Project Review

Post-Project Benefits Review & Economic Analysis

Summary

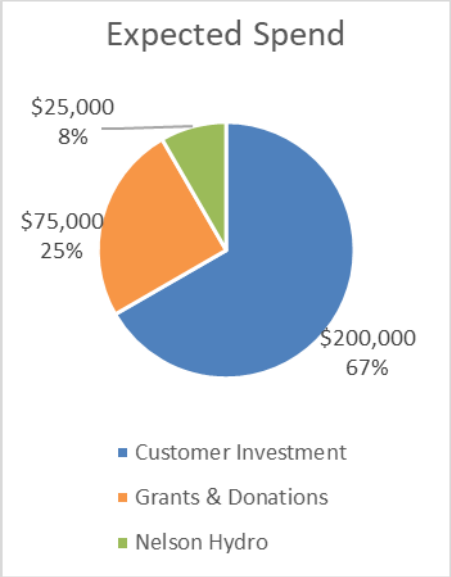
Originally proposed in 2014 as part of the Nelson Hydro EcoSave Program, the original intent of the Nelson Community Solar Garden was for staff to learn about solar generation to adapt to the emerging trends within the electric industry and to provide customers the opportunity to be apart of a local renewable energy project. The original concept proposed the purchase and install of a 50kW solar array at an estimated capital cost of $293,514 of which $200,000 was to be from customer investment, $75,000 was to be from donations, and $25,000 was to be from Nelson Hydro with an estimated annual operation cost of $2,000 per year after the project was commissioned.

Source 1: Luke Mori 2017

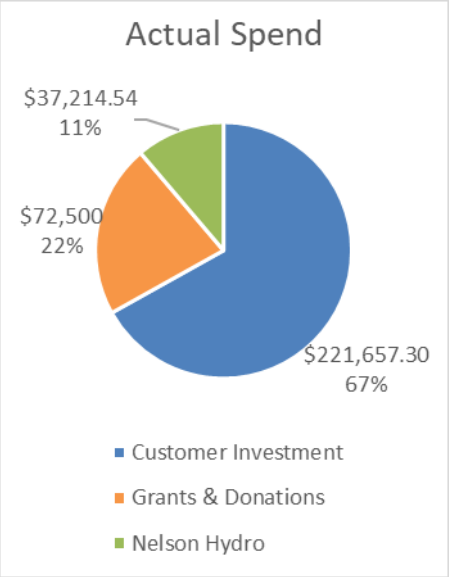
The centralized solar array, known as the Nelson Community Solar Garden, was commissioned in Bonnington in June 2017 after a 19-month project. The project scope increased to 60kW Solar Array due to increased customer interest with 240 customer solar panels installed. These panels generate on average 66,622 kWh[1] of energy annually and credit approximately 133 Nelson Hydro Accounts. 8 solar panels were added by Nelson Hydro for generation redundancy totalling 248 panels in the Solar Array. In the end, the project actually cost $331,372 of which $221,657.30 was from customer investment, $72,500 was from grants and donations, and $37,214.54 was from Nelson Hydro. Over the four years since

[1] Average is based on actual annual generation from ENPHASE Energy Co. from Jan 1 2018 to Dec 31 2021

commissioning, Nelson Hydro spent an average of $4,446 (2018-2021) in operating and maintenance expenses with 2020 being the lowest at $1,567.02.



