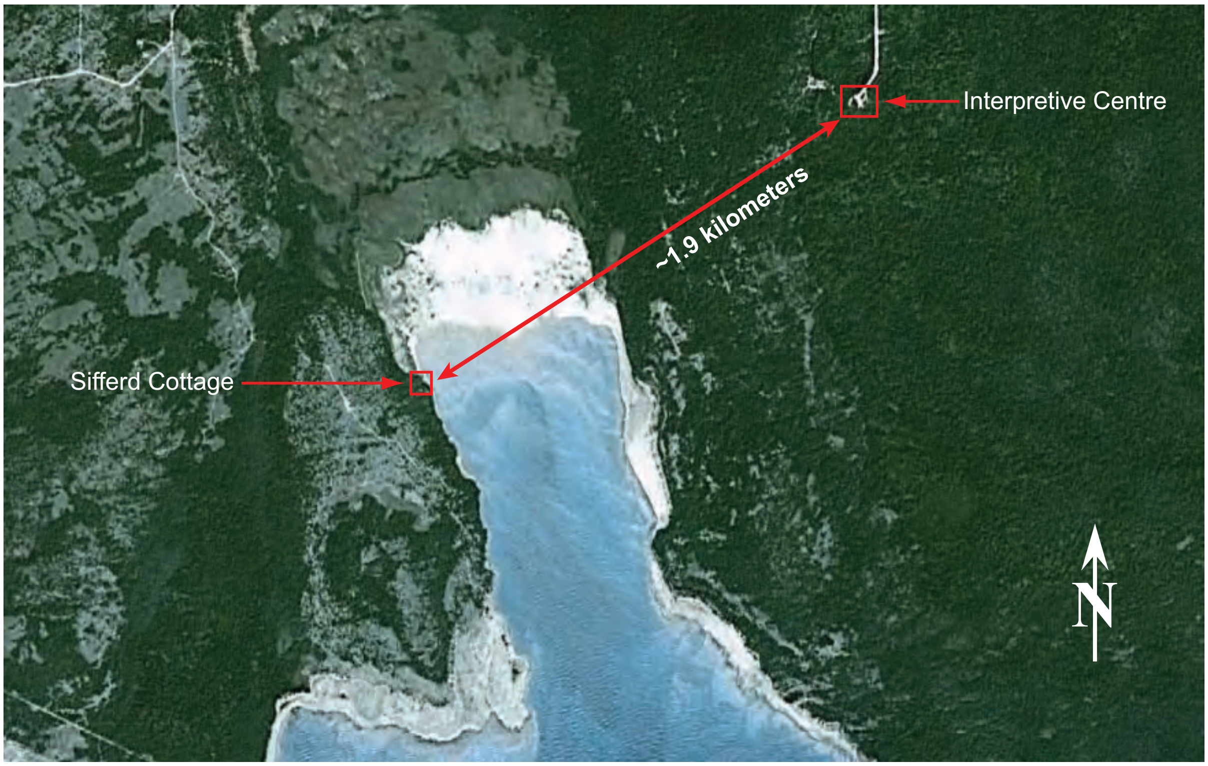

Figure 2. Locations of the Visitors Centre and Sifferd Cottage in relation to Misery Bay.

Misery Bay Visitors Centre

This 197 m^2 (2,130 ft^2) single storey facility was designed by architects Klaus and Marjut Dunker and opened in June 2002. The environmental design intent of the Visitors Centre was to construct a thermally efficient building envelope based on the 'mass and glass' strategy for passive solar buildings. By providing large south-facing glazing areas that permitted direct solar gains to strike a massive concrete floor, passive heating of the space was estimated at providing nearly two-thirds of the annual space heating energy demands. Building energy simulations indicated the building would be highly resistant to freezing in the absence of an active heating system[7], and a propane fired heating system was employed to supplement the passive solar heating during winter months, and to provide domestic hot water. Refrigeration and cooking is also propane fired as the budget afforded to photovoltaic panels and battery storage of electrical energy did not support an electric refrigerator. The building and all bathrooms are fully accessible to persons with disabilities.

Potable water is supplied by a drilled well and sanitary waste is conveyed to a bio-filter septic system. There is no electricity supplied from the utility grid to this facility due to the long distance from the main road to the Visitors Centre, hence there is also no telephone service. A satellite Internet system has been installed and a local emergency radio is also available. A propane powered back-up electrical generator is located in a separate building to automatically supplement the photovoltaic energy system when the storage battery levels are low due to excessive power demands, cloudy conditions and/or snow cover over the panels.

[7] See discussion on Pages A-8 and A-9 of Appendix A. Recent energy simulations confirm the building would stay above freezing if the trees were trimmed back to avoid shading during winter months, a originally envisioned.

Figure 3. The Visitors Centre (looking East) is located at what would have been the original shoreline of ancient Lake Nipissing (predecessor to Lake Huron). 2010.

To the south of the Visitors Centre down a short roadway is located a 35 m^2 (380 ft^2) storage garage that was used during construction to secure tools and materials. It is largely unused at this time but features a large covered area in front that may be converted into an inclement weather shelter/picnic area at times when the Visitors Centre is not open to the public.

Figure 4. View of Visitors Centre from handicapped parking area (left image) and view of the observation deck looking East. 2010.

Figure 5. Interior views of the Visitors Centre indicate a clean and dry facility with all finishes and furnishings in good order. 2010.

Figure 6. Exterior bathrooms are only open during operating hours leaving visitors without access to bathroom facilities at other times. A composting toilet is planned for 2011 in the parking lot area for this purpose. 2010.

It is important to note that composting toilets were originally planned for the Visitors Centre and a large, insulated space was provided beneath the bathroom areas to house the composting drums. The current toilet facilities could be readily retrofit to replace flush toilets with composting toilets enabling their use when the facility is not staffed.

Figure 7. Some of the glazing unit seals have failed indicating interstitial condensation and the need for replacement (top left). The wood siding is beginning to indicate signs of weathering and should be refinished within the next few years to avoid deterioration of the wood. Permanent ramps and/or paving needed at lower level door (top right) and battery/mechanical room (bottom left). Generator shed (bottom right) is in good condition and a photovoltaic panel has been mounted on a pole to maintain charge of the generator's starter battery. 2010.

Figure 8. Offices feature older computer technology and cathode ray tube (CRT) monitors that are much less energy efficient than Energy Star compliant equipment that is currently available (top left and right). Kitchen area is spacious and functional (bottom left). The propane stove[8] cannot be practically replaced with an electric range because these draw excessive amounts of power that would rapidly drain the battery storage capacity (bottom right). Expansion of the photovoltaic solar energy collectors and/or the installation of a wind turbine would allow replacement of the propane fridge with an electric model. This would eliminate the venting of products of combustion into the indoor environment. 2010.

The Visitors Centre is entering its 10th season of operation in 2011 and the overall condition is very good. The wood siding is in need of refinishing, several of the glazing units have experienced seal failures and require replacement, and proper ramps are required at the lower level door and battery/mechanical room. These items may be considered to fall within normal maintenance and repair requirements.

The storage garage/shed is also in good condition and only requires to be cleaned out of remnant materials, and obsolete equipment so that it can take on more effective future use. (Not pictured.)

One notable problem reported in 2010 was the contamination of the well water by E. coli and this has currently been addressed by posting notices at all water fixtures warning that the water is not potable. It is not possible to determine whether or not the contamination signals a failure in the effectiveness of the septic system. Given the recent upgraded solar panels, it is feasible to install and operate a UV sterilizer given that the volume of water consumption is relatively low on a daily basis, provided this method is approved by Ontario Parks. As noted earlier, UV sterilization is a prudent safeguard for water even when it is labeled as non-potable.

[8] It was reported the propane stove has only been used to boil water and it could be replaced with a modest microwave.

Sifferd Cottage

The Sifferd Cottage is an early 1960s vintage, wood-frame building constructed on a concrete foundation set over the alvar. The building has no evidence of settlement or structural distress and is in good condition considering its age and exposure.

Figure 9. North elevation of Sifferd Cottage (top left). The South elevation features a massive stone fireplace. (top right). Accumulations of leaves and twigs near bottom of siding allowed to remain without routine cleaning have initiated deterioration of the wood siding (bottom left). The roof structure is straight and true, and the metal roofing is in good condition, but some of the chimney flashings require repair and/or replacement (bottom right). 2010.

Architect Klaus Dunker reported that:

- Some minor roof repair is necessary and the flashings checked and possibly redone, especially around chimneys
- A small roof over the rear entrance door should be built to shelter the door from rain.
- The concrete floor condenses in wet weather (cold concrete slab) and lifts the vinyl tiles. Improved venting of the building would help control and removal of condensation. Wood flooring would be less susceptible to condensation.
- Exterior siding should be cleaned and re-stained; also at places the surrounding ground has risen due to accumulation of detritus and covers the siding board. The ground around the building should be removed to at minimum 4" below wood siding boards and cleaned seasonally.

Figure 10. Deterioration of the wood siding is evident on the east elevation (top right), The well was reported to be functional, but the hand pump is in a state of disrepair (top right).[9] The questionable condition of an observation deck has caused it to be barricaded from visitors (bottom left). The privy building is in good condition, but no longer permitted for use by environmental regulations governing Ontario parks (bottom right). 2010.

[9] Ellie and Tom Moore reported that the water quality of the well has been very good historically. A small, solar powered water pump could be installed to deliver water to the Sifferd Cottage. UV sterilization is a viable option for safeguarding water quality and if this method is not approved by Ontario Parks, potable water can be delivered to the site for drinking only.

Figure 11. Railings for stairs leading to upper level are missing (top left) and railings for stairs leading to mezzanine, as well as mezzanine guards (bottom left and right) do not comply with Code requirements. Attic loft must be cleared of clutter to afford safe egress (top right). 2010.

Aside from the deficiencies noted, the Sifferd Cottage is highly suitable for housing researchers and affords comfortable accommodations during summer months and generous cooking facilities. Potable water and sanitation facilities are essential services before the building can be occupied, as well as the provision of smoke alarms on each level of the building.

Renewable Energy System Analysis

A comprehensive analysis of renewable energy system options was performed for both the Visitors Centre and the Sifferd Cottage. The complete analysis is presented in Appendix A of this study. The following discussion summarizes the findings and recommendations.

Visitors Centre

Based on the foreseeable future use of the Visitors Centre (May to October) the following renewable energy system performance issues, priorities and options were identified:

- The present system of photovoltaic (PV) panels and batteries is more than adequate for the current and reasonably foreseeable usage.
- The intervention/investment with the greatest impact on the ecological footprint of the facility is to trim trees to the south of the Visitors Centre and improve passive solar performance. This intervention results in the largest reduction in non-renewable energy demand of any option.
- Wind turbine is relatively expensive (only a 3 kW unit was modeled) and a much larger capacity would be needed to entirely meet heating demands throughout the entire winter. However, the wind turbine has the potential to eliminate the propane boiler if the objective is ensure the building, including battery storage area, remains above freezing temperatures. It also contributes to the diversity of renewable energy generation thereby extending the reliability of the energy system.
- Installation of a wind turbine is preferable to solar thermal panels as this provides redundancy, additional capacity and the potential for space heating sufficient to maintain the building above freezing (i.e., heated battery room).
- Solar thermal is helpful in summer months for domestic hot water but is not effective in winter months without massive amounts of thermal storage. Solar thermal panels are only justifiable if there is an increased demand for domestic hot water during the current operating schedule (i.e., showering facilities).
- It is advisable to replace inefficient equipment and lighting and encourage conservation through feedback and education. An energy dashboard is an available option for displaying the amount of power being demanded and the amount of energy consumed. This technology has been found to be effective in modifying users' energy consumption behaviour.
- Wood heating, while not analyzed in this study, is potentially a carbon-neutral strategy for supplemental space heating. It is also a fail-safe technology with no need for auxiliary energy and there is ample fuel available from deadfall, etc. It is an aesthetic feature that can also be used for cooking (baking) at special events.
- Contaminated well water may require sterilization. A UV sterilizer consumes approximately same amount of energy as an electric refrigerator, hence if the propane fridge continue to provide service, the results of this analysis remain fairly accurate.
- Composting toilets to replace existing flush type would save on water pumping and reduce electrical energy consumption. The units to be installed in the parking area this year (2011) will give a good indication of their suitability.
- Remote monitoring of system status is possible to determine acceptable battery charge levels, but this assumes the satellite Internet service is active and connected to an active computer.
- Remote visual monitoring of the building is possible with a remote network camera connected directly to the satellite Internet modem, rendering it accessible for viewing via the Internet. This option only requires the satellite Internet to be operating. For an example of the image quality and rendering, visit http://roof-cam.daniels.utoronto.ca.
- A remote weather station for research purposes can be installed to broadcast current conditions and store climate data. This assumes the satellite Internet service is active and connected to an active computer, or broadcasting to a hosting organization (i.e., Environment Canada). Grant support for a weather station is worthwhile exploring among federal and provincial agencies.

