INTERIOR HEALTH AUTHORITY CRESTON VALLEY HOSPITAL

SOLAR THERMAL PRELIMINARY OPTIONS ASSESSMENT

Prepared for:
Interior Health Authority
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Prepared by:
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File: 1339-001.01
June 2012

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June 28, 2012
File: 1339-001.01

Interior Health Authority
2355 Acland Road
Kelowna, BC V1X 7X9

Attn: Ted Spearin, P.Eng., CEM, CSBA – Energy Manager, Environmental Sustainability

Dear Mr. Spearin,

Re: Interior Health Authority Creston Valley Hospital Solar Thermal Preliminary Options Assessment (POA)

Hemmera is pleased to submit the attached report to the Interior Health Authority.

Included is an assessment of potential future solar air heating system options at Creston Valley Hospital. Further included is an assessment of local pollutant emissions reductions and of performance variability at several IHA locations.

We trust that you find this submittal satisfactory. Should you have any questions or require more information, please do not hesitate to contact the undersigned.

Sincerely,
Hemmera

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EXECUTIVE SUMMARY

Hemmera was retained by the Interior Health Authority to provide a preliminary options assessment of solar air wall technology at Creston Valley Hospital (CVH). Client objectives included:

A. Gain an understanding of solar wall installation feasibility through a go/no-go site evaluation
B. Obtain an overview of a range of solar wall system implementation options in conjunction with the technology's characteristic financial metrics (e.g. simple payback, lifecycle costing)
C. Gain insight into project capital cost options

CVH offers the following renewable energy resource opportunities:

- **Site-specific Local Climate:** The local climate provides an economical opportunity for a solar thermal installation to preheat building fresh-air during three of four seasons
- **Shading:** Solar collector shading is considered negligible
- **Spatial Availability:** Ample space is available for a maximum of 314 m^2 solar air wall area
- **Structural Integration:** No concerns were raised at the time of the site visit
- **Load:** Space heating utility costs of $78,000 provide a strong opportunity for annual savings

In the following tables, Option A is a smaller system option. Option B is the largest feasible system onsite and provides a trade of between lower energy cost and a high internal rate of return (IRR). Option C is a larger option that has been added for comparison with other IHA sites. Due to the very high energy intensity seen in hospitals, there is often only limited wall space available to achieve noticeable savings.

Preliminary Options	Solar Energy	GHG Emit.	Investment Costs		
	eMWh ^{thermal}	Tonnes	Gross	Grants	Client Net
Present case	**-**	**479**	**-**	**-**	**-**
A. 10% Solar, 198 m^2 Wall	150	449	$ 76,000	-	$ 76,000
B. 13% Solar, 314 m^2 Wall	**205**	**438**	**$ 111,000**	**-**	**$ 111,000**
*C. 23% Solar, 800 m^2 Wall**	*349*	*409*	*$ 256,000*	-	*$ 256,000*

Note: * Option C has been added for comparison with other IHA sites; Option B is the largest feasible system

Preliminary Options	Savings	Energy Cost	IRR	Payback	Payback
	Annually	$/ekWh		Simple	Actual
Present case	**-**	**$0.050**	**-**	**-**	**-**
A. 10% Solar, 198 m^2 Wall	$6,850	$0.045	13.6%	11	9
B. 13% Solar, 314 m^2 Wall	**$9,210**	**$0.043**	**12.8%**	**12**	**9**
*C. 23% Solar, 800 m^2 Wall**	*$14,730*	*$0.039*	*9.8%*	*17*	*12*

Local pollutant emissions at CVH are estimated to be reduced per the following table.

Preliminary Options	NO_x	CO	CH_4	N_2O	VOC	TOC	SO_2	PM
	kg/year							
A. 10% Solar, 198 m2 Wall	23	19	0.5	0.5	1.3	2.5	0.1	1.7
B. 13% Solar, 314 m^2 Wall	**31**	**26**	**0.7**	**0.7**	**1.7**	**3.4**	**0.2**	**2.4**
*C. 23% Solar, 800 m^2 Wall**	*53*	*45*	*1.2*	*1.2*	*2.9*	*5.8*	*0.3*	*4.0*

A geographic assessment illustrated that seasonal available solar energy, ambient temperatures and wind conditions vary at different IHA service areas. Annual energy saving opportunities range between $7,300 and $12,000 (for Penticton and Fernie, respectively). Assuming the facilities show a current utility cost similar to CVH ($0.050/ekWh), Nelson, Kelowna and Vernon could achieve comparable reductions in energy cost to CVH (i.e. $0.043/ekWh) with a 314 m^2 solar thermal installation. Fernie and Revelstoke show the largest GHG reduction potential.

Hemmera recommends that a 314 m^2 solar demonstration project be implemented at CVH utilizing transpired solar air wall technology for building fresh-air pre-heating. Gross investment cost for the commercial-type installation is $111,000 and is applicable to design-build projects. Included are solar equipment costs, insulated ducting, mechanical accessories, freight, design and installer labour costs.

By reducing CVH heating related GHG emissions from currently 479 tonnes to 438 tonnes per year, this demonstration project would add to the Interior Health Authority's image as a climate change mitigation leader in British Columbia.

Should the client wish to pursue the installation of a solar air wall system via a design-spec-tender process, detailed design may be developed prior to tendering (or issuing of an RFP) to arrive at a quality-installation. This will avoid high bidder costs or bidder contingencies due to limited industry experience.

Financial Subsidies

FortisBC may currently offer subsidies for a few select pilot solar air wall projects. Should the client wish to pursue a project, it is recommended that the client inquire with FortisBC's Energy Efficiency and Conservation (EEC) team about available subsidies for "Innovative Technologies" such as solar air walls.

Design Alternatives

Should the client wish to pursue a smaller installation, Option A comprised of 125 m^2 total wall area presents an alternative with strong financial and environmental benefits.

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1.0 INTRODUCTION

Hemmera was retained by the Interior Health Authority (the "Client") to prepare a Preliminary Options Assessment ("POA") of a potential future solar thermal ("solar") installation at the Creston Valley Hospital ("CVH"), located at 312 15th Avenue North in Creston, BC (the "Site").