Source 2: Project Proposal, 2015

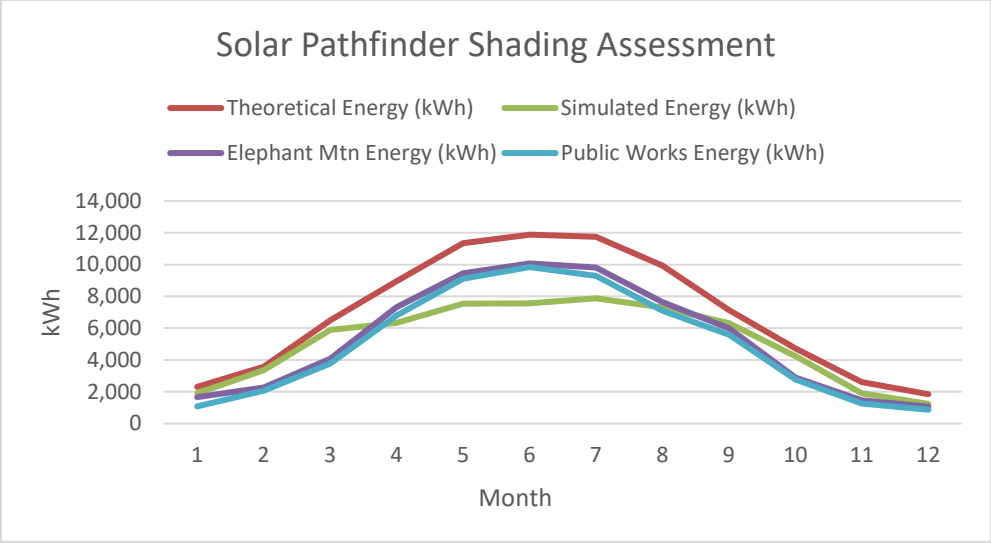


Source 3: Project Analysis, 2022

Background

In September 2014 as part of a Solar Pathfinder Shading Assessment, Nelson Hydro installed solar sensors at the top of Elephant Mountain and on the roof of the Public Works building in Nelson to determine the solar irradiance, the regional viability and engineering feasibility. 12 months of solar data was collected at these locations and then analyzed against theoretical (clear sky) and simulated (cloud factor) data for a 49.9kW array.

Month	Theoretical Energy (kWh)	Simulated Energy (kWh)	Elephant Mtn Energy (kWh)	Public Works Energy (kWh)
1	2,308	1,906	1,655	1,082
2	3,582	3,357	2,274	2,069
3	6,493	5,884	4,080	3,784
4	8,944	6,323	7,316	6,791
5	11,351	7,536	9,455	9,104
6	11,877	7,551	10,067	9,839
7	11,751	7,875	9,821	9,282
8	9,942	7,299	7,640	7,096
9	7,143	6,315	5,998	5,588
10	4,716	4,243	2,892	2,772
11	2,609	1,914	1,459	1,271
12	1,847	1,236	1,062	868
Grand Total	**82,563**	**61,439**	**63,719**	**59,546**

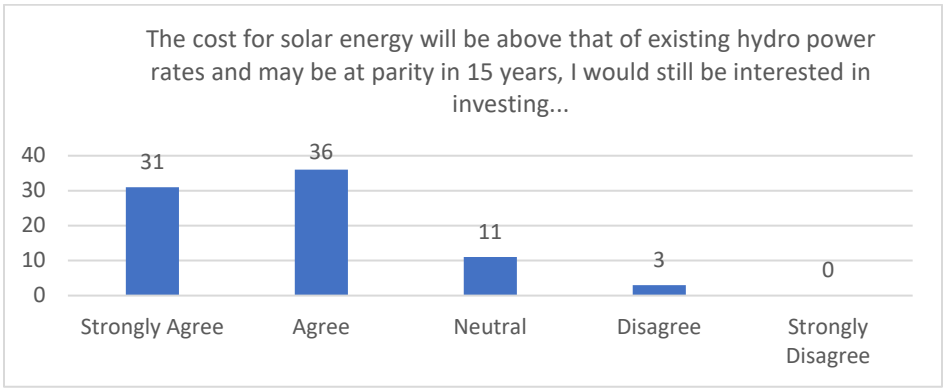


Source 4: Nelson Hydro, 2015

A Concept Study was completed in October 2014 that assessed the generation and economic feasibility of a 50kW solar photovoltaic array installation in six possible locations. Using the Solar Pathfinder data from 2014, various simulations were performed (location, tilt, shading, etc.) to calculate estimated annual energy production and cost. For the preferred location and tilt, the cost of equipment and installation for a 50kW array was estimated at $211,272 with a simulated 61,440 kWh annual generation. The average energy cost was estimated at $0.20/kWh for the project assuming it would be financed by a 3% loan over 25 years with no operating costs. (Jetson Consulting Engineers Ltd., 2014)

