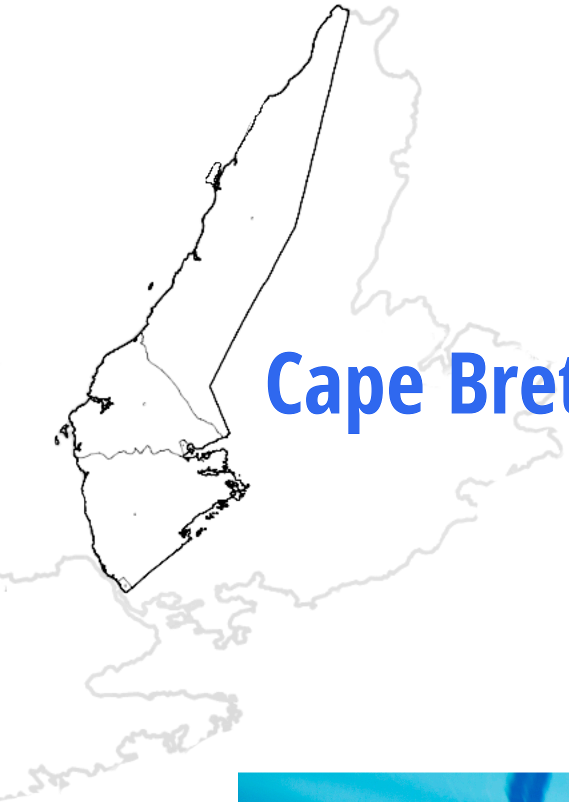
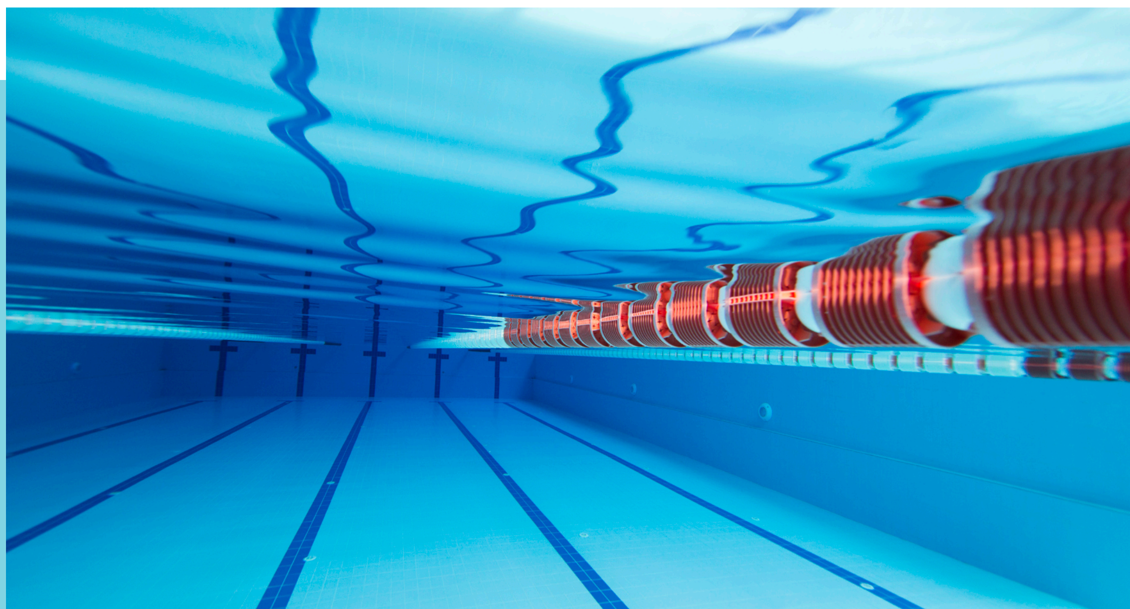


Cape Breton West Aquatic Centre

A feasibility study to inspire
low-carbon communities

February 2023



Margaree
Environmental
Association

Project Support:

The MEA woould like to thank the Low Carbon Communities program for their financial support of this project.