1.1 OBJECTIVES

This report provides insight on the various traits of solar thermal technology while satisfying the following project objectives:

A. Provide an understanding of solar wall installation feasibility through a go/no-go site evaluation;

B. Obtain an overview of a range of solar wall system implementation options in conjunction with the technology's characteristic financial metrics (e.g. simple payback, lifecycle costing, etc.); and

C. Gain insight into project capital cost options per engineering class "C" cost estimate.

1.2 SCOPE OF WORK

The following scope of work was completed to achieve the objectives outlined above:

Table A Scope of Work

Steps	Scope of Work
a. Project Kick-Off Onsite	• Meet Client and facility staff onsite for initial kick-off meeting (e.g. site engineer) • Gather understanding of Client project wish list , preferences, and facility usage and background information • Gather facility technical information and drawings as needed • Obtain insight into site specific construction opportunities and limitations
b. Renewable Energy Resource Assessment	• Consolidate and analyse facility background material • Determine facility envelope integration and mechanical interconnection opportunities • Define solar system sizing options as are suitable to the Site • Derive estimate of solar energy resource generation potential and environmental benefits (i.e. GHG emissions reductions) for pre-defined options
c. Financial Sensitivity Analysis (Class Cost Estimate "C")	• Derive project budget costs per engineering class "C" cost estimate • Tabulate conventional yearly financial performance metrics • Chart financial viability of solar energy technology over product lifespan • Demonstrate characteristic lifecycle savings metrics for solar energy system options at the Site (e.g. ROI, resource energy cost, e.t.c.)
d. Recommendation	• Summarize solar project feasibility at this Site based on project findings • Recommend two to three project options that are financially attractive while satisfying the Client objectives • Present a report for Client review

1.3 INFORMATION SOURCES

This assessment is based on a site visit conducted on June 14 and 15, 2012. Assistance was provided by local facility maintenance staff. Building rooftops, building exterior and interior floors and spaces were examined, and an understanding of the site was gained.

- **Site Location:** 312 15th Avenue North, Creston, BC
- **Site Layout:** This site consists of the original building built in 1968 and an emergency wing that was added in 2001. Total usable building space measures 7,450 m^2 on two floors (i.e. main floor and lower floor) and includes the 612 m^2 emergency wing
- **Background Information:**
  - Monthly gas and electricity utility history (received from Ted Spearin)
  - Photos of architectural and mechanical drawings (from site maintenance staff)
  - Mechanical balancing reports for emergency wing (from site maintenance staff)
  - Utility information for Revelstoke Hospital for space heating fraction (from Ted Spearin)
  - Various site photos taken during site visit

1.4 GENERAL ASSUMPTIONS AND METHODOLOGIES

This assessment is based on the following assumptions:

- **Building Thermal Load Applicable to Solar Air Wall:**
  - Preheating of outdoor fresh-air for space heating at CVH
  - Building utility consumption data is available in **Appendix B** and Appendix C
- **Equipment:**
  - Original building: (4) gas-powered air handling units ("AHUs") provide heating and cooling (AHU 1x-4x). 100% outdoor-air is used (zero indoor-air recirculation) as per the client
  - Emergency wing: (1) rooftop gas-powered AHU provides heating and cooling by partially utilizing recirculation air (AHU-1). 85% annual average O/A supply has been assumed; based on ASHRAE 62 Ventilation Standard, gas-utility history and DDC information at the site visit
  - Cleaver Brooks boiler provides primary heating supply for AHU heating coils
- **Assessment Assumptions:**
  - Natural Gas: average utility cost $0.033/kWh ($9.1/GJ) for utility bill Jan 2008 to Dec 2011, greenhouse gas emission factor: 0.056 tonnes/GJ[1]
  - Electricity: average utility cost $0.083/kWh for utility bill Jan 2007 to Dec 2011, greenhouse gas emission factor: 0.0154 tonnes CO^2eq./MWh[2]
  - Heater seasonal efficiency: 65% estimate per NRCan for natural-gas boiler with pilot-light

[1] NRCan, Office of Energy Efficiency, CO^2 Emissions Factors
[2] B.C. Ministry of Environment, Greenhouse Gas Inventory Report, Emission Factors for Electricity Generation in B.C.

  - Estimated building total flow rate is 24,000 CFM, scaled from 1,960 CFM via the floor area served by AHU-1 (612 m^2) to the total building floor area (7,450 m^2)
  - Weather station data: Creston has been selected from hundreds of weather stations across North America as the most suitable location; microclimatic local weather fluctuations can be assumed to be accounted for. Site-specific features that may impact wind speeds on the solar air wall (e.g. building geometry, adjacent trees) were taken into account by use of an attenuation factor of 0.4 applicable to local wind speed information
  - Performance estimates: RETScreen[3] 4.0 simulation software was employed, and building heat recapture through the solar air wall area has been considered. NRCan recommends using version 4.0 as it accounts for variable wind speeds at different locations (omitted in previous revisions, resulting in overestimated performance)
  - Solar collector data: the following data was employed for performance estimates representing various solar industry products: collector type = transpired; solar spectrum absorptivity (alpha) = 0.94 for black collectors; solar system performance factor (n) = 0.93 representing various equipment suppliers (note: performance factor estimate is subject to an outdated NRCan incentive program terminated in December 2010)

- **Financial Assumptions and Calculation Methodologies:**
  - Class C budget cost estimates are based on equipment and installation costs applicable to specialized solar air wall and general HVAC equipment suppliers as required; costs apply to projects tendered as design-build arrangements. For design-spec-tender arrangements, per Hemmera experience cost increase may apply and strongly depend on third-party experience and related scope of work, e.g. specifications, construction management, quality control (QC), or project unknowns
  - Coefficients of performance (COP) seen in solar thermal systems are commonly very high and lead to very low incremental utility costs (typ. <5% of savings). In spite of this, increased fan energy consumption resulting from suction through the solar air wall has been considered
  - A booster fan will be omitted at this site
  - Lifetime calculations and future natural gas and electricity costs have been estimated at average 5%[4] annual cost inflation
  - Net Present Value (NPV) and Internal Rate of Return (IRR) of solar energy have been based on solar air wall cladding and system lifetime of 40 years. Financial metrics may vary for different system sizes, which is a result of a relatively high specific energy yield of smaller installations (smaller solar fractions) versus the benefits of economies-of-scales of larger installations. For NPV calculations, a discount rate of 6% is assumed4
  - Solar Energy Cost (i.e. levelized energy cost, or resource cost) is total energy cost provided by the hybrid heating system. Solar energy cost is calculated through lifetime expenses (converted via CPI inflation to today’s value) divided by the energy produced. This number in $/kWh, compared with the today’s energy cost in $/kWh, demonstrates the savings potential offered by solar thermal energy

[3] RETscreen is an internationally recognized simulation software and has herein been employed as a high-level screening tool for calculations of solar thermal system energy yield. It is published by Natural Resources Canada.