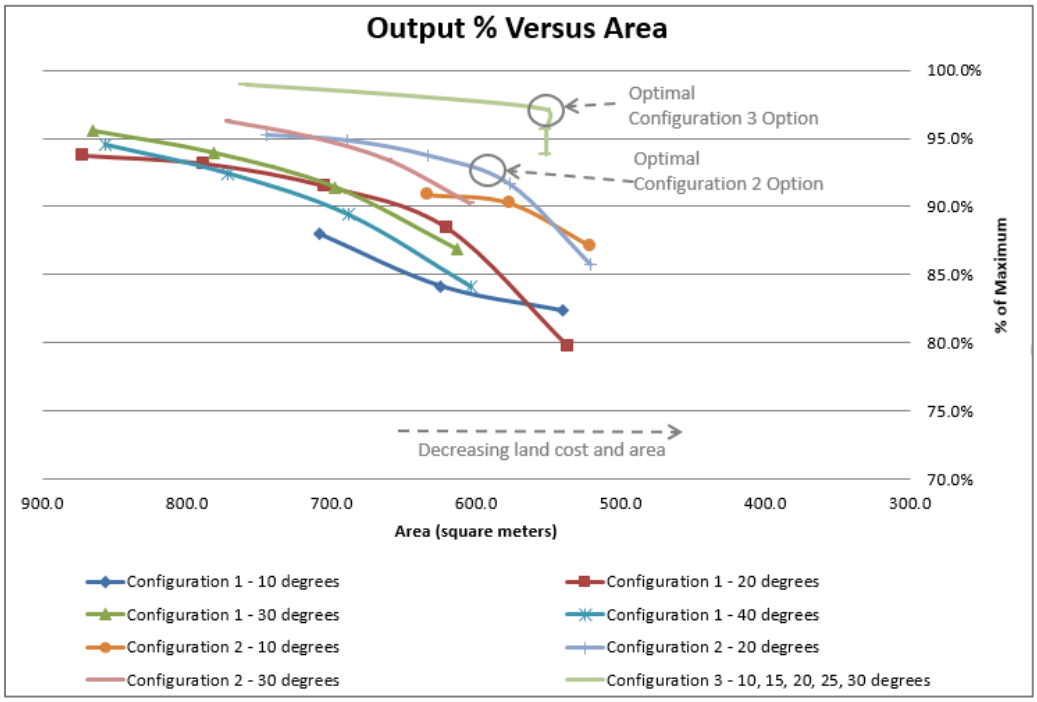
Given this preliminary data, solar generation was determined to be feasible so the next step was to talk to those in the community interested in learning more.

The public was invited to attend a Conversation Café in April 2015 to learn more about the project. This event was well attended and there was much discussion, interest and support. The green-light to proceed with the project was confirmed when 67 attendees responded to the survey that they either agreed or strongly agreed with investing (Figure Source 5). Consensus was achieved and the project continued to the next phase.



Source 5: Conversation Cafe Survey Results, 2015

A Spacing Analysis was completed in May 2015 for the location of 192 panels producing 260 watts each at the Bonnington site whereby the annual energy output for three configurations for three areas were modelled and compared against the theoretical maximum (no shading) to isolate the optimal angle and row spacing required for the array. A minimum threshold of 90% energy production was considered a viable target by the consulting engineers. Configuration 2[2] was recommended with 91.7% of the maximum possible energy production, generating an estimated 62,960kWh annually with an energy density of 109.1 kWh/yr/m2. (Jetson Consulting Engineers Ltd, 2015)



Source 6: Spacing Analysis, 2015

The project kicked-off on November 17th, 2015 with the City Council's approval[3] to proceed with the pre-sale of solar panels to generate the necessary funds for the project. It was determined upfront that the project would only advance to the construction phase if 75% of the panels needed for a 50kW Solar Array were sold within a four-week period. Pre-sales were so successful that the project's scope increased to build a 60kW Solar Array and the preparation of the site began to remove old foundations and other residual civil infrastructure shortly thereafter. With the increased scope, the proposed project budget was revised to $301,628 and the schedule was extended by fourteen months. A competitive bid process to order solar equipment was held, contracts awarded, and the equipment was ordered in February 2016. From May to August 2016, construction tenders were issued and awarded. Construction started on site in September 2016. 90% of construction was complete by December 2016 and the remaining was deferred to the Spring 2017 for warmer weather. The 577m^2 solar array was built with 248 photovoltaic panels and

[2] 4 rows of panels with each row having 2 vertical and 24 horizontal panels. Rows 1 - 3 at 20 degrees at 1 meter above the ground level with 5-metre spacing between adjacent rows. Row 4 situated at an angle of 39 degrees at 1 meter above and 4 meters behind the front edge of the third row.

[3] Council Resolution 2015/316 and 2015/317 of November 17th 2015

micro-inverters with 1 wireless gateway. The Grand Opening and Ribbon Cutting Ceremony was held on June 24th, 2017.