Project Partners:

Conrad Taves design consulting

PLANNING & DESIGN

CBCL

West Cape Breton Aquatic Centre: Feasibility Study

Introductory Letter

The Margaree Environmental Association (MEA) is pleased to present this feasibility study of an indoor year-round aquatic and recreational centre proposed to serve western Cape Breton Island. The study is the result of more than a year's work by MEA's executive committee and the project co-ordinator. We are excited by the findings, and look forward to subsequent phases of the project, as the aquatic centre becomes a reality and a source of pride for our community, our county, our province and beyond. Indeed, we have the opportunity to create a cutting-edge iconic building, which like the Halifax Central Library, will be inspirational to all.

MEA has been a registered non-profit society in the province of Nova Scotia since August 1988. For the past 35 years, MEA has engaged in a variety of activities aimed at making the environment and our communities safer and healthier. The Board of the Margaree Environmental Association is composed of individuals qualified and experienced in the fields of environmental protection, alternate energy production, law and health promotion.

It is the relationship between environmental and human health that attracted the MEA to the concept of a year-round indoor aquatic centre for North/Central Inverness County. The vast majority of public facilities in Nova Scotia to date rely on carbon-based fossil fuels, and there is a dire need to model the potential for carbon-neutral public buildings.

The Nova Scotia Department of Natural Resources and Renewables announced their "Low Carbon Communities" (LCC) program in the fall of 2021, calling for expressions of interest for projects that would promote greenhouse gas reductions and engage local communities in addressing their needs. The MEA applied to the LCC fund and was fortunate to receive $75,000 from the program, with MEA in turn contributing $25,000 in cash and in-kind services.

The feasibility study is the first phase of the proposed aquatic centre development, and subsequent phases will require close collaboration amongst governments and the public. This is clearly a project designed for the future. It will be a compelling and persuasive example of a carbon-neutral building. It will be a valuable facility supporting future long-term community health that will teach our population to swim and feel comfortable in the waters that surround us. It will attract future families, businesses and tourists to western Cape Breton, and help celebrate and vitalize our communities and cultures.

Maria Coady
Neal Livingston
Brian Peters

BELOW
Guildford Aquatic Centre, Surrey, B.C.

Cape Breton West Aquatic Centre

A feasibility study to inspire low-carbon communites

TABLE OF CONTENTS:

1 EXECUTIVE SUMMARY

Through decades of work on issues of human and environmental health and protection, the Margaree Environmental Association (MEA) became interested in exploring the idea of a year-round indoor aquatic health and recreational centre for western Cape Breton that would be carbon and energy neutral, and could serve as an iconic example of beautiful and responsible public architecture. MEA received funding from the Department of Natural Resources & Renewables Low Carbon Communities Program to conduct a low-carbon feasibility study of such a development. This study is the result of 10 months of research, consultation, design and documentation, and successfully demonstrates that a carbon-neutral aquatic centre is feasible, and may be applied to the design of other public buildings. The initial goals of the study evolved as the work progressed, becoming focused on defining a zero-carbon model and investigating the requirements for sustainability. The ownership, building design and funding model for the project will be determined during future phases, after extensive engagement with the public and potential project partners. This report's focus on energy and sustainability reflects our project's unique approach to feasibility, assessing long-term operational costs as well as short-term building costs, and is a pioneering effort to clarify the issues and inspire enthusiasm for the Cape Breton West Aquatic Centre.

To understand what has been done, and to envision what is possible, MEA researched examples of aquatic centres within Nova Scotia as well as in other Canadian provinces and even another continent, and chose to focus on six case studies:

- The Strait Area Pool in Port Hawkesbury, Nova Scotia
- The Cornerbrook Regional Recreational Centre, Newfoundland & Labrador
- The East Hants Aquatic Centre, Nova Scotia
- The Terme Merano Aquatic Centre, Italy
- The Golden Aquatic Centre, British Columbia
- The Revelstoke Aquatic Centre, British Columbia

These projects demonstrate different development approaches and provide opportunities to learn from both the successes and the challenges they encountered. Together, they paint a compelling picture of diverse, vital aquatic and recreational activities, with such features as children's play areas, lap pools, hot tubs, water slides, saunas, climbing walls, waterfalls, multi-purpose rooms, and inclusive/accessible change rooms: ideas to fuel our own vision and aspirations.