Sifferd Cottage

Presently, there is no renewable energy system at the Sifferd Cottage and there are only a propane powered stove and refrigerator available. Analysis of a PV system assumed the same fundamental configuration as that of the Visitors Centre, featuring an 800 Watt PV array and 16 batteries, each nominally operating at 6V and with a capacity of 320 Ah. They are allowed to discharge by 22% from maximum capacity. This yields a total effective capacity of 6.7 kWh (24.3 MJ). The array is assumed unshaded and the system components are assumed to have the same efficiencies as that of the Visitors Centre. Three scenarios were examined: lights and pumps only; lights, pumps and electric refrigerator; lights, pump and laptop. The Cottage is assumed to be operated from May 1 to October 31.

Based on the analysis, it was concluded that:

- This system is adequate for all three scenarios, except in the latter two there was a minor shortage of energy in September and October.
- While not explicitly modeled, this system has sufficient capacity to also run a UV-sterilizer during the summer months.

Under the scenario where the propane powered equipment remains and insufficient funding is available in the short term to purchase and install a complete PV system, there are stand-alone solutions for composting toilets and portable solar-powered charging devices. This technology would restrict the Sifferd Cottage to day use only, but would comply with environmental, health and safety regulations.

Figure 12. The Clivus Multrum M54 ADA Trailhead (left) is a stand-alone, self-contained, composting toilet building (privy or outhouse) with a solar panel to run the venting/aerating system. Portable photovoltaic charging station for personal computers and mobile electronic devices is effective during summer months when solar intensity is high and daylight hours are long. [Note: Production on model shown has been delayed until later this year.]

For practical and aesthetic purposes, it should be noted that Mr. Rick Gagnon recommended that the PV array be located up to 50 metres away from the Sifferd Cottage, mounted on a tall pole to remain inaccessible to visitors, and located so that the panels remain completely unshaded at all times of the year.

Operational and Maintenance Issues

Unlike year-round facilities, Misery Bay Provincial Park does not enjoy continuity among staff and continues to depend largely on its volunteers, Friends of Misery Bay. As such, it is important that newcomers, both from Ontario Parks and volunteer organizations, gain the benefit of a secure but conveniently accessible body of documentation describing schedules, procedures, contacts, etc.

- Comprehensive site plan indicating all roads, buildings, service wiring/piping, septic system, well, renewable energy systems, etc.
- Complete set of 'as-built' drawings and specifications (regularly updated to reflect any changes). [Note: Complete as-builts are currently not available.]
- Complete inventory of furnishings, fixtures, appliances and equipment.
- Operations and maintenance manual (printed and online) describing opening, shutdown, maintenance and schedules for the entire facility, including the renewable energy systems.
- Staff/volunteer orientation and training procedure.

Building facilities are a relatively expensive investment compared to technology such as an automobile, yet it is widely acknowledged that cars, worth a small fraction of a building, benefit from a much better system of inspection, maintenance and repair. Building facilities management practices are generally poor in North America due to a predominance of relatively new facilities, unlike other parts of the world where a large proportion of building stock is several centuries old and it is understood that maintenance, repair and rehabilitation are normal requirements for their conservation.

Inspection/Maintenance	Daily	Weekly	Monthly	Seasonally
Propane Tank Level				
Electrical Generator				
Boiler				
Domestic Water Heater				
Batteries				
Well/Pump				
Septic System				
UV Sterilizer				
Composting Toilet				
Emergency Radio				
Satellite Internet				
Circle Check (Building)				
Circle Check (Garage/Shed)				

Table 2. Example of an inspection/maintenance checklist. Note that each procedure should be correspondingly documented in an operation/maintenance manual containing regular service and emergency contact information.

The periodic replacement of building elements and the rehabilitation of surfaces/finishes is essential to the sustainability of any facility. Roof replacement, exterior re-finishing, replacement of wood decking/railings are examples of items that must be addressed systematically to avoid costly damage (e.g., rain penetration, rot, etc.). Preventive strategies reduce the compounding of costs (repair of damage followed by replacement of faulty element that should have been replaced before the damage occurred). The most prudent approach to proactive facilities management is to prepare a reserve fund study where annual and periodic costs associated with maintenance, repair, replacement and rehabilitation are projected into the future to establish the equivalent annual amount needed to sustain a proper operating condition.

This study recommends the following course of action:

1. Preparation of a complete documentation package for the Misery Bay Provincial Park facilities.
2. Development of a comprehensive inspection, operation/maintenance procedures manual.
3. Forecast and establish an operation/maintenance, repair, replacement and rehabilitation budget.
4. Implement a regular updating of the above to reflect the evolution of the facilities.

Possible Future Uses of the Park

This study does not advocate any possible future uses of the park and facilities, but a number were identified during discussions with stakeholders. While the present facilities and supporting resources are highly limited to the current type and extent of usage, it is important to anticipate and prepare effective strategies to evaluate and implement future uses.

The present usage largely involves visitors hiking the trails and observing the ecology, whether or not the Visitors Centre is accessed. The Visitors Centre is generally not perceived as a destination in itself, but as a gateway to the Misery Bay environment. This situation could change as the surrounding community and affiliated organizations realize the Visitors Centre is an ideal setting for meetings, symposiums, and colloquiums involving small groups. Internet access and presentation facilities are currently adequate for such purposes and there are suitable accommodation and meal options available within a 30-minute driving radius on Manitoulin Island. Aside from becoming a potential revenue stream, this usage may promote awareness and future support of the Friends of Misery Bay. Such a usage would likely be confined outside of July and August when the highest level of public visitation occurs, leaving the latter half of April, May, June, September, October and former half of November available for this type of use.

Similarly, the Visitors Centre is an ideal educational venue for school field trips during these four months. School boards have funding set aside for these purposes, and a user fee (e.g., flat rate per bus load) could more than fully recover the cost of caretaking. It is important to note that for both of these possible uses, there is a need to have personnel available to open, operate, clean and close the facilities.

Across Misery Bay, the Sifferd Cottage remains an untapped resource that could be transformed into an ecological research station. Academics and scientists are presently restricted in their choice of research venues at Misery Bay. While it is possible, and often preferable, to locate the provision of accommodations and meals elsewhere on the Manitoulin Island, there is a need to provide a station facility for lunch meals, bathroom breaks, meetings, telecommunications (Internet) and storage of equipment, samples, etc. It also serves as a refuge during inclement weather conditions. A university biology program would seriously consider Misery Bay as a research field trip venue if suitable facilities were available at a reasonable cost. Accommodation in the Sifferd Cottage is also a possible option, but for a much smaller number of people than a typical field school and/or research exercise. Under these circumstances, potable water and proper sanitation facilities are essential.

As the previous renewable energy analysis indicates, the Visitors Centre is not conducive to continuous winter operation as it is currently configured. However, with the provision of composting toilets and WiFi Internet access, it could become a popular snowshoeing and cross-country skiing destination. There is sufficient renewable energy generation to operate the park-and-pay equipment and satellite Internets, as well as a remote security camera. A fire pit and shelter from the wind at the garage/shed structure would provide comfort and amenity for winter visitors.

Finally, while it may be difficult to imagine in the near to medium term, Misery Bay Provincial Park could become part of a larger eco-tourism industry on Manitoulin Island. An aging population and escalating gasoline prices will likely drive a trend toward more local tourism destinations in the Great Lakes region, and Manitoulin Island has a great deal of distinctive ecological settings that are accessible by land and water. This suggests that a much larger number of visitors can be expected in the future and there may be a need to expand parking areas, outdoor composting toilets, and operating schedules.

Sustainability Challenges and Opportunities

An important part of this study centered on the sustainability challenges being faced by Misery Bay Provincial Park. The discussion that follows does not focus on changes to Ontario economy and government budgets, even though these are significant factors. Instead, only those aspects that can be influenced by the stakeholders are considered.

Barriers to Ecological Research/Outreach Programs

In view of Misery Bay's remarkable ecological setting, it is important to identify barriers to ecological research and outreach programs. Climate change will have some impact on the Misery Bay ecosystem and this phenomenon is worthy of research and dissemination by itself, beyond the traditional areas of research involving alvar ecotopes. Outreach programs by nature conservation advocacy groups like Friends of Misery Bay rely on having world-class scientists and researchers reporting on the ecological significance of Misery Bay. This neutral third-party assessment is a necessary means to enhanced fundraising in the form of grants, donations and transfers from various private and public sector organizations with a sustainability agenda.

The currently identified barriers to fostering research and outreach programs are a lack of suitable research facilities and an effective public relations program. These two factors are somewhat symbiotic and together they have the potential to advocate a sustainable future for Misery Bay Provincial Park.

Research, Broadcasting, Promotion and Fundraising

The fundraising opportunities by conservation advocacy groups like Friends of Misery Bay are highly dependent on research, broadcasting and promotion, and the key relationships are depicted in Figure 13.

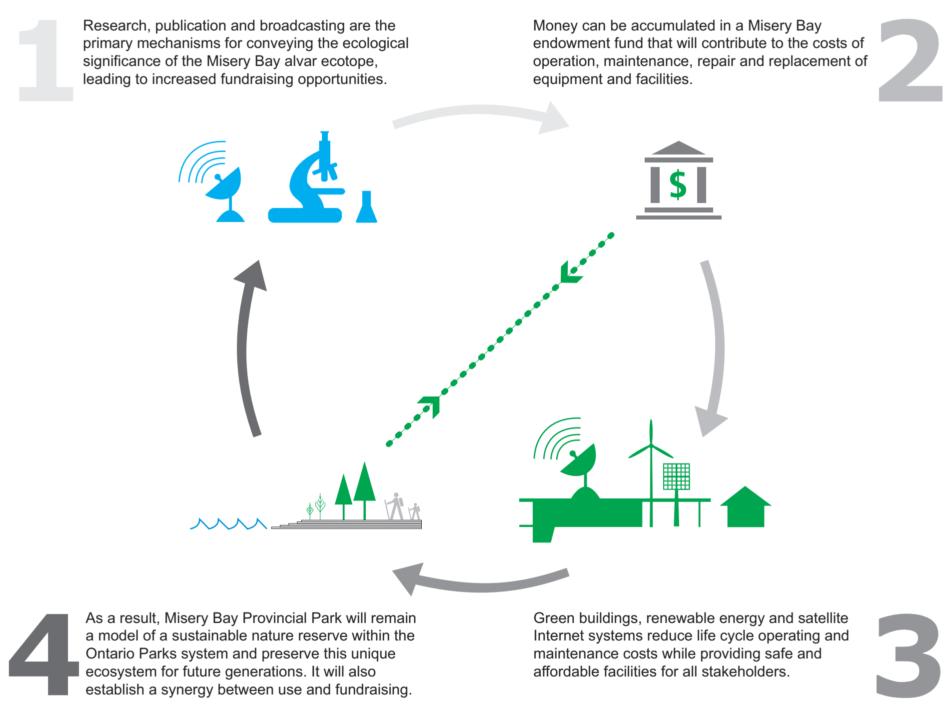

Figure 13. Relationship between research, funding, facilities and recreation, and their symbiosis with sustainability. In an era of shrinking government budgets, user pay systems are an ideal means of sustaining public facilities while maintaining a minimal ecological footprint. High profile research and dissemination are the most effective means of attracting funding from the private and public sectors.

Sustainable Development Strategies

How much annual funding is required to maintain the existing facilities and services at Misery Bay Provincial Park over the useful life of the buildings and their supporting infrastructure? What is the sustainable ecological footprint exerted by park users? As with all issues pertaining to ecological carrying capacity and sustainability, it is important to appreciate there are limits within which the Misery Bay ecosystem can continue to thrive alongside human occupation, and the park's facilities can be supported by available government and non-government resources. This section of the study seeks to examine possible strategies and scenarios to strike a balance between ecology, culture and technology.

Since the time of the pioneering work in the field of sustainable development, the focus of global attention has shifted to emphasize intergenerational equity. The concept of intergenerational equity is based on three principles: *conservation of options* (diversity of natural and cultural resources); *conservation of quality* (planetary quality and condition); and conservation of access (*equitable rights of access to the legacy of past generations*).[10] Within this context, it is the ethical obligation of the originating generation to minimize adverse impacts on inheriting generations when carrying out built environment (infrastructure) interventions that have social, economic and environmental implications.