[4] Annual commodity inflation: 4% for natural gas, 6% for electricity [Metro Vancouver].

2.0 PRELIMINARY OPTIONS ASSESSMENT

2.1 RENEWABLE ENERGY RESOURCE ASSESSMENT

CVH has been reviewed during the site visit and it consists of two levels. A number of south facing walls may be well suited for a solar renewable energy installation. The following figure shows the south-east portion of the building (left); further suitable south-facing walls are inside the courtyard (requiring window openings) and in front of the mechanical penthouse and access stairway located above (right). To the far west (in the left photo, west of the Emergency entrance) an additional south-facing wall is available.

Figure 1 Installation Area

The site visit provided the necessary information for an initial assessment of available solar renewable energy resource onsite. Initial findings are described as follows:

- **Site-specific Local Climate:** Geographic location and annual climate onsite will enable a solar thermal system to preheat building fresh-air during three of four seasons (design period). During this period both buildings' southern walls are predominantly unobstructed from receiving solar radiation, and hence will contribute to building space heating.

  A performance report is available in section 2.3, "System Options". Weather data, including solar intensity, cloud coverage, wind speeds, local ambient temperatures, was selected from a database of several hundred weather stations across Canada; the Town of Creston was available.

- **Solar Collector Shading:** During the design period the sun is at an elevation of 17-65 degrees. For the majority of south-facing walls, any obscuring effects by existing site features and nearby building protrusions are considered negligible during the design period in spring, fall and winter. South-facing walls that may experience limited shading during morning or afternoon hours include the courtyard and the most eastern wall.

  Where all the mentioned walls (i.e. south east portion, courtyard, mechanical penthouse, staircase, Emergency entrance) are considered for solar thermal heating, a solar shading factor of 5% has been used in performance calculations.

- **Spatial Availability:** This site offers sufficient space for a solar project (pilot type).

  The building provides maximum 314 m2 of usable wall area (or 3,380 ft2 with 1,240 ft2 for the courtyard and the most eastern wall). An additional 10% will be attained with a solar air wall canopy. The 314 m2 solar installation, as illustrated in Table B below, would use 100% of the currently usable wall area at CVH.

  The solar air walls would connect via insulated ducts with the fresh-air intakes of the existing AHUs located in the mechanical penthouse; there is adequate space available for the interconnecting duct runs. The wall to the west of the Emergency entrance could be connected to the new AHU (No. 1) that serves the Emergency wing.

- **Structural Integration:** During the site walk-through no observations were made, nor were concerns raised by maintenance staff that building walls could potentially be weathered or structurally compromised. It can be assumed[5] that the structural integrity is sound for all walls.

  Structural approval of any selected system size is commonly obtained during the detailed design phase through a professional engineer licensed in British Columbia.

- **Ambient Reflections:** Benefits of additional solar radiation through ambient reflections from glass buildings, water features or snow fields are not available at this site.

The following **Table B** provides an overview of a sample solar renewable energy installation showing system characteristic parameters and traits.

Table B Resource Assessment

	Creston Valley Hospital As-Built (1968)	**Creston Valley Hospital Solar Retrofit**	**Units**
Location			
Weather Station Data	Creston BC		-
Latitude / Longitude	49.1 North / -116.5 West		Degrees
Site-Specific Resource			
Average Air Temperature	8.4		degC
Avg. Daily Solar Radiation (horizontal)	3.6		kWh/m^2/d
Wind Speed [6]	0.8		m/s
Energy Basis			
Space Heating Equipment	Natural Gas	Natural Gas - Solar	-
Seasonal Efficiency (AFUE)	65%	65% (Gas)	%
Annual Heating Demand [7]	1,545	1,545	eMWhr
Annual Space Heating Cost	$78,000	see savings below	$

5 Addition of solar equipment to the wall structure commonly adds approximately 2.5 psf of wall load. This additional wall load applies to the carrying capacity of many commercial type walls and is applicable to metal and concrete structural design. If the building has been professionally designed and is not subject to environmental issues such as rot and insect infestation, then it is highly unlikely for there to be a requirement for structural upgrade.

6 Weather station wind speed data has been adjusted from 10m standard height to average solar air wall height

7 Tertiary energy, i.e. building load side

	Creston Valley Hospital As-Built (1968)	Creston Valley Hospital Solar Retrofit	Units
Solar Thermal System			
Solar Energy Supply 7	-	205	eMWhr
	-	13%	%
Solar Collector Area	-	314*	m^2
Max. Solar Air Wall Area	(314)	(314)	m^2
Installation Angle	-	90	Degrees
Installation Orientation	-	South	-
Costs			
Capital Cost Estimate	-	$111,000	$
Annual Maintenance	n/a.	$0	$
Annual Operating Cost [8]	n/a.	$0	$
Annual Gas Utility Savings[9]	-	$9,210	$
Simple Payback	-	12 years	-
Equipment Life Expectancy	n/a.	40+ years	Collectors
	n/a.	20 years	Mechanical
Emissions			
GHG Annually	479	438	tCO^2e

Note: * Use of a solar air wall canopy is common and would increase the solar collector area

It is demonstrated that a solar air wall size of 100% available wall area could reduce building annual heating costs by approximately 13%. How this system compares to other installation size options, is discussed later.

A solar thermal installation is technically feasible at this site. A detailed investigation follows.

2.1.1 Thermal Loads

Unlike traditional mechanical systems, the energy generation potential of solar thermal systems is subject to fluctuations in daily and seasonally available sunshine. In order to *right-size* a solar thermal system, its energy supply needs to relate to the building's annual thermal energy demand – the energy supply needs to be less than or equal to the building thermal load. **Table C** below lists these *key* design parameters.

8 No operations staff required
9 Secondary energy, i.e. utility supply

Table C Thermal Load

	Creston Valley Hospital As-Built (1968)	Units
Energy		
Utility	Natural Gas	-
Utility Cost	$0.033	$/kWh
	$0.050 (fuel tertiary equiv.)	$/ekWh
Utility Secondary Energy Use	3,710	MWh
Space Heating Share [10]	64% (36% DHW, other)	%
IHG Adjustment [11]	N/A	%
Utility Heating Use (Second.)	2,380	MWh
GHG Emissions	479	Tonnes
Space Heating Est. Cost	$78,000	$
Heater Seasonal Efficiency	65% (pilot light)	%
Thermal Load (Tertiary)	**1,540**	**eMWh**
Supply Air		
Outdoor-Air Flow Rate	**24,000**	**CFM**

The total annual thermal load for space heating at CVH is 1,540 eMWh (2,380 MWh gas consumption). The corresponding total gas cost is $78,000 and tertiary energy cost is $0.050/ekWh.