From these six precedents, the East Hants Aquatic Centre was chosen to be the benchmark case study on which to base the energy modelling for the proposed Cape Breton West Aquatic Centre. The facility is relatively new, close to western Cape Breton and serves a comparable population; it therefore provides a useful base model to evaluate for current energy use, then calculate the impact of conservation measures and on-site energy generation, and determine the feasibility of achieving carbon neutrality for the proposed Cape Breton West Aquatic Centre.

The study considers possible options for the location of the aquatic centre. The socio-economic profile of western Cape Breton (including the demographics, health status, lack of recreational facilities and expressed priorities of the public) suggests that North/Central Inverness County is an ideal location for this project. The Margaree area is within a 30-40-minute drive from the communities of Chéticamp, Grand Etang, Inverness, Mabou, Port Hood, East Lake Ainslie, Middle River, Whycocomagh and Baddeck, and Margaree Forks is the area's central community, located near the crossroads of several well-travelled highways. Four potential sites were identified and evaluated; three in Margaree Forks and a fourth adjacent to the Cape Breton Highlands Academy and Education Centre in Terre Noire. All four sites are able to accommodate a carbon-neutral facility, and two of the sites in Margaree Forks (the old school site and the old soccer field) are preferred.

MEA contracted the engineering firm CBCL, which conducted the energy modelling, analysed the data and documented its findings in a comprehensive report (Appendix A). Using the East Hants Aquatic Centre as the base model, the report recommends applying improved materials and systems to lower energy use by 55% and carbon emissions by 60% through the following measures:

- Building envelope: increase insulation value by 15%; upgrade to triple glazed windows
- Shower drain water heat recovery; recover 25% of waste water heat
- Air source heat pump
- Heat pump hot water heater
- Solar water heating; reduce energy to heat water by 27%
- Solar air heating
- Occupancy demand pump; reduce pump energy consumption by 38.5%
- High efficiency energy recovery ventilation
- Daylight lighting controls; save 20% of lighting cost in areas with windows and/or skylights
- Pool cover usage; save 13.5% of pool heating load

The cost to upgrade the baseline model with the above measures is estimated at $3.2 million. This would provide an annual energy savings of $148,008 and reduce the load and stress on the high-efficiency equipment, increase longevity of the building and reduce maintenance costs.

The total annual energy consumption for the proposed facility is estimated at 680,256 kWh. Using solar power generation, the facility would require 600-610 kWpDC PV to render the building net zero energy. The roof area of the new facility could accommodate 405 kWp, with an additional 200 kWp on the ground. The installation cost is estimated at $1,210,000. All four sites have adequate area to accept this infrastructure. In addition, the electrical grid capacity at the four potential building sites is more than adequate to provide the 500kVA service and could receive at least 500 kW of power injected into the grid.

A net metering agreement with Nova Scotia Power would allow the facility to produce a surplus of renewable energy, export it to the grid and receive full credit for the surplus to be used in periods of higher energy consumption. It is expected that the net metering limit in Nova Scotia will increase to 1 MWpDC in the future, meaning that the 600-610 kWpDC would be well within the new limit.

Embodied carbon, as opposed to operational carbon, represents the total of greenhouse gas emissions that occur throughout the lifetime of the building materials, including resource extraction, transportation, manufacturing, construction, maintenance and demolition. It is important to consider embodied carbon in order to achieve carbon neutrality. There are measures to reduce embodied carbon, and tools to estimate it so that the best materials will be used.

To stimulate the imagination and offer an idea of what the Cape Breton West Aquatic Centre might look like, the study presents some schematic design concepts, illustrating potential project siting and preliminary spatial layout, with exterior and interior renderings.

Community stakeholder engagement is a key component of developing a public facility, with a multi-phase public engagement process informing each stage of the concept and design. The community consultation strategies used to develop the East Hants and Golden aquatic centres are revealing and instructive. The East Hants process included eight community-level design workshops, three visioning workshops, and three open-house sessions before the design was finalized and the project put to tender. The Golden process included two distinct phases of engagement: the first to establish an understanding of the needs and desires of the community; the second to share options for development and make the community aware of the cost implications for each. This engagement work results in better understanding of community needs, and greater inclusion and public buy-in of the development.