Figure 14. The triple bottom line of social, environmental and economic sustainability is achieved through the appropriate adaptation of culture and technology within an ecological context. The potential for this adaptive process to evolve and appropriately meet the needs of future generations forms the basis of this sustainability study.

[10] Weiss, Edith Brown. *Environmental Change and International Law: New Challenges and Dimensions*. United Nations University Press,1992. http://www.unu.edu/unupress/unupbooks/uu25ee/uu25ee00.htm#Contents

Viewed through the lens of intergeneration equity, the Misery Bay Provincial Park facilities are exemplary in their vision of modest but robust assets demonstrating environmental responsibility. Figure 15 explains the rational for this assessment. It illustrates an investment that begins in a base case state corresponding to minimum codes and standards. For every improvement to the durability, efficiency and environmental sensitivity of the asset, a corresponding capital cost and life cycle cost (net present value) is calculated, thus indicating the life cycle savings associated with the improved level of performance. An examination of life cycle savings versus incremental capital costs for facility improvements beyond the base case indicates that the first round of improvements yield gains in life cycle savings that far exceed the incremental costs. This trend is commonly observed in real projects because our minimum standards deliver such poor long-term performance that the slightest improvement yields immense life cycle cost savings. It also reveals the power of intelligently deployed technologies to act as economic levers attaining large returns of life cycle savings for small amounts of capital outlay. As the process of incorporating performance enhancing measures continues, the difference between the two is invested toward further improvements, and eventually the life cycle savings begin to level out as the capital cost approaches the life cycle cost (e.g., zero footprint infrastructure). At some point, the life cycle cost and capital cost curves intersect causing the life cycle savings to go to zero. This marks the threshold of intergenerational equity.

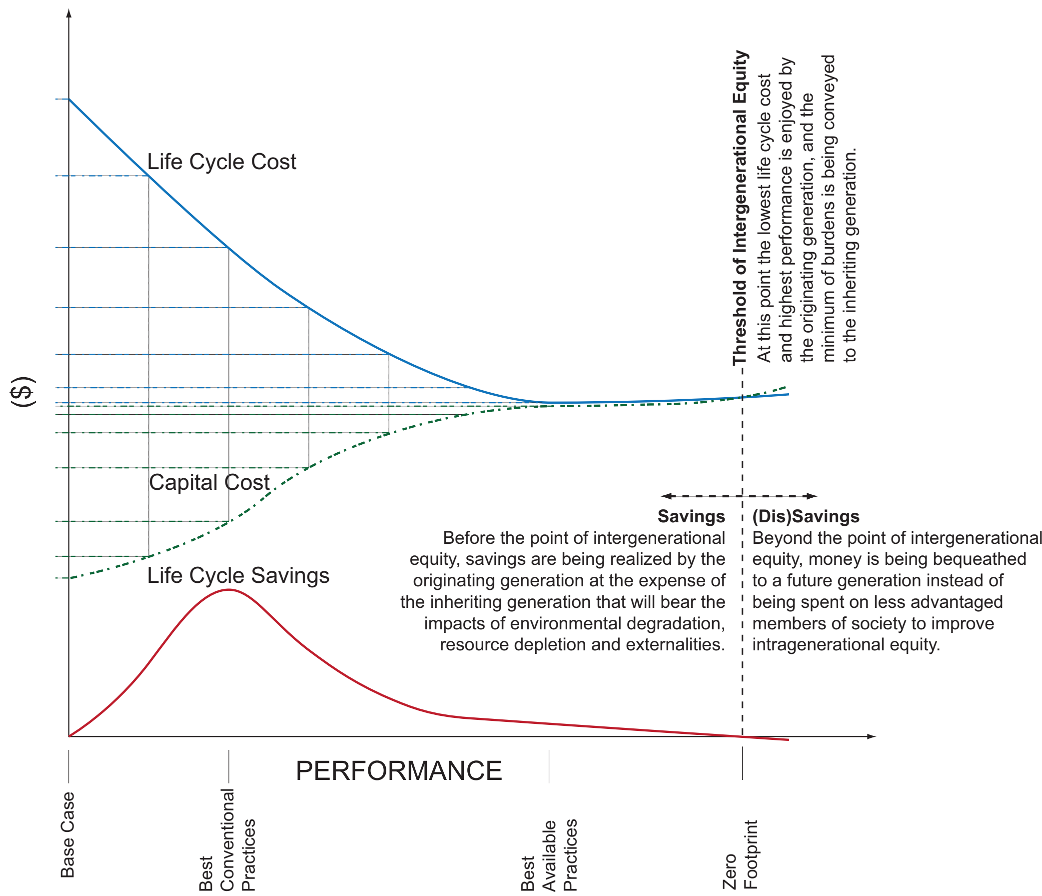

Figure 15. Relationship of an infrastructure asset's life cycle cost, capital cost and life cycle savings to an economic measure of intergenerational equity. (Performance levels are approximate and notional acknowledging multiple metrics constitute a broader performance index.)

The facilities at Misery Bay are at, or very near to, this threshold because of the durability, efficiency and low energy demands of the Visitors Centre. Many projects do not attain this level of performance because concerns over first costs displace long term benefits from more costly investments. This was not the case for the Visitors Centre where long-term design thinking dominated and reinforces why this ethic should continue to be applied in future decision making.

The need to strive for appropriate technologies that *'do better with less'* and add value without the additional input of exhaustible resources is a formidable challenge in an era of shrinking government budgets and an increase in the number and diversity of environmental organizations seeking funds to promote conservation of our ecological heritage. This challenge goes beyond renewable energy technologies and implies a need to craft an intelligent migration path that supports the sustainable development of Misery Bay Provincial Park.

Some of the guiding principles to achieve this objective are outlined below.

Planning for minimal environmental and community impacts - ensuring that future growth and development is not hindered by infrastructure type or location and configured to eliminate or significantly reduce disruption when renewal/replacement is necessary.

Design for adaptability - providing for future changes of use or the accommodation of technologies without the need to displace current.

Design for durability - selecting materials and equipment with long service lives and low maintenance costs that will provide several generations with reliable and undisrupted service.

User-pay capital recovery - adjusting park user fees to responsibly afford future investments in operations, maintenance, repair, replacement and renewal.

Adopting appropriate resource conservation policies - tying growth to sustainable resource utilization targets so that new park development is required to adopt appropriate conservation programs such that no net increase in life cycle costs is transferred to inheriting generations.

The recommendations made in by this study are based on these guiding principles and should not be considered static. As the context changes, new groups and ideas must have a forum for discussion and debate such that a process of continuous dialogue among all stakeholders is fostered. Only a dynamic process guiding the evolution of Misery Bay Provincial Park can assure its survival across future generations. The open and transparent interplay of ecology, culture and technology is a reliable vehicle for advancing these principles of sustainability.

Sustainable Development Scenarios and Recommendations

This concluding section of the study seeks to establish a framework for ongoing discussions among stakeholders. It looks at some possible future scenarios and provides constructive recommendations for a future course of action.

Future Scenarios

Based on the experiences of numerous conservation organizations across North America, it is unlikely a sustainable future for Misery Bay Provincial Park is achievable without the engagement of succeeding generations. It will be difficult to attract volunteers and to collect sufficient users fees if there is no interest among the upcoming generation. This is not a sustainable future scenario, and therefore there is only one alternative scenario - to move forward without increasing the ecological footprint of the facilities.

Under this second scenario, there are several options. Investing in environmentally responsible facilities and expanding the use of the park through promotion and fundraising will require a master plan that engages all stakeholders. Media relations and broadcasting are critical to raising awareness and stimulating interest. Accordingly, the Visitors Centre and the Sifferd Cottage become destinations in themselves hosting functions that generate revenues and increase the visibility of the park.

The first option to achieving this scenario is by government funding alone. Ontario Parks and the Ministry of Natural Resources may wish to promote nearly carbon-neutral facilities situated on a world-class ecosystem as the future of new park developments across Ontario. The second option is to partner with the Great Lakes university sector to secure research funding that will contribute to the necessary investments needed to carry out a robust program of scientific study and dissemination. A third option is to aggressively fundraise among the private sector and conservation advocacy organizations for donations in support of the enhancement of Misery Bay facilities and operations. Finally, all of these options can be pursued together so that no single stakeholder is excessively burdened.

The critical consideration for the Misery Bay facilities is maintaining a migration path towards evolving renewable energy systems and clean technologies. Decisions that would render it technically difficult or economically prohibitive to migrate to future alternatives should be avoided. At this point in time, adaptability and flexibility are not significant issues for the existing facilities and they do not pose any barriers to future initiatives. The reason it is important to keep this concept in mind is that the cost of these technologies is decreasing while their performance is improving. In another 10 or 20 years, it may be possible to cost effectively achieve a robust, carbon neutral facility providing the basic infrastructure is compatible. In practical terms this suggests that non-renewable energy forms should be avoided and that renewable energy options should be encouraged.

Misery Bay Provincial Park facilities have already achieved a net-zero energy status in that their renewable energy production far exceeds the non-renewable energy consumption (propane). Technically speaking, the facilities are net-positive in respect to energy. With respect to becoming carbon neutral, it is important to appreciate this term is somewhat of a misnomer. A carbon neutral building is defined as a facility with net-zero greenhouse gas emissions over its life cycle. This includes all aspects of the processes related to the extraction, manufacturing, transportation, construction, operation and demolition of the building. At this point in time, with the exception of igloos and mud huts, there are no absolutely carbon neutral buildings. Instead, there exist a wide variety of low-carbon buildings some of which claim being carbon neutral by virtue of purchasing carbon offsets. In fact, looking at Misery Bay Provincial Park holistically, if it was to achieve carbon neutrality it would have to account for the greenhouse gas emissions of vehicles used to travel to and from the park. Clearly, it is not in the interest of the stakeholders to entertain such semantics. However, it is worthwhile to practically minimize the ecological footprint of the facilities and to maintain exemplary standards for sustainability. As long as the park facilities do not exceed the ecological carrying capacity of Misery Bay, some degree of carbon emissions is permissible. For example, the management of the tree line may require the use of chainsaws and the question to ask is how much energy is saved by passive solar gains for the small energy expenditure associated with fuel for the chainsaws and vehicles used to transport workers to and from the site. A process of reasonably assessing costs and benefits is key to responsible decision making and a sustainable future.

Recommendations

The following recommendations have been provided in the interest of all stakeholders. They are presented in the spirit of collegial discussion and the authors of this study fully acknowledge these are neither binding on any stakeholder nor exclusive of better intentions and ideas.

- There is a need to establish a working group that will forge a comprehensive master plan and a coherent set of sustainability strategies for the future of Misery Bay Provincial Park. The master plan should include milestones and funding requirements corresponding to the necessary and desired investments.
- In the very short term, it is important to carry out the required maintenance and repair cited in this study in order to conserve the existing facilities. This will enable medium and long term planning to proceed without compromising the hard work and resources embodied in the existing facilities.
- The Sifferd Cottage is an untapped resource that can be made available to the scientific research community in some form of use with relatively low initial expenditures. This facility is critical to a longer term mission of research and dissemination that will foster fundraising opportunities.
- Means of engaging the upcoming generation in the support and operation of the park must be explored and promoted. Friends of Misery Bay must look ahead and imagine the make-up of its future board of directors. A balanced matrix of local and native stakeholders working with external members from industry, government and academia is likely to provide the broadest perspective on park issues and opportunities.
- Ontario Parks should consider using Misery Bay Provincial Park to pilot a program of expanding services without increasing its ecological footprint. This will serve to inform future policies and programs.
- Conservation is the key to sustainability. Natural conservation through energy efficiency improvements in lighting and equipment, and future improvements in the cost and efficiency of renewable energy technologies, will inevitably lead to a lowering of the carbon footprint. This should be coupled to an ongoing promotion of energy and resource conservation at this exemplary facility.
- For reasons of safety and security, the continuous operation of a WiFi system and a security camera are recommended. Telecommunications would enable email and text messaging and the live cam link would animate the park web site.
- Media relations and public outreach are key to the long term viability of Misery Bay Provincial Park. Raising public awareness of its existence, promoting use of the park to educational institutions, and partnering with stakeholders to host high profile events are among the strategies needed to compete for the funding of Canada's nature reserves.
- The open and transparent sharing of information and discussions among stakeholders is the most effective means of bringing the best ideas to the table. It is important to establish a regular protocol for information exchange and dialogue so that this process can be properly planned and scheduled.