The total estimated building outdoor-air flow rate, drawn through the solar thermal system and supplied to the AHUs, is 24,000 CFM (scaled from 1,960 CFM O/A supplied to the Emergency wing).

Detailed thermal load information is available in **Appendix A** and **B**.

2.2 SYSTEM SIZING GUIDE

Economics of renewable energy technology are represented by two characteristic parameters, a) solar energy cost as per **Figure 2** below, and b) return on investment (ROI) per **Figure 3**. Solar energy cost is the levelized cost of energy over the system lifetime considering capital cost, operation & maintenance cost, and cost for conventional fuel input.

[10] NRCan “Comprehensive Energy Use Database” used where data not available
[11] Internal Heat Gains (IHG) adjustment from NRCan baseline facility type where applicable

Figure 2 System Sizing Guide – Energy Cost

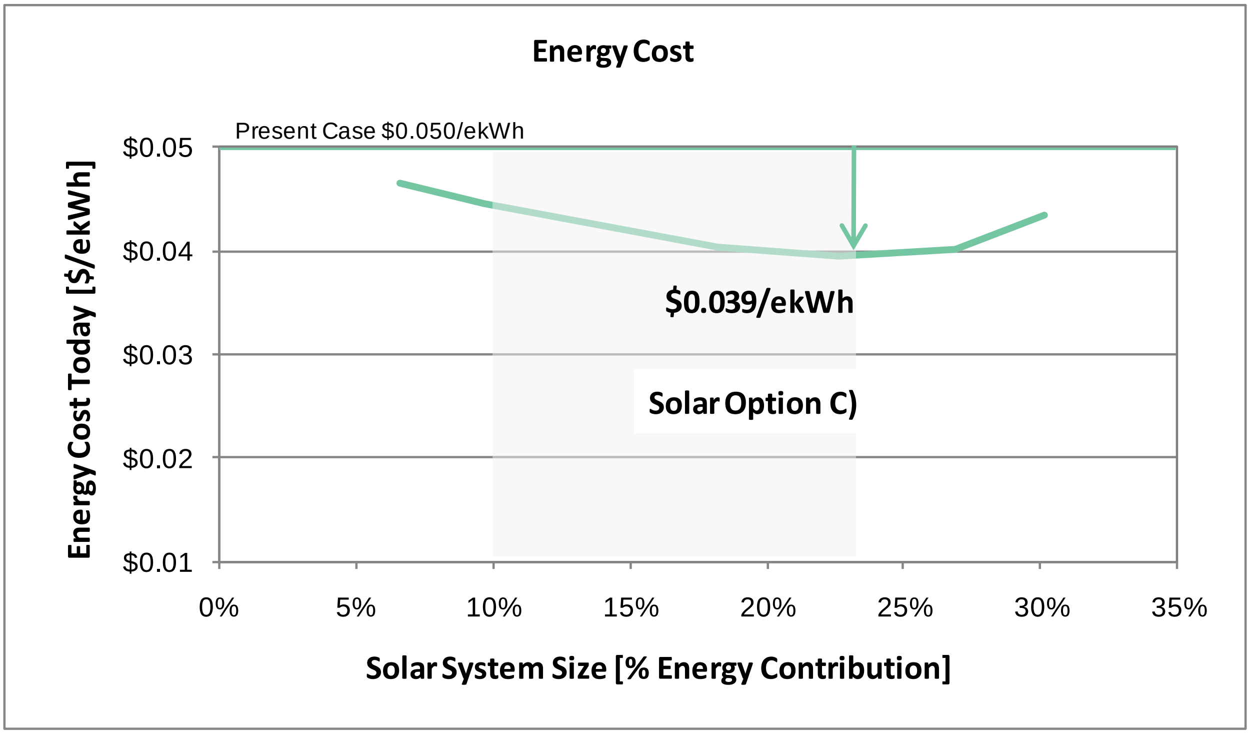


Figure 2 illustrates the tertiary energy cost for various solar system sizes. It can be observed that with a larger solar installation utility energy expenditures can be reduced considerably – from currently $0.050/ekWh to $0.039/ekWh. The area between 10-23% solar system size is characterized by Option C on the right side (downward facing arrow), and by Option A on the left side (see **Figure 3** below, upward facing arrow).

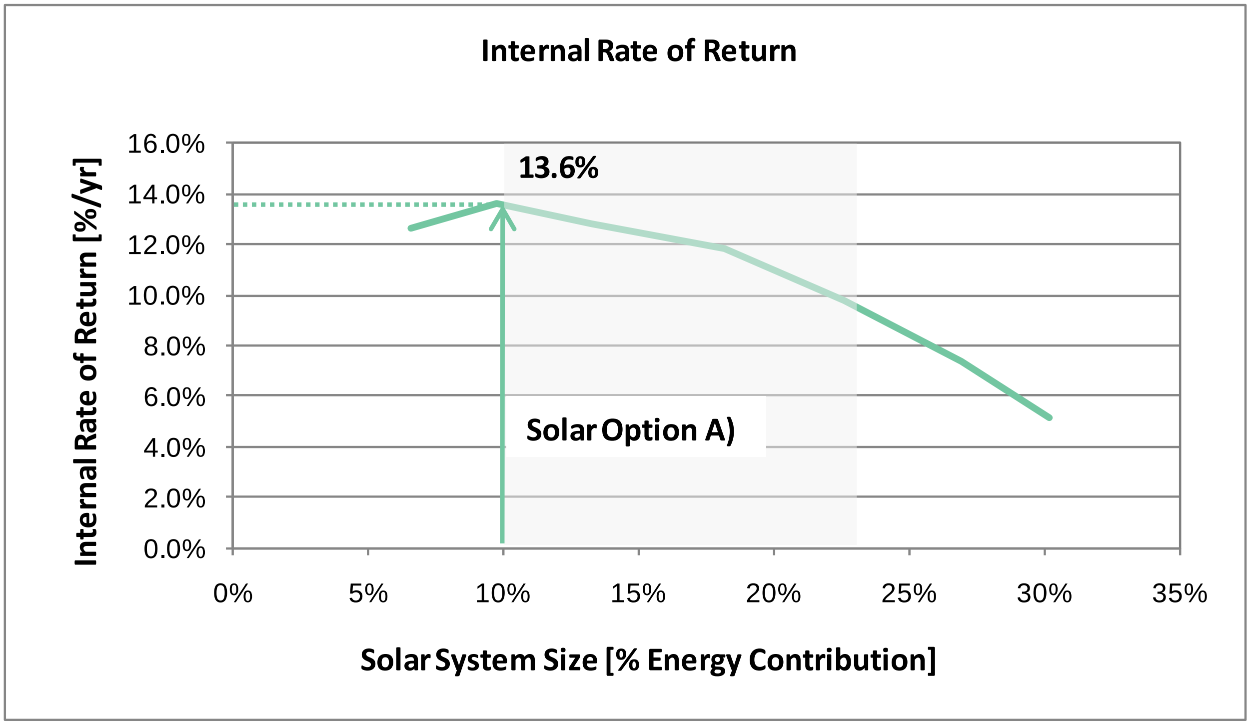
Energy costs will increase for large solar installations above approximately 23% solar fraction. A solar system with an annual solar fraction of 23% may supply more heat than needed in the summer months. To match the load demand during the winter months, however, a large solar thermal system would be needed. The capital cost involved in upsizing the system to meet winter demand would outweigh the savings – the reason why energy costs would be higher for installations above 23%.