In western Cape Breton two initiatives have launched the community engagement process for recreational development. The Municipality of the County of Inverness's Recreational Master Plan, to be released in spring 2023, together with the enclosed feasibility study by the Margaree Environmental Association, establish a foundation for focused community engagement on recreation in general and on the development of the Cape Breton West Aquatic Centre specifically.

Current demographic trends, public input and health indicators for western Cape Breton indicate signficant and increasing need for a year-round, indoor recreational facility to serve a population that is both aging and increasing in size. As early community engagement has confirmed, access to the safety, health and wellness benefits of aquatic education and recreation is a top priority for residents in our region.

Initiating the next step in the community engagement process, MEA held a public meeting in Margaree Forks on February 22, 2023. At this meeting the committee presented the proposal for a carbon-neutral aquatic centre, serving western Cape Breton, located in Margaree Forks. More than 90 people attended, mostly in support of the proposal and contributed suggestions for its development, documented in Section 8 of this report. After the session, 21 attendees signed up as nominees to serve on a project advisory committee. The advisory committee will help inform the subsequent development phases of determining project ownership, funding, site selection, design, tendering, construction and operation.

It is clear that there is strong public support for an aquatic facility to serve the communities highlighted in this report, and this study shows that carbon neutrality can help make it feasible to develop this type of long-term sustainable community asset. The population of western Cape Breton needs year-round opportunities to exercise, learn to swim, access therapeutic health programs and have fun.

Our society needs to address the causes of climate change, and we need to construct buildings that don't burn carbon for energy and that use high-efficiency materials and equipment to lower operational costs. The proposed Cape Breton West Aquatic Centre has the potential to serve as a model for other public buildings, and to help envision the healthy, low-carbon communities that our future depends upon.

BELOW
Sunset view of Margaree Harbour from Belle Cote, N.S.

2 INTRODUCTION

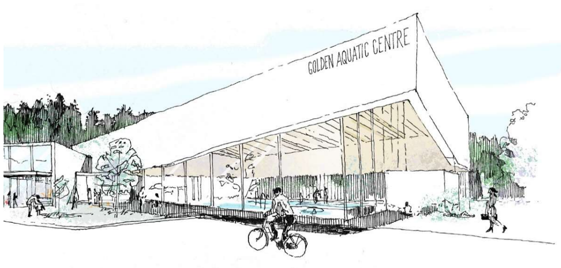
West Cape Breton Aquatic Centre:

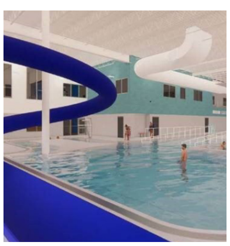
A feasibility study to inspire low carbon communities

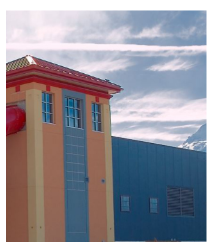
The purpose of this study is to demonstrate the feasibility of developing a zero-carbon year-round indoor aquatic centre to meet the health and recreation needs of the people of western Cape Breton Island. The Margaree Environmental Association, who conducted the study, hopes its impact will extend beyond inspiring the realization of this specific project, providing a model for future public buildings in Nova Scotia, as our society looks to address the challenges of climate change and secure the health and happiness of future generations.

Typically, development of a major public project such as this will take five years or more from the feasibility phase to the opening of the facility. This first project phase is designed to build enthusiasm for the aquatic centre and demonstrate that it is feasible to develop a sustainable, carbon-neutral public building.

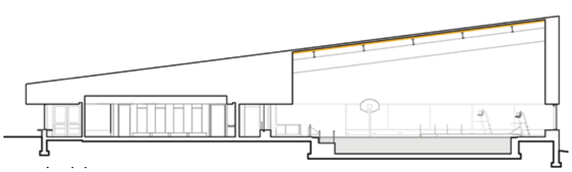
Our study paints a compelling picture of the potential to design a state-of-the-art facility and envision a vital element of future low-carbon healthy communities. There is currently no year-round aquatic centre to serve the people of western Cape Breton, despite significant indication of its need and potential benefits, as this report attests. For the health and well-being of our communities and our planet, the Margaree Environmental Association hopes that the citizens of western Cape Breton and all three levels of government will find evidence in this report that such a facility is needed in our community and that it is possible.