The technical analysis of renewable energy options that forms a large part of this study must be viewed in its proper context - as one among many forms of stewardship that are needed to sustain Misery Bay Provincial Park. Human factors, economic and political forces will always exert a larger influence on the sustainability of public assets than technology. Culture selects technology that subsequently impacts ecology to a lesser or greater degree. The culture of stewardship holds out the most hope for nature conservation and it is hoped the technical details of this report do not obscure that reality.


Misery Loves Company
F.O.M.B.

Appendix A

Misery Bay – Sustainable Energy System Strategies

This Appendix quantifies all major energy strategies for operating the Misery Bay Interpretive Centre, including estimates on electrical energy demand, solar PV system energy generation, and passive and active heating of the space. It also includes a similar analysis (for just the PV system) at the Sifferd Cottage.

Note: All calculations are predictions that are based on best practice and are intended to be used for system sizing and to gain an understanding of major quantities of energy; results will be inapplicable if the space is used significantly differently than assumed or if the building or system is significantly altered.

System objective: Operate the Interpretive Centre year-round and eliminate the need for fuel by meeting all needs through on-site renewable energy collection. Operate Sifferd Cottage until the same conditions but only from May 1 to October 31.

Constraints

- The facilities shall not be grid-connected.
- The windows are partially shaded by vegetation (tree line location is estimated in simulations).
- Electrical energy must be stored (until battery capacity is reached) or used immediately and on-site.

Assumptions (unless otherwise noted)

- Climate data used was Sault Ste. Marie, which, in general, is slightly more severe (colder with less solar radiation) than Misery Bay.
- The building was modeled as specified by the architectural drawings.
- The Interpretive Centre will be operated year-round, with activity primarily occurring during business hours (9:00 – 17:00).[1]
- The Interpretive Centre has infiltration averaging 0.05 air changes per hour (ach), which is equivalent to about 1.0 ach at 50 Pascals depressurization.
- A tree line was approximated to account for shading of solar collectors and windows, as shown below.
- The PV modules mounted on the south façade are removed to prevent shading of windows.[2]

---

[1] The operating schedule used for energy modeling is intended to analyze annual energy consumption and indoor temperatures, recognizing the facility is actually operated on a seasonal basis only. This information is useful in the future should changes to the operating schedule be envisioned.

[2] Removal of the PV modules on the south facade for energy simulation purposes was intended to determine potential overheating of the space in summer. Shading provided by these modules was found to be beneficial and in the event the modules are removed, it is advisable to mount alternative shading devices on the existing supports.

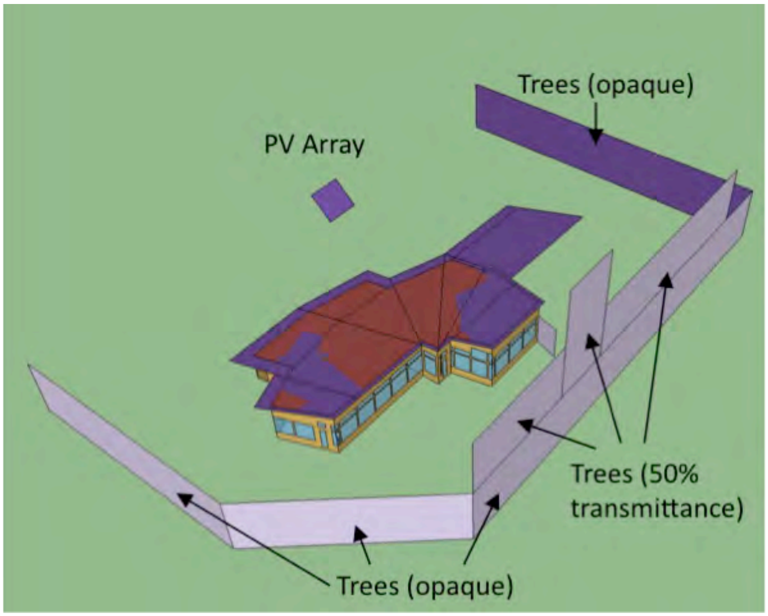

Figure 1: Isometric view of the energy model; showing assumed solar obstructions and PV array.

Strategies

- Reduce energy use through automation (e.g., daylight/motion sensors), due diligence, and electrical power consuming equipment upgrades.
- Size PV array and battery to meet demands; because of potentially long-overcast periods in the winter, the battery must be sized to provide energy for several days without replenishment.

Electricity Demand

Three cases are considered:

1) As is; most equipment on during opening hours with little attention to conservation,
2) Equipment is used conservatively and lights are turned off when daylight is adequate (threshold assumed 300 lux), and
3) Case 2 plus equipment is upgraded to energy efficient models.

The cases are quantified in the table that follows. Except for the fridge (currently propane) and exterior lighting, the loads were distributed fairly evenly during the operating hours (9:00 to 17:00) and assumed to be equal on every day of the year (with the exception of lighting, which is affected by daylight availability in the second two cases).

Table 1: Summary of energy consumption cases. Changes towards less energy use (left to right) are highlighted.

	1) Nominal					2) Improved Operations					3) Improved Equipment				
	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)
Kitchen															
Fridge	1	75	200	24	1.8	1	75	200	24	1.8	1	75	200	24	1.8
Coffee Maker	1	900	900	0.5	0.45	1	900	900	0.5	0.45	1	900	900	0.5	0.45
Lighting															
Interior Lighting	166	10	1660	8	13.28	166	10	1660	0.9	1.494	166	5	830	0.9	0.747
Exterior Lighting	5	50	250	2	0.5	5	50	250	2	0.5	5	25	125	2	0.25
Office Equipment															
Computer	2	110	110	8	1.76	2	110	110	4	0.88	2	50	50	4	0.4
CRT monitor	2	75	75	8	1.2	2	75	75	4	0.6	0	0	0	0	0
Printer	1	100	100	1	0.1	1	100	100	1	0.1	1	100	100	1	0.1
Other Equipment															
TV	1	375	375	4	1.5	1	375	375	2	0.75	1	375	375	2	0.75
Peak Power Draw (W) or Energy/Day (kWh)			**3420**		**20.59**			**3420**		**6.574**			**2455**		**4.497**

Electrical Energy Collection and Storage

Two cases are explored: 1) with the system that was proposed (48-battery storage bank) with a 1200 Watt, tower-mounted PV array, and 2) a system that is sized to meet all predicted electrical needs.

System Configuration

The PV array supplies power to an inverter, after which it supplies the instantaneous demand or is stored in the battery bank if there is excess generation. A charge controller protects that battery and controls charging and discharging. The inverter is assumed 90% efficient and the system is assumed to have 5% miscellaneous losses.

1) Nominal System

PV Array

The system is assumed to be mounted 16 feet above the ground (at its centre) with a slope of 45 degrees and a south-facing azimuth. It remains mostly un-shaded except for early morning, late afternoon, and for a brief period (about 1 hour) midday in winter when it is shaded by trees. The system has a peak nominal output of 1200 W.

Storage

Each battery is 320 Ah @ 6V. With 48 batteries and a 22% allowable depth of discharge (DOD), the maximum energy storage is 320 Ah * 6 V * 48 *22% = 20.3 kWh (73 MJ). Charging and discharging losses are assumed to be 10% each. Thus, the round-trip storage efficiency is about 81%.

Performance

The system is modelled with the nominally proposed PV system and the three possible demand cases. Results are summarized in Figures 2 through 5. For all graphs that follow, the *deficit* is the monthly shortage of energy relative to the predicted demand. The *produced* <u>useful</u> energy is the total monthly energy produced by the PV system. The *demand* is the predicted monthly electrical energy requirements. This value can vary between months for two reasons: 1) the number of days per month, and 2) for the cases where daylight availability is considered. It is important to note that while monthly results are reported, sub-hourly time step simulations were used. This means that it is possible to have a predicted electricity shortage even if the total generation is equal to or exceeds the consumption because relative timing is important.

Case 1 with the nominal PV system clearly indicates that there is consistently a shortage of available electricity throughout the year.

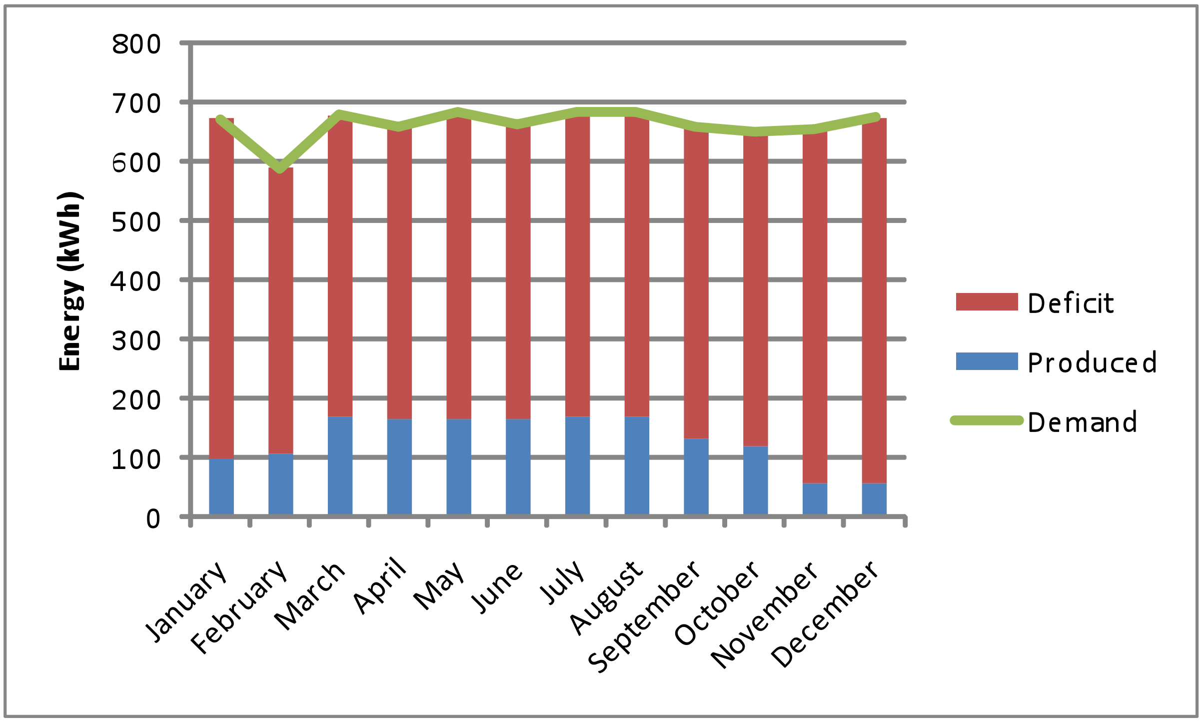

Figure 2: Case 1 - nominal PV system and loads.

Case two indicates that loads are met for the spring and summer months but that there is a significant shortage – up to about 80% - in the winter months.

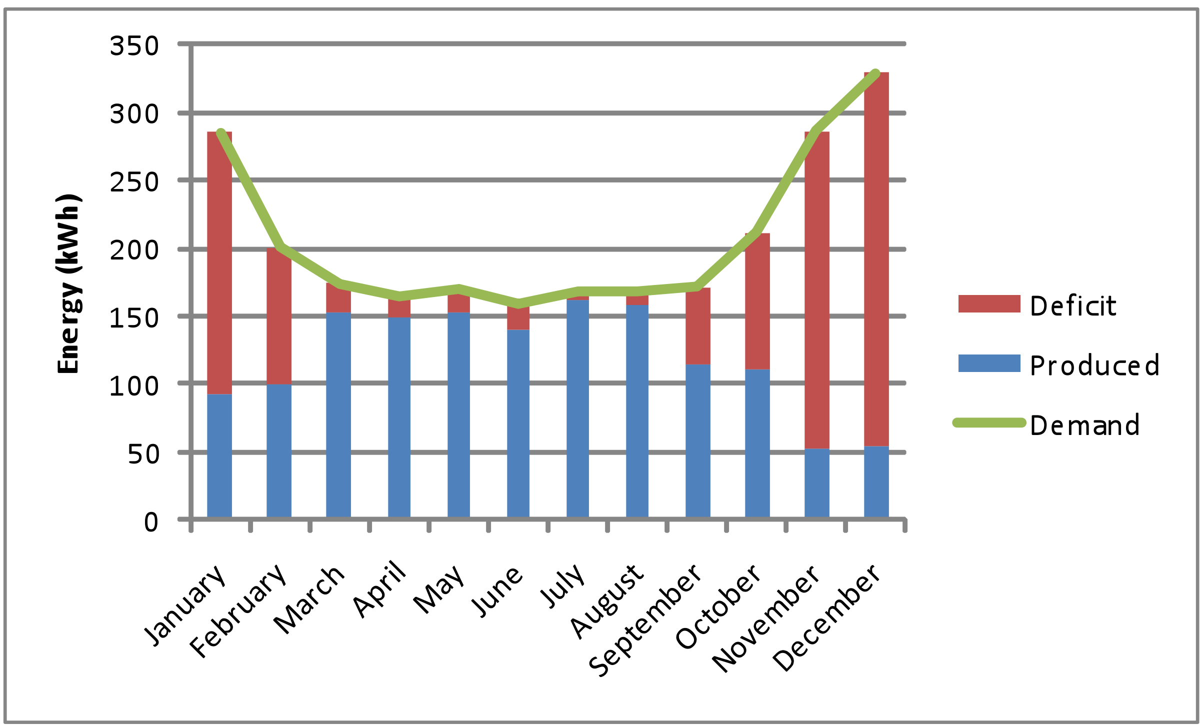

Figure 3: Case 2 - nominal PV system and reduced loads through conservation.