Guide: the Client may choose a solar system size that is smaller than indicated by the lowest point on the curve, i.e. 23% solar fraction for Option C. (Note: at this site a solar installation would be limited to 13% as a result of wall spatial constraints.)

Figure 3 below shows the return on investment or annual rate of return (annual internal rate of return, IRR). Compared with the previous energy cost curve, ROI is better for smaller solar systems (10% solar fraction) but a better energy cost can be obtained for the large solar system (23%).

Guide: the Client may choose a solar system size that provides a trade-off between strong energy cost and strong ROI – while considering their primary objective of attaining notable yearly utility cost savings.

Figure 3 System Sizing Guide – ROI



For Option A with 10% solar fraction, an annual ROI of 13.6% is estimated. For large solar systems ROI may diminish to 9.8% (at 23% solar fraction or annual energy contribution).

Guide: In summary, this section highlights that at CVH the most cost-effective project options are estimated to fall within solar fractions between 10% and 23%.

2.3 SYSTEM OPTIONS

As a result of lifecycle system sizing described in the previous section, the following solar thermal system options have been derived. **Table D** presents three economical options that suit the thermal load requirements onsite.

Option A is a smaller system option. Option B provides a trade of between low energy cost and high internal rate of return; it represents the largest feasible installation at CVH. Option C has been added as a basis for the client to determine what qualitative benefits may be obtained at other similar IHA sites.

Table D System Options

Preliminary Options	Solar Energy	GHG Emit.	Investment Costs		
	eMWh thermal	Tonnes	Gross	Grants	Client Net
Present case	**-**	**479**	**-**	**-**	**-**
A. 10% Solar, 198 m2 Wall	150	449	$ 76,000	-	$ 76,000
B. 13% Solar, 314 m^2 Wall	**205**	**438**	**$ 111,000**	**-**	**$ 111,000**
*C. 23% Solar, 800 m^2 Wall**	*349*	*409*	*$ 256,000*	-	*$ 256,000*

Note: * Option C has been added for comparison with other IHA sites; Option B is the largest feasible system

Option B is highlighted in the above table as the **recommended option** and gross investment cost is $111,000. For this option, all southern walls would be utilized for a solar energy generation, i.e. south east portion, courtyard, mechanical penthouse, staircase, Emergency entrance (option A utilizes all southern walls except in the courtyard and the most eastern wall).

Due to the very high energy intensity seen in hospitals, there is often only limited wall space available to achieve noticeable savings with solar air walls. All cost options include solar air wall equipment, insulated ducting, mechanical accessories, freight, design and installation contractor labour.

2.4 Economic Assessment

The economic benefits for options A-C are available in the following **Table E**. Presented are annual savings and lifetime financial metrics. Average annual utility costs are estimated to be $78,000 at $0.050/ekWh (equivalent kWh, based on building tertiary thermal load).

Table E Financial Metrics

Preliminary Options	Savings	Energy Cost	IRR	Payback	Payback
	Annually	$/ekWh		Simple	Actual
Present case	**-**	**$0.050**	**-**	**-**	**-**
A. 10% Solar, 198 m2 Wall	$6,850	$0.045	13.6%	11	9
B. 13% Solar, 314 m^2 Wall	**$9,210**	**$0.043**	**12.8%**	**12**	**9**
*C. 23% Solar, 800 m^2 Wall**	*$14,730*	*$0.039*	*9.8%*	*17*	*12*

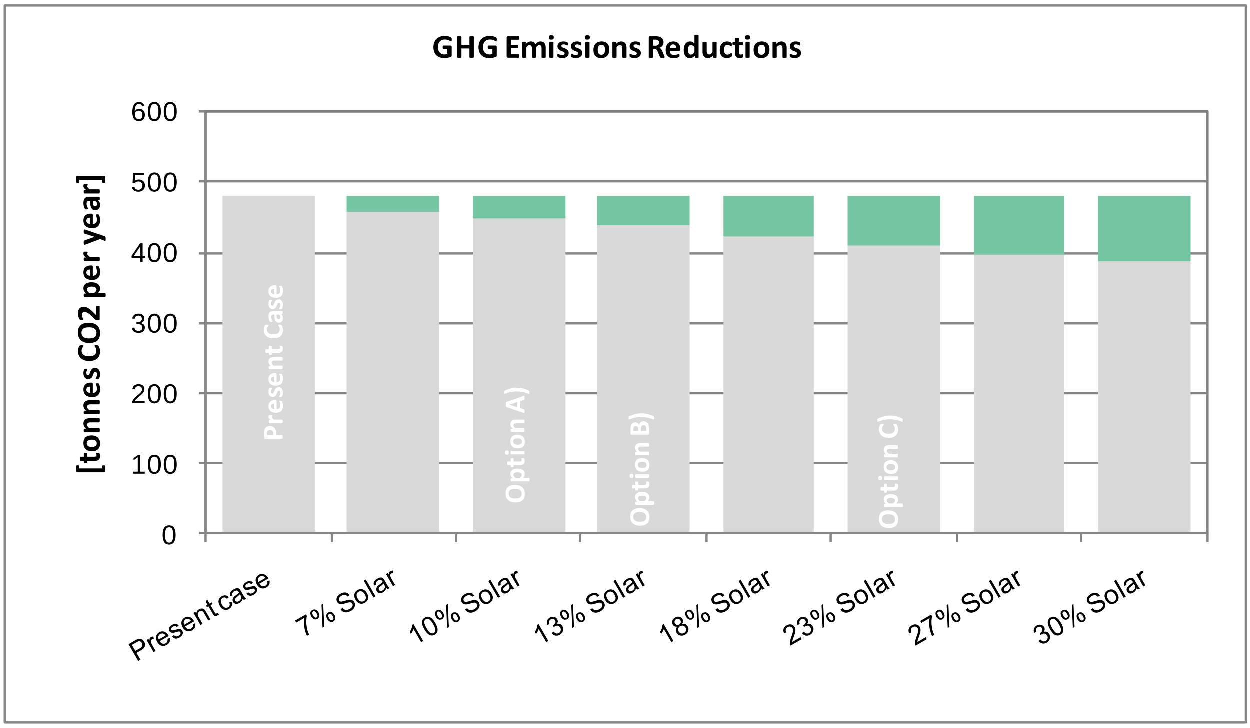
Note: * Option C has been added for comparison with other IHA sites; Option B is the largest feasible system