Final costs amounted to $331,372 of which $221,657.30 was from customer investment, $72,500 was from grants and donations, and Nelson Hydro contributed the remaining of $37,214.54. Over the four years since commissioning, Nelson Hydro spent an average of $4,446 (2018-2021) in operating and maintenance expenses with 2020 being the lowest spend at $1,567.02.

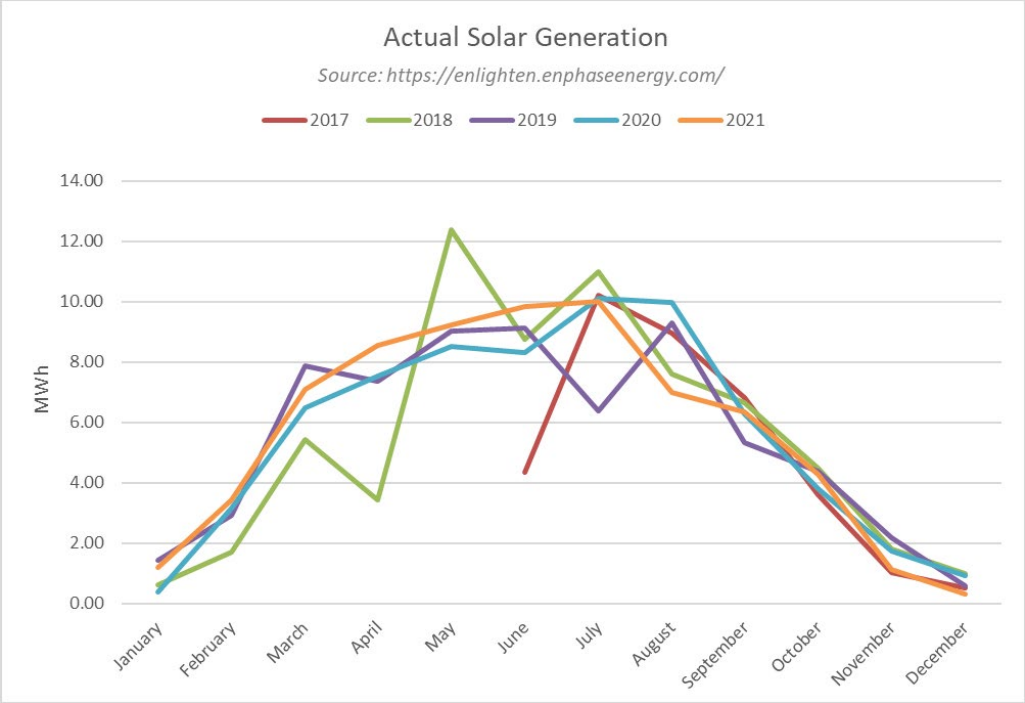
Source 7: Grand Opening, 2017

Unfortunately, in May 2018 Nelson Hydro spent an additional $17,916 for panel replacement and a security system due to a theft of 6 panels and micro-inverters. These costs have not been included in the annual operating and maintenance expenses as they were covered by insurance.

Results

Nelson Hydro completed a detailed economic analysis of the costs and benefits of owning and maintaining solar generation products and services. Utility companies use Levelized Cost of Energy (LCOE) as a metric for investment planning. It establishes a common comparative baseline across various forms of energy generation over their lifetime. LCOE is calculated as the average net present cost of electricity generation for a generating plant over its lifetime. Calculating the LCOE from an investment perspective using the project and maintenance actuals to the end of 2021 results in a LCOE of $0.47/kWh.

The following chart illustrates the actual generation since commissioning in June 2017.



Source 8: Enphase Energy Co. Nelson Community Garden Annual Generation Reports

Lessons Learned

Overall Nelson Hydro realized all of the expected benefits (Appendix A – Expected vs Actual Realization of Benefits) stated in the original project proposal. One of those benefits was to gain experience and learn from the pilot project so there are a few lessons learned. For example, more civil studies and planning could have been completed upfront to prepare the site for construction so minor schedule delays were avoided. Security could have been identified as a higher risk with cameras and other features included in the project scope to deter thefts. There also could have been more proactive public communications on the engineering and investment immediately after the Grand Opening to thwart the spread of misinformation. Increasing staff communications similar the amount of communications the Solar Garden Community received would have increased awareness and a sense of pride with Nelson Hydro staff.