Case 3 shows some surplus generation in the summer, but a considerable shortage in the winter. When the battery charge is plotted (Figure 5), it is clearly the lack of PV generating capacity that is causing shortages in electricity availability, since the battery remains largely uncharged and never fully charged during the winter months. In general, the performance would indicate that a higher battery capacity would be beneficial only if there were significant day-to-day variation in battery charge. While the graph indicates that excess electricity is available in the summer months, in would be impractical to store this quantity of energy until winter in the battery. Thus, the best option to supply all of the electricity with the PV is to increase the PV array capacity. Figure 4 indicates that a shortfall of 150 kWh might occur in December, which represents 3.7 times the generation in that month.

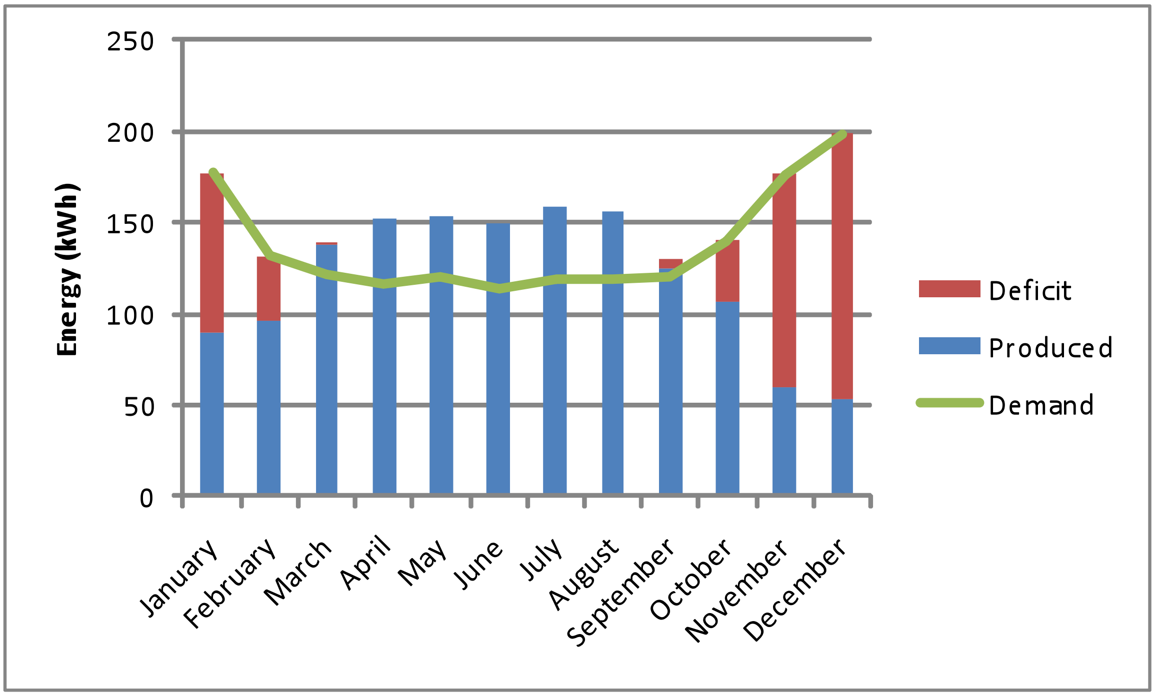

Figure 4: Case 3 - nominal PV system and reduced loads through conservation and upgraded lighting and appliances.

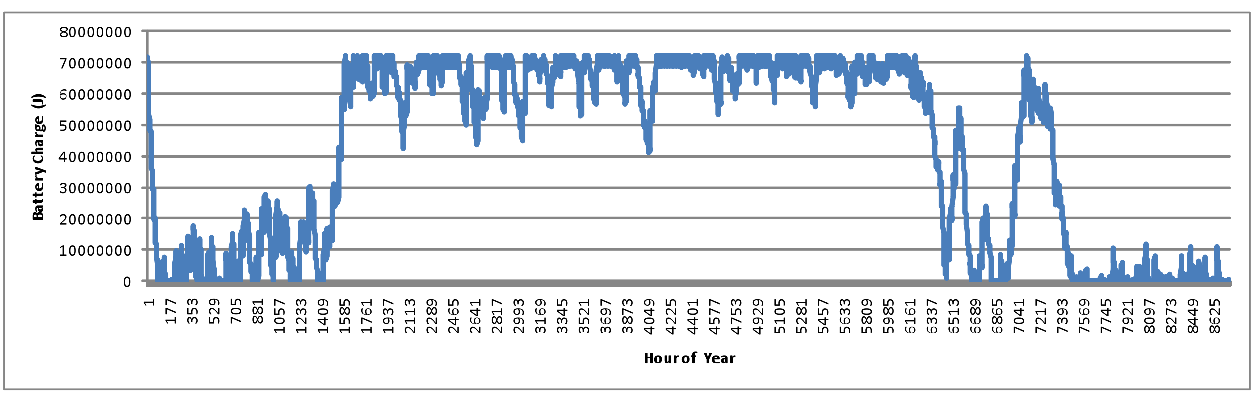

Figure 5: Battery charge (energy) for Case 3. The peak useful capacity is 72 MJ (20 kWh) with a maximum depth of discharge of 22%.

2) Upgraded System

In order to attempt to predict an upgrade of the system to provide enough energy to meet demands even in December, the PV and battery capacity were incrementally increased. The minimum sizes for the PV array and battery were found to be about 4800 W (four times the nominal) and 108 MJ (50% increase over nominal), respectively. As indicated by Figure 6, the demands are barely met in the most critical month (December), while excess capacity of about 500% occurs in the summer months.

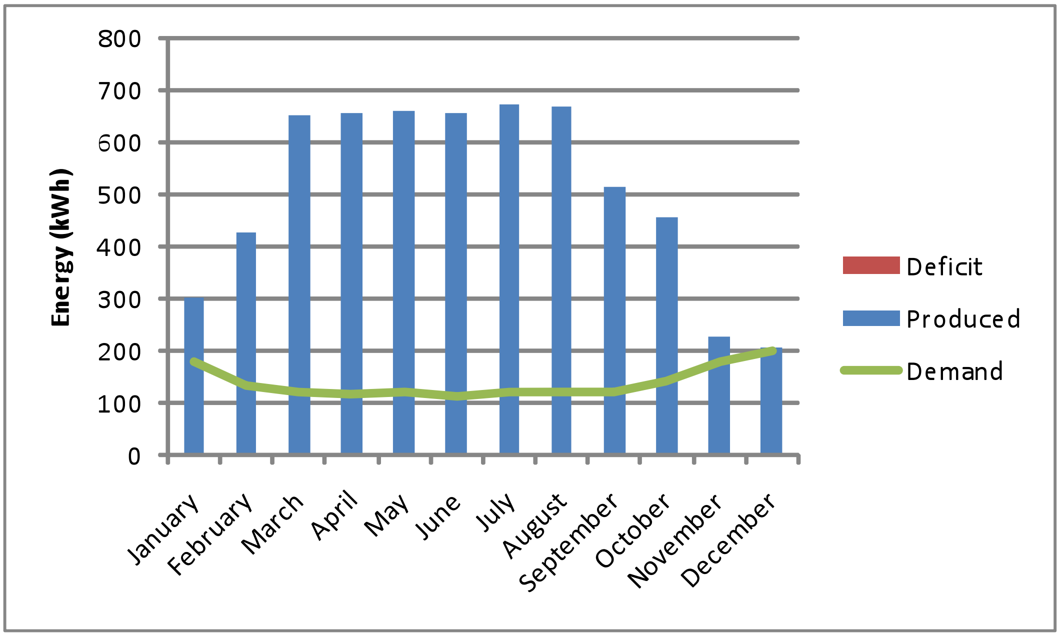

Figure 6: PV system performance with an increased array size (4800 W; 4 times nominal) and 108 MJ battery capacity (50% increase over nominal).

PV System Recommendations

Simulations performed on the PV system indicate that the nominal system, combined with energy efficiency measures (Case 3), can produce about 74% of the building's annual electricity needs. However, critical periods in November and December, during which multiple consecutive overcast days often occur, require a much larger system to achieve 100% solar fraction. The minimum size of system needed to achieve this was found to be a PV array and battery that are 300% and 50% greater than nominal, respectively. It is recommended that the nominally proposed system or one that is slightly larger (within about 50%) be used and that the rare shortage be met either by adjusting power consumption (e.g. reducing light use) or by briefly running the generator. Since the generator is already installed, the cost of running it is simply that of the fuel and maintenance. From an economic standpoint, sizing the PV system to achieve 100% solar fraction is unlikely to be superior to burning small amounts of fuel. This is particularly true because such a PV system would produce significant excess electricity in the summer, which would have little value (even as heat).

Passive Solar Performance

The building was modelled with and without the presence of shading to determine how the building is predicted to be performing relative to how it was originally conceived. The model is shown in detail in Figure 2 (solar obstructions are not shown for clarity). The windows were assumed to be triple-glazed, low-e, and air-filled. Window frames were assumed to be wood. The case with least energy use (case 3) was used for estimating internal heat gains). When the air temperature in the space exceeds 20°C it is assumed to be naturally ventilated with a mean rate of 1 m^3/s.

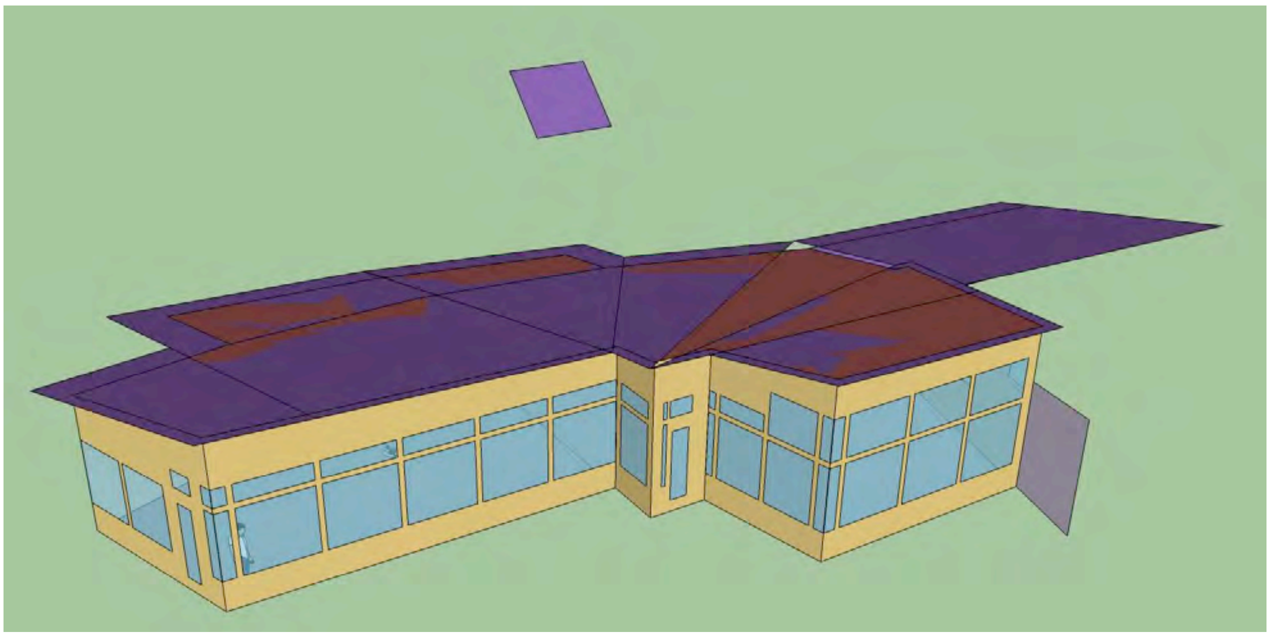

Figure 7: Energy model. Note that window frames and doors are modelled but do not appear in the image.