The **recommended Option B** is estimated to provide annual savings of $9,210 over the current $78,000, amounting to a remaining heating related utility cost of $68,790 per year – fan energy consumption increases (+4%) and resulting electricity expenditures are included. It is estimated that the client can anticipate lifecycle energy costs of $0.043/ekWh, compared with the current $0.050/ekWh. Actual payback considering energy cost inflation is 9 years. IRR is estimated at 12.8% annual return.

2.5 ENVIRONMENTAL ASSESSMENT

With increasing solar thermal system size the amount of GHG emissions is reduced proportionally to the renewable energy supply. Options A, B and C are estimated to reduce space heating related GHG emissions from currently 479 to 449, 438 and 409 tonnes per year, respectively. The below figure illustrates the GHG reduction potential.

Figure 4 GHG Emission Reductions



Proportional to solar energy generation and to GHG reductions arising from less natural gas burnt in the building boiler, local pollutant emissions at CVH may be reduced as per the following **Table F**.

Table F Pollutant Emission Reductions

Preliminary Options	NO_x	CO	CH_4	N_2O	VOC	TOC	SO_2	PM
	kg/year[12]							
A. 10% Solar, 198 m2 Wall	23	19	0.5	0.5	1.3	2.5	0.1	1.7
B. 13% Solar, 314 m² Wall	**31**	**26**	**0.7**	**0.7**	**1.7**	**3.4**	**0.2**	**2.4**
*C. 23% Solar, 800 m² Wall**	*53*	*45*	*1.2*	*1.2*	*2.9*	*5.8*	*0.3*	*4.0*

Note: * Option C has been added for comparison with other IHA sites; Option B is the largest feasible system

[12] EPA mission factors for small natural gas boilers (<100MMBtu/hr), no flue gas recirculation, no NO_x controls

Natural gas is one of the major combustion fuels used throughout the country. It is used to heat buildings, produce steam and generate industrial and utility electric power. A substantial portion of the fuel consists of combustible methane, further including butane, ethane, propane and inert gases. During its combustion in a boiler, a high combustion efficiency is typically achieved (different from a boiler's characteristic AFUE rating), and incomplete combustion can result in the emission of GHGs and pollutants. These emissions and pollutants include carbon dioxide (CO_2), nitrogen oxide (NO_x), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), volatile organic compounds (VOCs; total organic compounds are abbreviated as TOCs), trace amounts of sulphur dioxide (SO_2), and particulate matter (PM).

2.6 GEOGRAPHIC ASSESSMENT

Solar energy production depends primarily on local climate, building heating load and solar installation characteristics. In order to arrive at a geographic assessment that shows how a solar thermal system may perform in a variety of locations, a building load and solar installation need to be assumed. CVH has been used as the baseline facility, with a 314 m^2 solar thermal installation as the renewable energy source.

The IHA has a large geographic service area in different climatic regions, where seasonal available solar energy, ambient temperatures and wind conditions will vary. Energy, utility and GHG savings at any IHA service location have been determined via a desktop assessment for several IHA facility locations, as listed in the following **Table G**. Results are of qualitative nature given that site-specific characteristics were not examined (as part of the scope of work).

Table G Geographic Assessment

IHA Service Area	Solar Energy	Savings	Energy Cost	Payback	GHG Red.
	eMWh ^{thermal}	Annually	$/ekWh	Actual	Tonnes
East Kootenay					
CVH (report scope)	*205*	*$9,210*	*$0.043*	*9*	*41*
Fernie	260	**$12,000**	$0.040	**7**	52
Kootenay Boundary					
Castlegar	167	$7,300	$0.045	11	33
Nelson	213	$9,600	$0.042	9	**43**
Okanagan					
Kelowna	222	$10,100	$0.042	8	**45**
Vernon	196	$8,700	$0.043	9	**39**
Penticton	168	$7,300	$0.045	11	34
Thompson-Shuswap					
Kamloops	178	$7,800	$0.044	10	36
Revelstoke	232	$10,600	**$0.041**	8	47

It can be seen that annual energy saving opportunities range for IHA service areas between $7,300 and $12,000 (Penticton and Fernie, respectively). Assuming these facilities show a current utility cost similar to CVH (i.e. $0.050/ekWh), Nelson, Kelowna and Vernon could achieve comparable reductions in energy cost (e.g. $0.043/ekWh) with a 314 m^2 solar thermal installation. Fernie and Revelstoke show the largest GHG reduction potential.

For this geographic assessment, it should be noted that local site features such as building orientation and ambient shading have not been considered. This table has been created to illustrate how local climates can vary and affect solar energy generation; this and other factors need to be taken into account when deciding which location may be (or not be) well suited for a solar thermal installation.

Pollutant emissions can be assumed to be reduced proportionally to the solar energy generation potential.

3.0 RECOMMENDATIONS

Hemmera recommends that the Client pursue a solar thermal installation at Creston Valley Hospital. From several suitable walls and sizing options, the recommended option demonstrates the following characteristics and estimated installation costs.