In November 2019, Nelson Hydro issued an online customer survey. Customers were asked their opinion on four issues: electrical rates, customer service, reliability, and infrastructure investment. In total, 743 surveys were completed. Question #38 was concerning green energy project investment whereby the Solar Garden amongst others was cited as an example. 322 respondents (43%) indicated that green energy projects are an important area of investment focus, 212 respondents (29%) indicated that the were neutral on the subject, and 184 respondents (25%) indicated that green energy project investment should not be priority of Nelson Hydro, and 25 respondents (3%) did not answer. Some of the written comments for this question included some very clear statements about the need for prudent investment in solar generation and the majority preferred that Nelson Hydro focus on micro-hydro generation.

Conclusion

The Community Solar Garden has been an excellent customer service and learning opportunity for Nelson Hydro as it strives to be a utility that not only services the needs of its customers but is also viewed as a good green corporate citizen committed to and in support of the City Council's *Low Carbon Path to 2040, Community Energy and Emission Action Plan*.

Based on the results of the detailed economic analysis, it is unlikely that Nelson Hydro will invest in further large-scale solar generation at the community level until the technology advances and costs significantly decrease. Until then Nelson Hydro will continue to promote micro-solar generation at the customer level so that customers can individually offset their own hydro-electricity consumption with their own generation and therefore reducing Nelson Hydro's overall need to purchase additional electricity to meet the growing demand of its customers within its Service Area.

Appendix A – Expected vs Actual Realization of Benefits

Expected Benefits of the Project *(Project Proposal January 2015)*	**Assessment of the Actual Benefits Realized** *(Project Analysis February 2022)*
a. It gets Nelson in the game of distributed solar generation, providing and excellent opportunity for first-hand experience on both the business and technical aspects of solar PV, which positions the electrical utility better to adapt to a change to the business model in the future and makes it possible to capitalize on new opportunities like installing solar gardens in other areas.	This benefit has been realized. Much first-hand experience has been gained on the operations, maintenance, business, and technical aspects of solar generation.
b. It is an excellent customer service opportunity; Nelson Hydro strives to be a utility that not only services the needs of its customers but is also viewed as a good corporate citizen – the solar garden is another opportunity for delivering a good program that goes above and beyond offering pure electrical energy to its customers.	This benefit has been realized. 301,937.17 kWh of solar energy has been generated since commissioning in June 2017 until the end of December 2021 for subscribed members. Despite this benefit, there is a perception from a couple of non-Solar Garden participants that ratepayers subsidized the project to the benefit of participants despite attempts to correct this misinformation. The actual cost per ratepayer per year for the life of the solar asset is $0.14[4].
c. Elimination of individual building code and zoning issue concerns that could arise from construction of panels on residential rooftops.	This benefit has been realized. As of May 2021, 78% of account holders live in homes and are considered residential based on their rate designation.
d. Savings in time and energy of participants, as they don't need to research solar panels, hire a contractor, coordinate the installation etc...	This benefit has been realized. The biggest time savings occurred when a few investors communicated that they were already in the midst of a personal solar panel project and decided to cancelled it in favor of the more economical Community Solar Garden project.
e. Expanded access to renters, business owners, and non-profit organizations.	This benefit has been realized. As of May 2021, 22% of solar accounts fall into a commercial rate designation of churches, cooperatives, schools, and the college.

[4] Calculated by dividing the Nelson Hydro actual investment of $37,214.54 by the life of the solar asset of 25 years divided by the number of meters within Nelson Hydro Service Territory in December 2021 of 10,864.

f. Access to those who own houses with unsuitability issues, such as roof size, configuration, adjacent buildings, shading and other factors that may reduce power output.	This benefit has been realized. Some of the original investors disclosed their reasons for investing were the lack of structural suitability of their current housing for solar panels.
g. An opportunity to contribute towards the advancement and growth of solar energy.	This benefit has been realized. The Community Solar Garden project experience has been shared with many communities across Canada and in depth with the City of New Westminster as they continue to add more solar phases to their own community solar array.

References

Jetson Consulting Engineers Ltd. (2015). *Solar Garden Spacing Analysis.* Nelson: Elroy Switlishoff.

Jetson Consulting Engineers Ltd. (2014). *Project Evaluation Report.* Nelson: Elroy Switlishoff.