Passive Solar Results

First, the air temperature was allowed to float to determine its passive response. The annual air temperature profile for the space is shown in Figure 8. The results indicate that the space stays above 0.7°C when there is no shading and above -3°C when there is shading. The mean temperature difference is 2.7 °C. But the difference is consistently about 10°C during many of the critical periods in the winter. Note that the presence of the trees is beneficial in the summer; though this could be somewhat replicated with the use of movable mechanical shading devices (e.g., awnings) or deciduous trees. However, most overheating can be resolved with natural ventilation, alone.

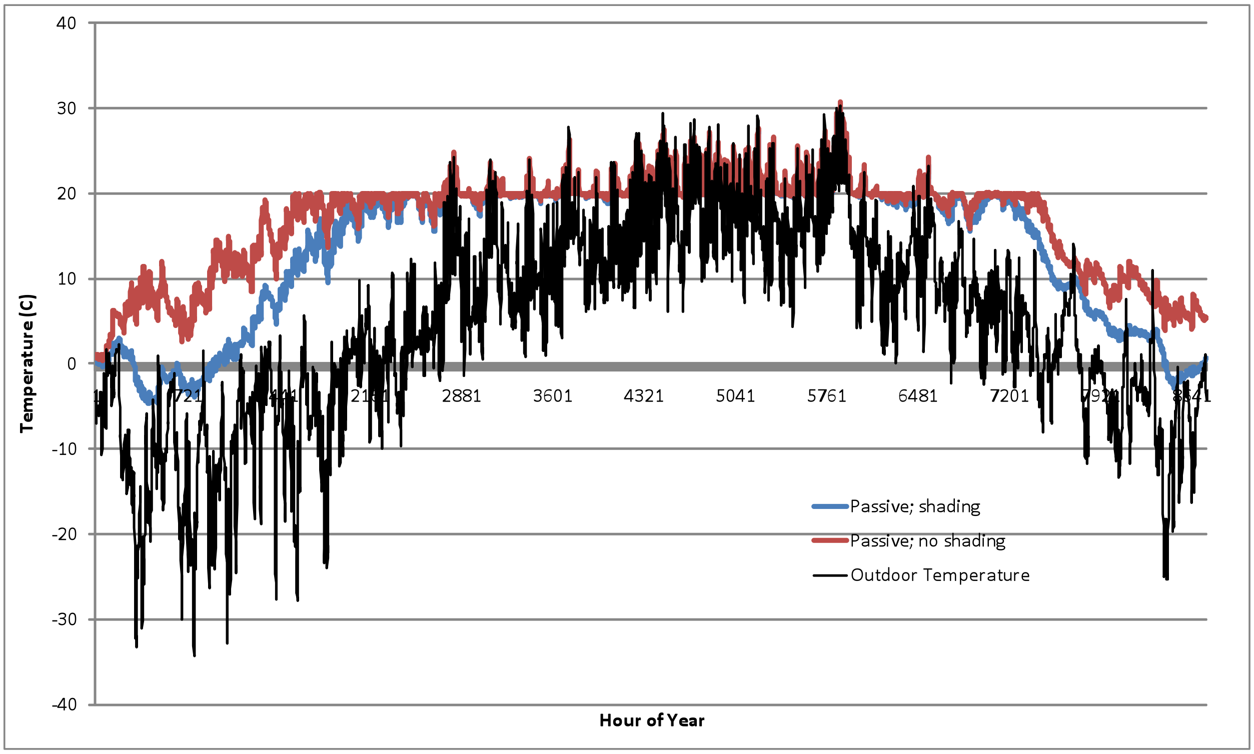

Figure 8: Passive temperature profiles for the building with both trees present and cleared.

Passive Solar with Active Heating

The heating load of the building was determined by adding heat to the space such that its temperature does not decline below 15°C. This is the first step towards estimating the appropriate size of solar thermal collectors for space heating. The predicted heating energy is shown in Figure 9. The results show that the heating energy is approximately doubled with the presence of trees. However, the length of the heating season is virtually the same length (within 1-2 weeks) regardless.

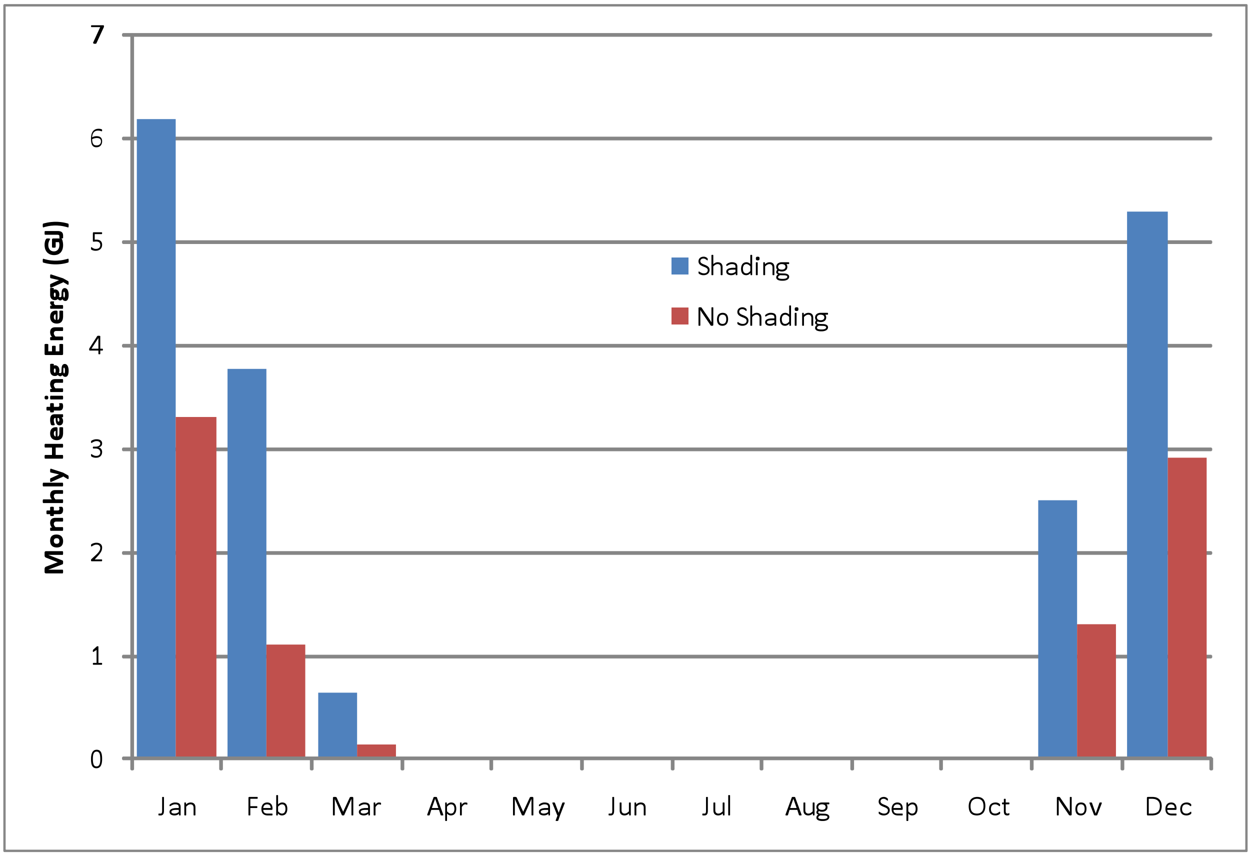

Figure 9: Predicted heating energy requirements if the building is actively heated.

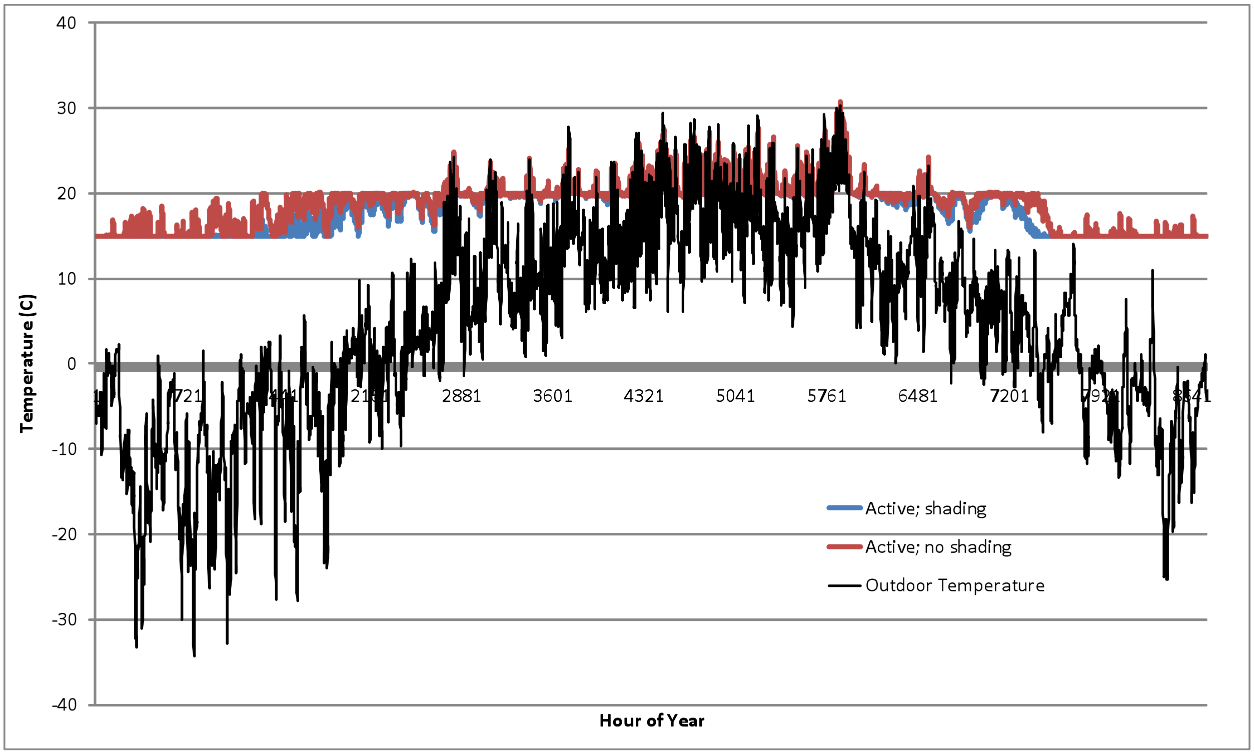

Figure 10: Active temperature profiles for the building with both trees present and cleared.

Active and Passive Solar Recommendations

While the presence of trees is predicted to cause the temperature of the space to briefly decline below 0°C, the temperature is unlikely to remain comfortable without some heating, regardless. In order to operate the facility at comfortable temperatures (above 15°C), either mechanical heating must be used or the facility should be operated only from April to October, when it is passively maintained at comfortable temperatures. This period parallels that when the nominally-proposed PV system can meet all electrical needs.

Addition of a 3 kW Wind Turbine

The addition of a 3 kW wind turbine mounted on a 20-meter tower was evaluated. The turbine is intended to provide diversity to the PV array and to provide auxiliary heat to the space. The wind turbine was simulated such that if the battery is not at full charge, it charges the battery; otherwise, the current is passed through a resistive heater contained within the space (during the heating season only).

As shown in Figure 11, the fraction of power supplied by the renewable energy systems is significantly improved from when there was not a wind turbine (as depicted by Figure 4). However, for the heating season, there is consistently a shortage. This can also be seen from Figure 12, which shows that the battery is never fully charged during the heating season – indicating that demand exceeds generation. It also indicates that there would be negligible improvement in performance by increasing the capacity of the battery, since its maximum capacity is not reached.