3.1 SYSTEM CHARACTERISTICS

A commercial-type demonstration solar heating system design may be implemented by connecting to the (5) AHUs on the rooftop (i.e. AHUs #1, and 1x-4x). This installation comprises of a total of 314 m^2 solar air wall area. It will maximize the use of available southern wall area consisting of multiple walls. Which walls connect via a duct run to the respective AHUs will need to be assessed during a detailed design phase. Cost-effective and efficient transpired unglazed solar air wall technology may be used for pre-heating of fresh-air for space heating at CVH.

The described solar thermal system is estimated to reduce current annual utility costs from $78,000 to $68,790, or save $9,210. Throughout its minimum lifetime of 40 years, the effective energy cost of the hybrid heating system is estimated to be reduced from presently $0.050/ekWh to $0.043/ekWh. The reduction in energy cost is attributable to the cost-free solar energy contribution following the initial capital cost investment.

By reducing CVH heating related GHG emissions from currently 479 tonnes to 438 tonnes per year, this demonstration project can add to the Interior Health Authority's image as a leading institution in climate change mitigation in British Columbia.

3.2 SYSTEM COST

Project gross cost is estimated at $111,000.

The information provided herein is neither a detailed design nor is it a system specification document. Prior to tendering, any such information may be developed by accurately specifying mechanical design and equipment requirements. This will avoid high bidder costs or bidder contingencies due to insufficient experience which is common with this new technology.

3.2.1 Financial Subsidies

FortisBC may currently offer subsidies on very few solar air wall installations. Should the client wish to pursue a project, it is recommended that the client inquire with FortisBC's Energy Efficiency and Conservation (EEC) team about available subsidies for "Innovative Technologies", such as solar air wall installations.

3.3 DESIGN ALTERNATIVES

- Should the client wish to pursue a smaller installation, a solar system comprised of 198 m^2 total wall area presents an alternative with strong financial and environmental benefits. This system would be installed on the southern walls except in the courtyard and at the most eastern wall. Project gross cost is estimated at $76,000 and annual utility savings at $6,900
- Based on available site operational information at the time of this report, CO^2 occupancy sensors are not part of the controls inventory. Further energy savings may be obtained by controlling building air changes via CO^2 occupancy sensors, especially in the less used building areas. Should the client consider this measure it is recommended that this be carried out concurrently with the solar retrofit project, in which case a smaller air wall may suffice

4.0 NEXT STEPS

In order to procure a high-quality solar thermal installation at Creston Valley Hospital, the IHA shall retain a specialized solar thermal designer who provides detailed design specifications and assistance leading up to a successful RFP. With currently limited available industry experience, the process will ensure that not only the mentioned environmental and technical benefits are achieved (including zero maintenance over the solar system's 40 year lifetime), but also reasonable capital cost targets are met.

5.0 CLOSURE

Hemmera thanks the Interior Health Authority for the opportunity to submit this work, and we trust that you will find this submittal satisfactory.

Should you have any questions or require more information, please do not hesitate to contact the undersigned.

Sincerely,
Hemmera

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6.0 STATEMENT OF LIMITATIONS

Hemmera has performed the Services in a manner consistent with the level of care and skill normally exercised by members of the renewable energy profession practicing under similar conditions at the time the work was performed. Client recognizes that opinions are based on limited data and that actual conditions and performance may vary from those encountered at the times and locations where the data was obtained, despite the use of due professional care. Any opinions provided represent a reasonable review of the information available to Hemmera within the established Scope, work schedule and budgetary constraints. Although the information obtained from this investigation is believed to be generally representative, the nature of renewable energy systems can be considered variable due to their interaction with the environment. No investigation – no matter how comprehensive – can wholly eliminate uncertainty regarding the possible presence of unidentified features or processes that may ultimately affect the performance of an actual full-scale renewable energy system during its operational life.

While providing the Services, Hemmera has relied in good faith on information provided by others as noted, and has assumed that the information provided by those individuals is both factual and accurate. Hemmera accepts no responsibility for any deficiency, mis-statement or inaccuracy in our Reports resulting from the information provided by those individuals.

Hemmera is responsible to Client for Services provided by Hemmera and the services of Hemmera subcontractors. Hemmera is not responsible for the acts or omissions of other parties engaged by Client nor for their construction means, methods, techniques, sequences, or procedures, or their health and safety precautions and programs. This agreement has not created any rights or benefits to parties other than Client and Hemmera. No third party has the right to rely on Hemmera opinions rendered in connection with the Services without Hemmera written consent and the third party's agreement bound to the same conditions and limitations as Client. Any use that a third party makes of these opinions, or any reliance on or decision made based on it, is the responsibility of such third parties. Hemmera accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on these opinions.

7.0 COPYRIGHT NOTICE

APPENDIX A

Gas Utility Bill for Creston Valley Hospital

Creston Valley Hospital (1968) Date	Read Usage (GJ)	Gas Cost ($)	Use [kWh]	Cost [$]	Gas Cost [$/kWh]
Jan-07	2022	3,065			
Feb-07	1532	2,797			
Mar-07	1289	2,664			
Apr-07	980	2,495			
May-07	698	2,340			
Jun-07	487	2,225			
Jul-07	242	3,707			
Aug-07	372	4,564			
Sep-07	614	6,159			
Oct-07	1088	2,554			
Nov-07	1590	2,829			
Dec-07	1930	17,411	3,568,014	52,812	0.015
Jan-08	2066	18,890			
Feb-08	1622	15,610			
Mar-08	1446	14,282			
Apr-08	1077	12,647			
May-08	675	9,342			
Jun-08	613	9,313			
Jul-08	409	7,353			
Aug-08	490	6,924			
Sep-08	623	7,252			
Oct-08	1080	11,264			
Nov-08	1366	13,482			
Dec-08	1925	19,089	3,720,089	145,447	0.039
Jan-09	1915	18,035			
Feb-09	1603	14,823			
Mar-09	1595	14,682			
Apr-09	1072	11,500			
May-09	726	5,740			
Jun-09	454	4,514			
Jul-09	311	3,844			
Aug-09	406	4,368			
Sep-09	549	5,191			
Oct-09	1291	10,447			
Nov-09	1449	11,945			
Dec-09	2078	16,575	3,735,894	121,663	0.033
Jan-10	1714	15,286			
Feb-10	1348	11,417			
Mar-10	1285	11,210			
Apr-10	1018	8,543			
May-10	932	7,675			
Jun-10	692	6,415			
Jul-10	578	6,396			
Aug-10	532	5,717			
Sep-10	769	7,122			
Oct-10	938	7,934			
Nov-10	1562	13,240			
Dec-10	1896	15,295	3,684,217	116,250	0.032
Jan-11	1852	15,074			
Feb-11	1754	14,211			
Mar-11	1402	12,338			
Apr-11	1253	10,284			
May-11	798	7,678			
Jun-11	644	6,787			
Jul-11	550	3,656			
Aug-11	457	3,007			
Sep-11	582	3,802			
Oct-11	1113	6,631			
Nov-11	1611	11,589			
Dec-11	1878	13,062	3,859,689	108,120	0.028