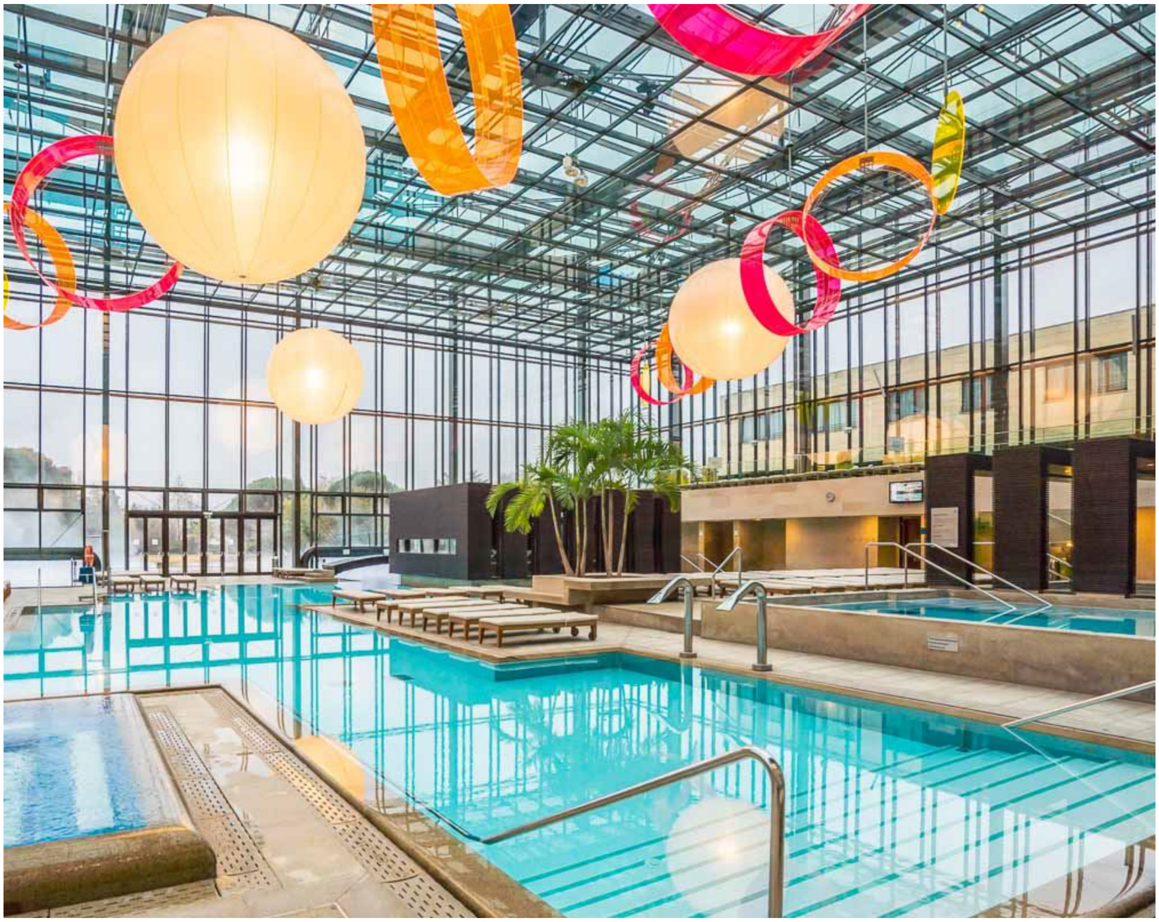




3 Precedent Case Studies



BELOW
Natatorium in Terme Merano



3 PRECEDENT CASE STUDIES

How do we determine what we want, what we need, what is possible?

The process begins by looking at what is out there, how others here and around the world have tackled the challenges of building and operating aquatic centres.

Of the countless examples of indoor aquatic facilities world-wide, our team sought to identify case studies that are relevant to our situation and/or criteria for our own project here in western Cape Breton. According to Statistics Canada, as of 2020 there are 801 publicly owned indoor aquatic facilities in Canada alone, of which 601 are 25 m in length, 70 are 50 m or longer, and 130 are leisure pools. By comparison, in Nova Scotia, those numbers are seven, two and two respectively, with the majority located in urban communities.