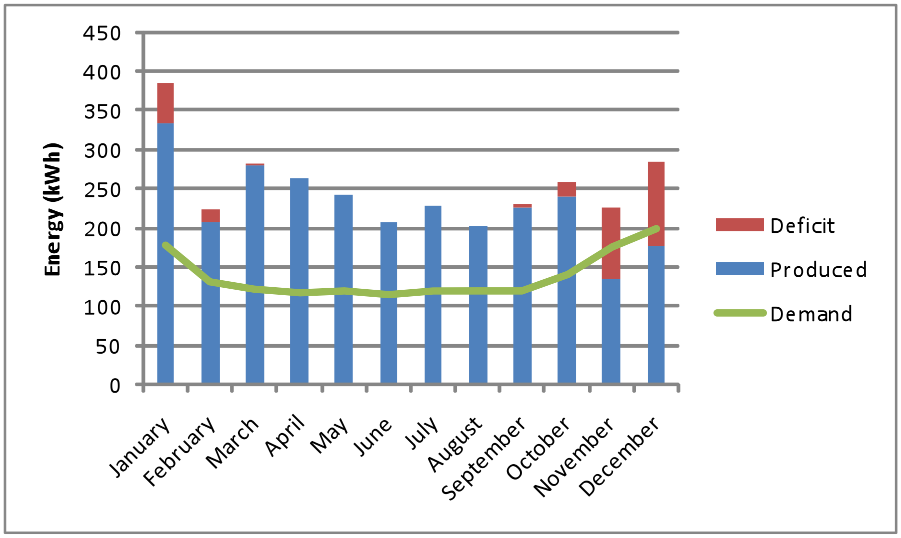

Figure 11: Electrical performance – wind and PV generation and demand.

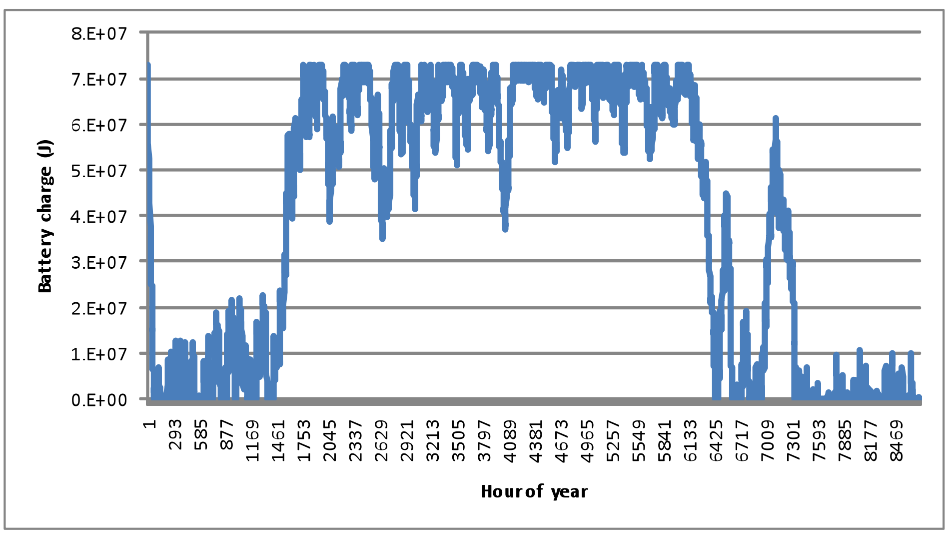

Figure 12: State of charge of battery during the year with the nominal PV array and 3 kW wind turbine.

Addition of a Solar Thermal Collector Array

A 4-panel (10.8 m^2 total) solar thermal collector array was investigated. The specifications for the panels are shown in Figure 14. The panels were modelled as being in series; thus sacrificing some efficiency in exchange for increasing the outlet fluid temperature. They are assumed unshaded and mounted above the PV array at a slope of 60 degrees and south-facing. In the simulation, the thermal energy produced (for fluid temperatures of greater than 15°C) was assumed to be distributed in the space using radiant floor heating. 2°C of temperature loss was assumed to occur between the outlet of the collector and the building. The resulting temperature of the space is compared to the situation where no solar thermal collectors are used, as shown in Figure 13. Both cases assume shading of windows from the surrounding trees as they are without any trimming. The simulation indicates that the solar thermal collector array raises the average winter indoor air temperature by about 5°C. However, there are still a few brief periods below freezing during several months of consistent sub-15°C temperatures. This is a result of the relatively high heat loss through windows compared to the modest energy input from the solar thermal collectors. However, if the objective of the system is confined to maintaining warm temperatures in the utility room (where the battery bank is houses), then the heat losses are significantly reduced. Further analysis (not graphed) with this variation indicates that the utility room can be maintained between 5°C and 20°C during the coldest days of winter. The two main strategies for further improving performance are to increase the solar thermal array size and to trim the vegetation to improve passive solar performance.

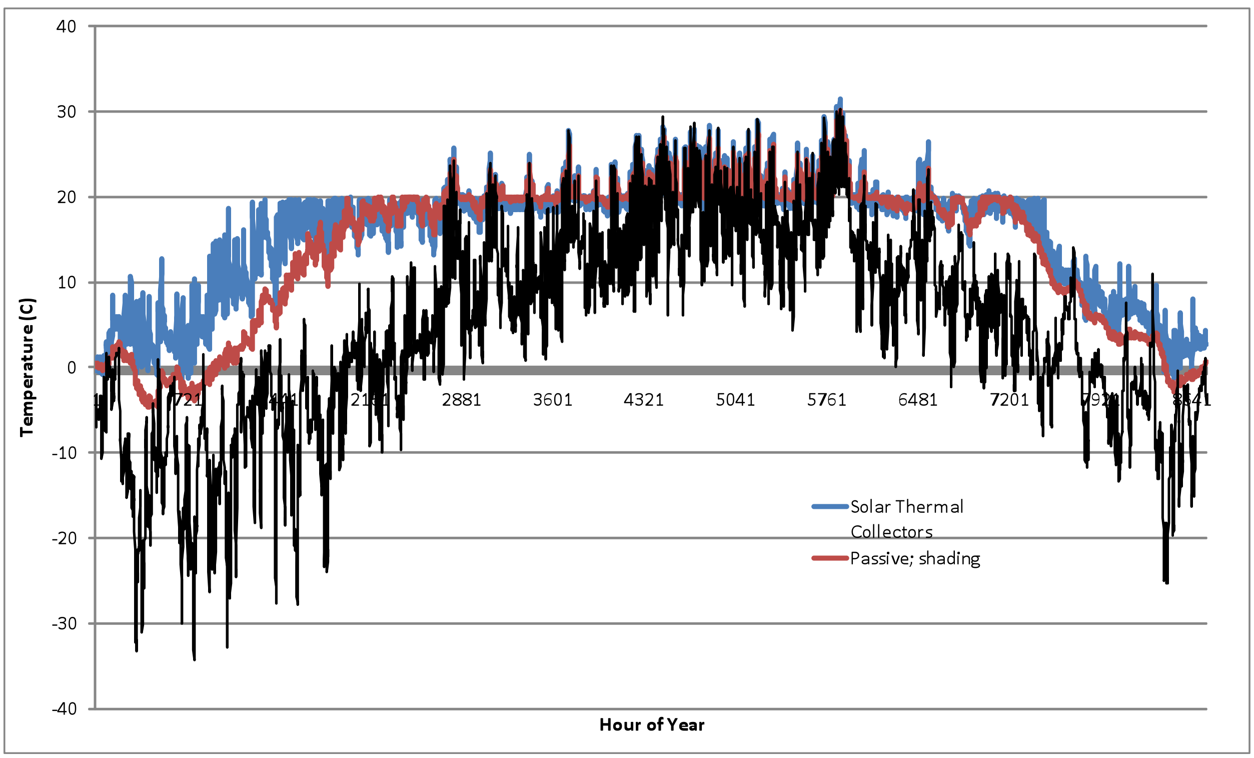

Figure 13: Annual temperature profile of building with and without solar thermal collectors.

SOLAR COLLECTOR CERTIFICATION AND RATING	CERTIFIED SOLAR COLLECTOR
SRCC OG-100	SUPPLIER: **Enerworks, Inc.** 252 Hamilton Crescent Dorchester, ON NOL 1GO Canada MODEL: Commercial Collector COL-4X8-NL-SG1-SH10US COLLECTOR TYPE: Glazed Flat-Plate CERTIFICATION #: 100-2006-006A

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of Btu Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY 23 $MJ/m^2 \cdot d$	MILDLY CLOUDY 17 $MJ/m^2 \cdot d$	CLOUDY DAY 11 $MJ/m^2 \cdot d$	CATEGORY (Ti-Ta)	CLEAR DAY 2000 $Btu/ft^2 \cdot d$	MILDLY CLOUDY 1500 $Btu/ft^2 \cdot d$	CLOUDY DAY 1000 $Btu/ft^2 \cdot d$
A (-5°C)	48	36	25	A (-9°F)	46	35	23
B (5°C)	45	33	21	B (9°F)	42	31	20
C (20°C)	39	27	15	C (36°F)	37	26	15
D (50°C)	27	16	5	D (90°F)	25	15	5
E (80°C)	15	6		E (144°F)	15	5	

A-Pool Heating (Warm Climate) B-Pool Heating (Cool Climate) C-Water Heating (Warm Climate) D-Water Heating (Cool Climate) E-Air Conditioning

Original Certification Date: September 14, 2006

COLLECTOR SPECIFICATIONS

Gross Area:	2.873	m^2	30.93	ft^2	**Net Aperture Area:**	2.691	m^2	28.97	ft^2
Dry Weight:	50.4	kg	111	lb	**Fluid Capacity:**	1.9	l	0.5	gal
Test Pressure:	517	kPa	75	psig					

COLLECTOR MATERIALS

Frame:	Galvanized Steel
Cover (Outer):	Low Iron Tempered Glass
Cover (Inner):	None
Absorber Material:	Tube - Copper / Plate - Aluminum
Absorber Coating:	Vapor Deposition Selective Coating
Insulation (Side):	Isocyanurate Foam
Insulation (Back):	Mineral Wool

PRESSURE DROP

Flow		Δ P	
ml/s	gpm	Pa	in H_2O
20	0.32	14184	56.94
50	0.79	42171	169.30
80	1.27	78210	313.98

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P) = Ti-Ta]

					Y Intercept	**Slope**	
S I Units:	$\eta =$ 0.7622	-3.2787 (P)/I	-0.0129 $(P)^2/I$		0.7683	-4.0348	$W/m^2 \cdot °C$
I P Units:	$\eta =$ 0.7622	-0.5778 (P)/I	-0.0013 $(P)^2/I$		0.7683	-0.711	$Btu/hr \cdot ft^2 \cdot °F$

Incident Angle Modifier [(S) = 1/cos θ - 1, 0°≤ θ ≤60°]

$K_{\alpha\tau} =$ 1.0 +0.0566 (S) -0.2167 $(S)^2$

$K_{\alpha\tau} =$ 1.0 -0.17 (S) (Linear Fit)

Model Tested: COL-4x8-NL-SGI-SH10US
Test Fluid: Propylene Glycol & Water
Test Flow Rate: 53 ml/s 0.84 gpm

REMARKS:

May, 2009
Certification must be renewed annually. For current status contact:
SOLAR RATING & CERTIFICATION CORPORATION
c/o FSEC ♦ 1679 Clearlake Road ♦ Cocoa, FL 32922 ♦ (321) 638-1537 ♦ Fax (321) 638-1010

Figure 14: Solar thermal panel specifications.

Sifferd Cottage PV Analysis

A similar approach is taken for the analysis of the PV system for Sifferd Cottage. Two main loads are considered: lighting and a water pump. The fridge is nominally considered to be propane-powered with zero electrical power consumption. However, an electric fridge and laptop computers are also considered in other scenarios. Lights are assumed to be used in the morning before sunrise and the evening, for a total of 6 hours per day. The pump is assumed to be used intermittently throughout the day. The fridge is on all day, while the computers are operated from 8:00 to 18:00. Three consumption cases are considered, as summarized by Table 2. The approximate 40 kWh of extra electrical energy in the first four months would be sufficient to power a single laptop for about 1300 hours (or two for about 650 hours, and so on). Ideally, they would be charged during times of excess generation (i.e., midday on sunny days).

The PV system, assumed to have the same fundamental configuration as that of the Interpretive Centre, has an 800 Watt PV array and 16 batteries, each nominally operating at 6V and with a capacity of 320 Ah. They are allowed to discharge by 22% from maximum capacity. This yields a total effective capacity of 6.7 kWh (24.3 MJ). The array is assumed unshaded and the system components are assumed to have the same efficiencies as that of the Interpretive Centre.

The Cottage is assumed to be operated from May 1 to October 31.

Table 2: Sifferd Cottage electrical loads summary.

	1) Nominal					2) Electric Fridge Added					3) No electric fridge; 2 Laptops added				
	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)	Qty. or m^2	Power Usage or Density (W or W/m^2)	Peak Power (W)	Hours/ Day	Energy/ Day (kWh)
Fridge	*Assumed propane-powered*					1	75	200	24	1.8	*Assumed propane-powered*				
Pump	1	500.00	500	1	0.50	1	500.00	500.00	1	0.50	1	500.00	500.00	1	0.50
Interior Lighting	5	25	125	6	0.75	5	25	125	6	0.75	5	25	125	6	0.75
Laptops	0					0					2	30	130	10	0.6
Peak Power Draw (W) or Energy/Day (kWh)			**625**		**1.3**			**825**		**3.1**			**755**		**1.9**

Note: Cases 1 and 3 above assume the currently installed propane fridge, Case 2 proposes installation of an electric fridge.