APPENDIX B

Electric Utility Bill for Creston Valley Hospital

Creston Valley Hospital (1968) Date	Read Usage (kWh)	Total Elec Cost ($)	Use [kWh]	Cost	Gas Cost
Jan-07	106,384	7892.29			
Feb-07	107,264	7971.04			
Mar-07	96,144	7371.00			
Apr-07	90,816	7115.40			
May-07	84,528	6816.59			
Jun-07	106,928	8208.90			
Jul-07	112,800	8769.59			
Aug-07	120,080	9033.40			
Sep-07	102,720	8087.70			
Oct-07	81,264	6515.89			
Nov-07	92,832	7285.20			
Dec-07	87,088	6842.32	1,188,848	91,909.32	0.077
Jan-08	84,944	6817.83			
Feb-08	89,264	7188.81			
Mar-08	78,864	6483.30			
Apr-08	74,800	6207.90			
May-08	88,640	7181.15			
Jun-08	88,976	7226.70			
Jul-08	108,608	8588.55			
Aug-08	118,336	9273.34			
Sep-08	86,816	7101.60			
Oct-08	84,992	6912.07			
Nov-08	81,472	6671.40			
Dec-08	77,696	6413.28	1,063,408	86,065.93	0.072
Jan-09	95,888	7868.73			
Feb-09	80,240	6891.08			
Mar-09	76,352	6612.90			
Apr-09	90,640	7634.70			
May-09	77,008	6659.73			
Jun-09	87,776	7453.20			
Jul-09	101,392	8590.72			
Aug-09	104,416	8936.37			
Sep-09	103,920	8933.70			
Oct-09	90,816	7915.85			
Nov-09	87,839	7590.90			
Dec-09	86,991	7528.97	1,083,278	92,616.85	0.078
Jan-10	102,287	8917.77			
Feb-10	92,511	8408.68			
Mar-10	84,383	7779.00			
Apr-10	99,919	8982.60			
May-10	76,735	7374.28			
Jun-10	98,639	8997.60			
Jul-10	110,095	9782.98			
Aug-10	118,239	10494.74			
Sep-10	96,863	9226.20			
Oct-10	89,087	8665.12			
Nov-10	95,151	8863.50			
Dec-10	113,159	10927.44	1,177,068	108,419.91	0.091
Jan-11	92,484	9372.53			
Feb-11	83,610	8627.22			
Mar-11	92,197	9591.08			
Apr-11	87,209	9026.16			
May-11	89,153	9151.11			
Jun-11	91,692	9034.46			
Jul-11	106,887	10318.59			
Aug-11	109,877	10533.93			
Sep-11	98,220	9669.39			
Oct-11	91,056	8794.48			
Nov-11	88,799	8326.71			
Dec-11	92,737	8675.51	1,123,922	111,121.17	0.093

APPENDIX C
Lifecycle Financial Charts

Figure C-1 Lifetime Cost Savings

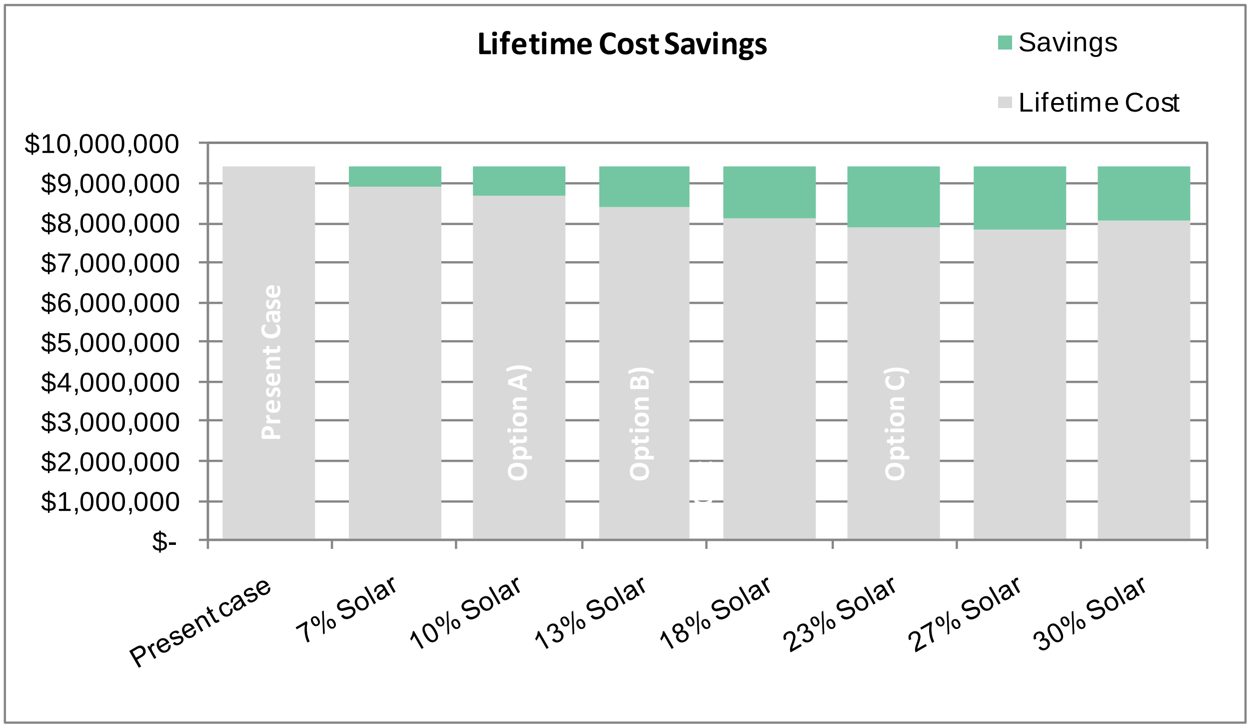

Figure C-2 Lifetime Cost