3.1 CASE STUDIES

We found few examples of underserved remote, rural communities like our own developing new aquatic facilities; we therefore examined a broad selection of case studies close to home, across the country and around the world, which ranged from practical and modest in scope to ambitious and aspirational. To maximize their relevance to current building practices and conditions, we focussed our attention primarily on projects that have been built recently.

ATLANTIC CANADA EXAMPLES

The past decade has seen a resurgence of interest and investment in recreational facilities in Atlantic Canada, with the completion of facilities in Pictou (2012) and Lunenburg (2013), and developments now underway on the South Shore of Nova Scotia and in Fredericton, New Brunswick.

After careful consideration, the three projects we chose to focus on as Atlantic Canadian examples are the Strait Area Pool (currently our closest aquatic facility), Cornerbrook Regional Recreation Centre (a Newfoundland facility with valuable documentation on the facility design) and East Hants Aquatic Centre (a recently completed Nova Scotian facility whose staff agreed to share operational information).

INTERNATIONAL EXAMPLES

This study was in part inspired by a facility in Meran, Italy, which a member of the MEA team was able to visit in person. Located in a relatively modest-sized town, the Meran aquatic centre serves as a major catalyst for the tourism industry and year-round amenity for residents in the larger catchment area. Those relevant situational and economic factors as well as the stunning architectural design provided an aspirational model for our study. We also examined design and technological innovations in Germany and Finland that support energy capture and conservation.

WESTERN CANADA EXAMPLES

The case studies that bore most relevance to our rural circumstances were British Columbian aquatic facilities located in the Tri-regional area of Central Kootenay, East Kootenay and Columbia-Shuswap: in Golden, B.C., a project team is now fundraising for a new facility, which will, as the MEA team hopes to do here in Cape Breton, bring state-of-the-art amenities within a reasonable distance for a large catchment of rural communities. At the same time, the Revelstoke Aquatic Centre provides parallels to our own current closest facility (the Strait Area Pool), having served for the last few decades as the nearest higher-level facility to Golden, with residents travelling 1-2 hours to access it.

1. https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2021002-eng.htm

STRAIT AREA POOL - MAIN NATATORIUM
9000 sq.ft. pool area built 1977 with
3200 sq.ft. reception + locker room
addition in 2005

Case Study
STRAIT AREA POOL
Port Hawkesbury, N.S.

Located in Port Hawkesbury, the Strait Area facility is the nearest pool available to Inverness County residents. It is included as a precedent for the information it offers on servicing a similar (and sometimes overlapping) rural population in a neighbouring region.

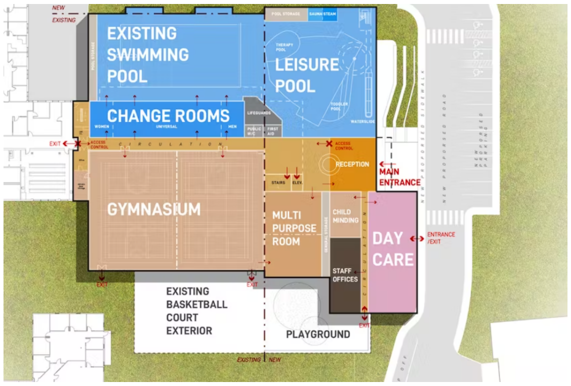
The Strait Area Pool facility was built in 1977, as an addition to the Strait Area Education and Recreation Centre, which includes the local high school (400 students) and public library. The Municipality of the County of Inverness provides funding for the pool on a per-user basis.

The Strait Area Pool includes the following features:

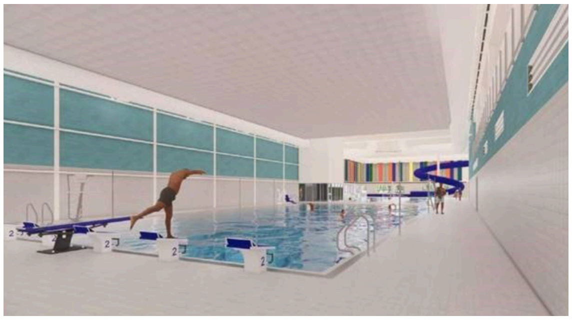
- 6-lane 25-metre salt-water pool
- wading pool, used for Learn to Swim programming, water exercises and recreational swimming
- pool-side seating for parents and friends to observe pool lessons and activities
- three changing rooms (male, female and family) with showers and lockers
- qualified lifeguards on duty at all times
- access to changing areas, pool and recreation room for patrons with limited mobility
- programming that includes parent & tot swim, public swim, senior swim, lane swim, afterschool swim, moonlight dip

It is also the home of the Port Hawkesbury/ Antigonish Swim Team (PHAST). More recent renovations saw the addition of the lobby, a dedicated reception area and improved locker/ change rooms.