Performance

As for the Interpretive Centre, sub-hourly simulations were used to predict the performance of the system. The first case (Figure 15), with only lighting and a pump, is predicted to nearly satisfy all demands. It is interesting to note that while total generation exceeds total demand for the month of October, there is still a small shortage. This is because the timing of generation does not coincide with demand, and for a brief period, the battery is fully discharged (to its allowable limit). Thus, the solution to this would be to marginally increase the battery capacity (or reduce loads), rather than increasing the PV capacity.

When an electric fridge is added, with a 75 Watt average power draw, there is consistently a small energy shortage throughout the summer season (Figure 16). This could be resolved with a PV capacity that is approximately 30% higher.

When the electric fridge is removed, but two laptop computers each drawing 30 Watts are added, nearly all loads are met except for a small shortage in September and October (Figure 17). Again, like in the nominal case, this could be resolved with a small increase in battery capacity since the total monthly generation exceeds the total monthly demands. The approximate 40 kWh of extra electrical energy is the first four months would be sufficient to power a single laptop for about 1300 hours (or two for about 650 hours, and so on). Ideally, they would be charged during times of excess generation (i.e., midday on sunny days).

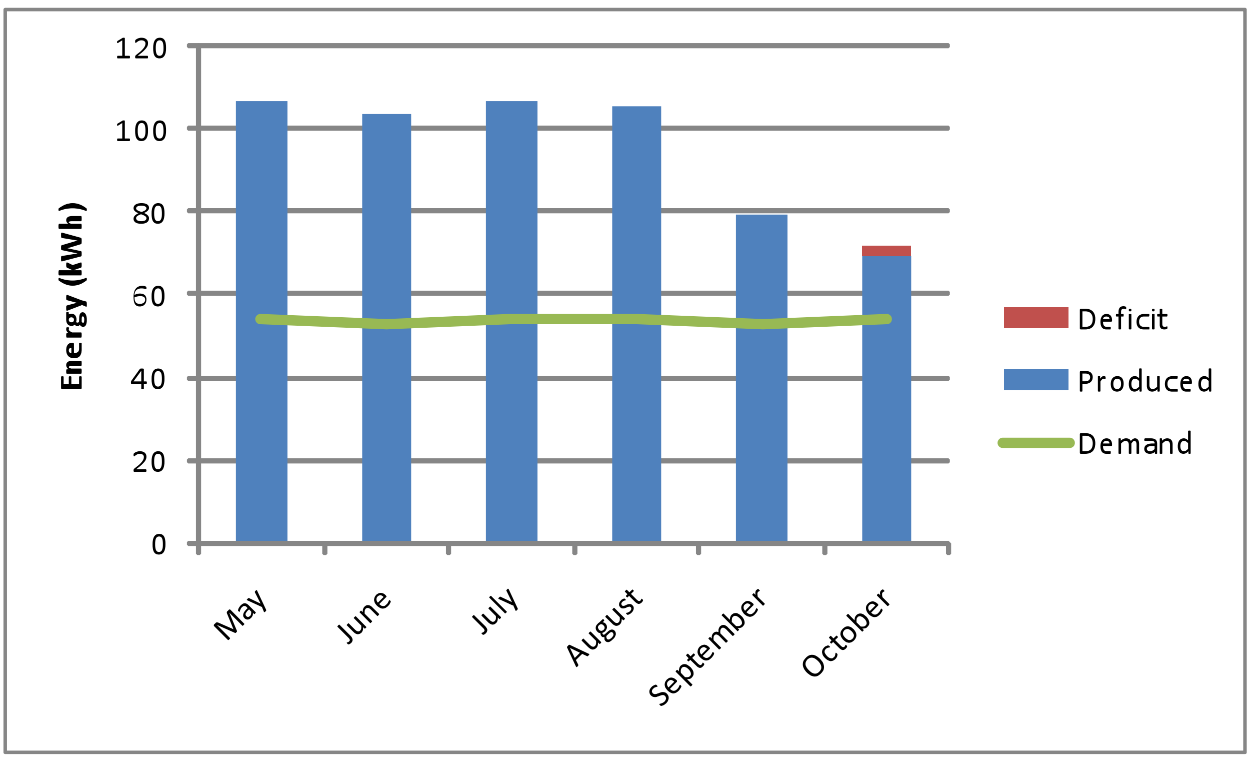

Figure 15: Sifferd Cottage nominal configuration PV system performance.

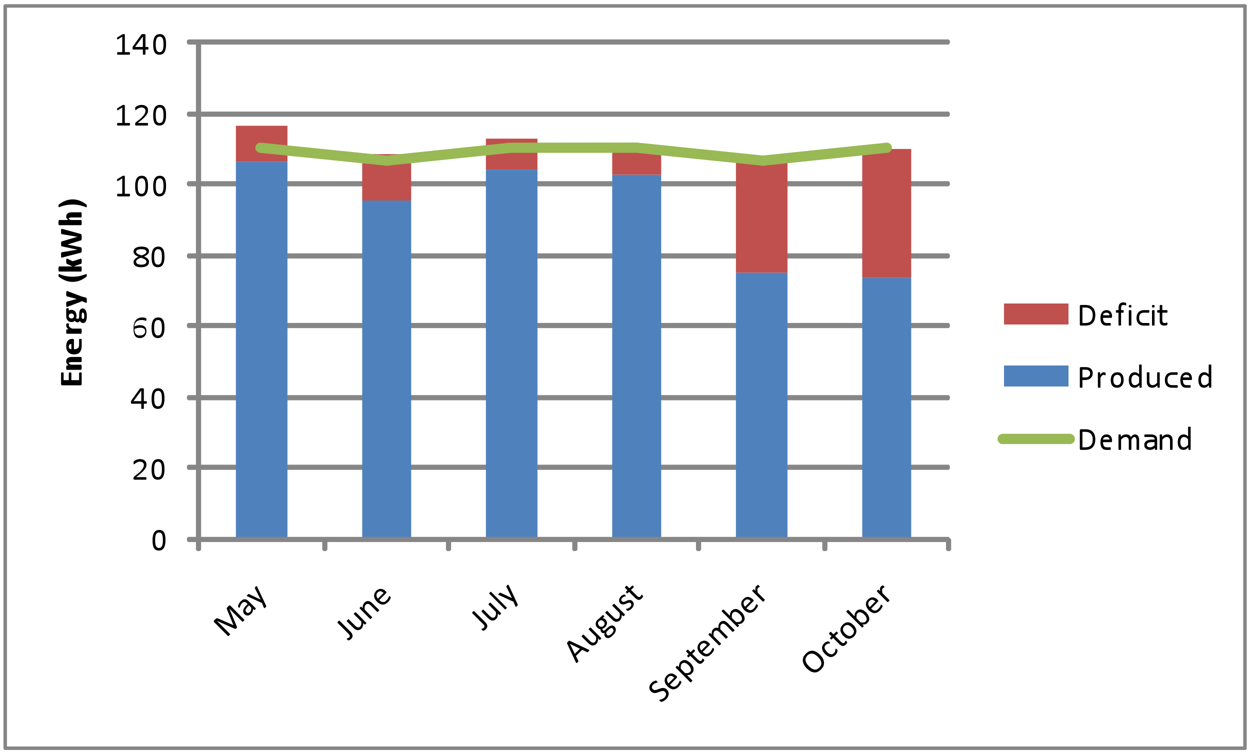

Figure 16: Sifferd Cottage (with electric fridge) PV system performance.

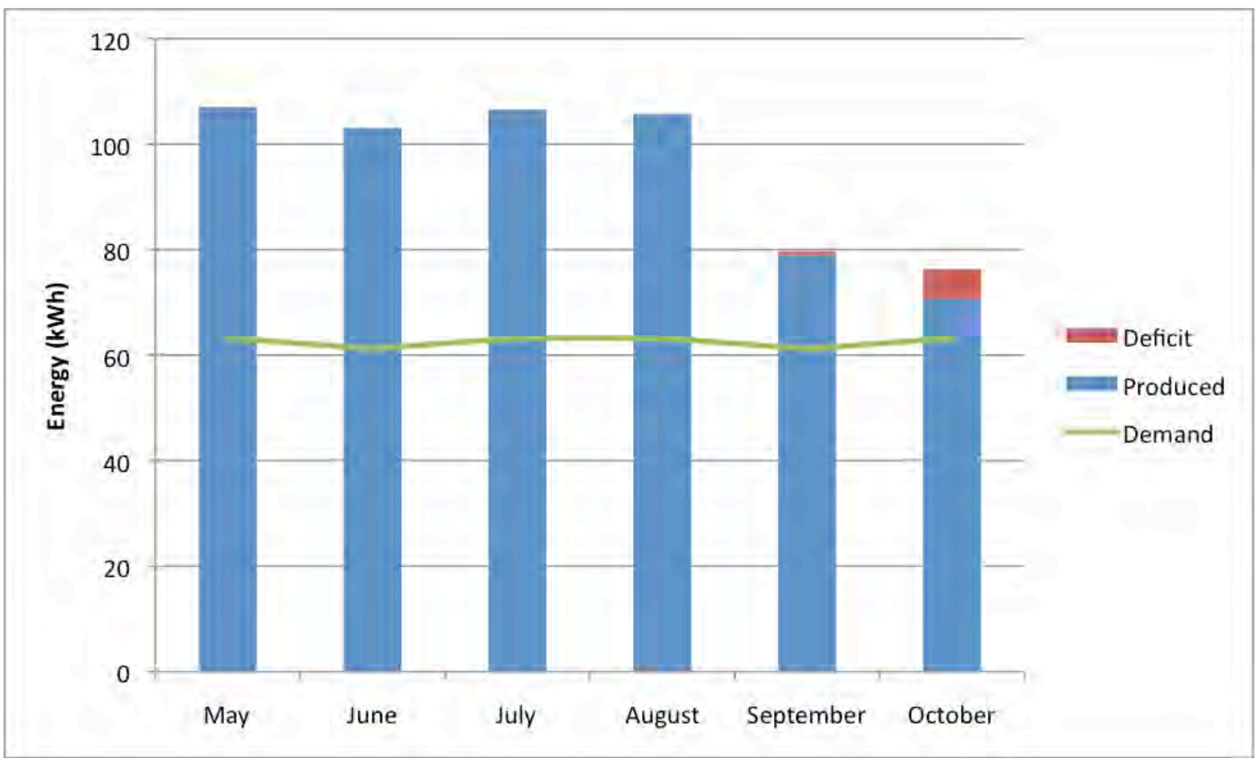

Figure 17: Sifferd Cottage (with two laptop computers) PV system performance.

Appendix B

Estimates of Work Discussed in this Study

Item	Cost †	Comments
Interpretive Centre		
Wind Turbine	$4,500 - $22,000	Range for 1.5 to 10 kW units, existing tower for PV array used to mount wind turbine.
Solar Thermal	$7,500	4 - panel array mounted on existing tower for PV array.
Web Cam	$3,000	Mounted on short tower in parking area to overlook entire facility.
WiFi	$900 per year	Building mounted in proximity to existing satellite Internet dish.
UV Water Sterilizer	$1,000	Up to 15 gpm.
Thermal Mass Fireplace*	$16,000	Assuming local stone is donated.
Glass Replacement, Ramps and Caulking/Staining of Exterior	$8,500	By local contractor.
Standalone PV Lighting for Shed	$2,500 - $3,500	One exterior area light and one interior utility light. (Example: Carmanah EverGEN™ 1700 Series.) This approach avoids trenching for wiring and provides year-round lighting that renders the facility visible at night from the air in the event of an emergency.
Sifferd Cottage		
Cleaning/Staining of Exterior	$3,500	By local contractor.
Roof and Flashing Repairs	$500	By local contractor.
Railings and Guards	$2,000	By local contractor.
Smoke Detectors	$100	3 - smoke alarms, by staff.
PV System	$14,000	Complete.
Stand-Alone Composting Privy**	$24,000	Completely assembled including shipping.

† Alls costs include supply, installation and applicable taxes.
* A modest sized free-standing fireplace could be constructed in the south-east zone of the building with the firebox facing south to serve surrounding seating. Dolostone has a comparable specific gravity to soapstone and was traditionally used as refractory bricks for furnace linings, making it an ideal thermal mass material.
** Alternative is seasonal rental of chemical toilets - obtain quotation from local supplier.