1. All figures and image references for Strait Area Pool can be found on the municipal website https://www.townofporthawkesbury.ca/StraitAreaPool



CORNERBROOK REGIONAL RECREATION CENTRE
Clockwise from top right: schematic plan layout and concept renderings of interior and elevation of the new facility, with completion expected in 2024



CORNERBROOK REGIONAL RECREATIONAL CENTRE

Cornerbrook, Nfld

The Cornerbrook Regional Recreational Centre is currently under construction, with an anticipated opening date slated for fall 2023. This project led by the municipality, in partnership with Memorial University, was the product of years of planning: it was seeded by the municipality's 2010 Leisure and Recreation Master Plan, which was followed by a Feasibility Study in 2017 and further developed in the 2019 Concept Design report.

Cornerbrook is located on the west coast of Newfoundland, with a population of around 20,000 and an outer catchment area of approximately 31,000 residents. After a pre-existing facility operated by the province began reaching the end of its usable life span and a second pool located on Memorial University's Grenfell campus was decommissioned, a natural partnership formed to develop a new facility to service the needs of the larger community.

The new facility requires an extension to the southwest wing of Memorial University's Arts and Science Building, where the decommissioned pool was located. The Concept Design report provided initial construction-cost estimates of approximately $17 million and a business model that has the facility operated by a not-for-profit organization with annual revenues and expenses balanced at approximately $2.2 million.

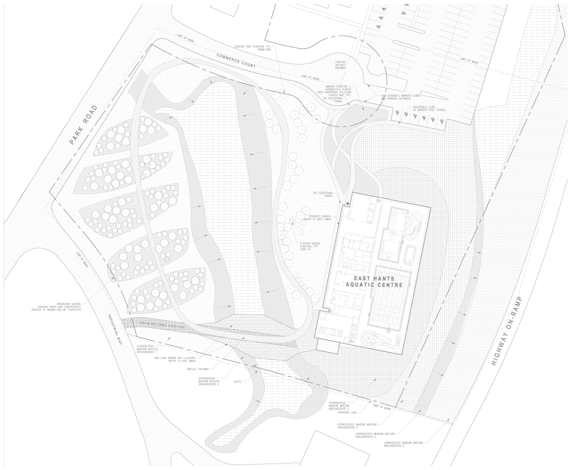
The facility has been developed as a design-build project, with the final tendered contract agreement valued at $22,293,007, including HST. The overall project is a cost-shared investment of $24.7 million between all three levels of government, with the City of Cornerbrook contributing $5 million.

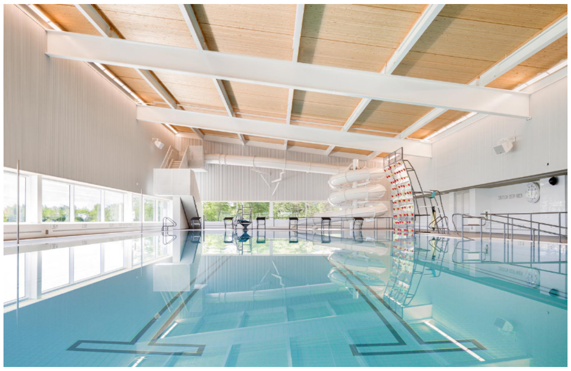
The Cornerbrook Regional Recreational Centre will include the following features:

- 6-lane 25-metre competition pool
- full-size dividable gymnasium
- dividable multi-purpose room
- full-service daycare
- child-minding area
- fully accessible leisure pool (with lazy river)
- therapy pool
- water slide
- wet and dry saunas
- fitness centre
- lounge area linking all the facilities

1. All figures and image references for Cornerbrooks Regional Recreation Centre can be found on the municipal website https://www.cornerbrook.com, and Concept Design Report: Corner Brook Regional Recreation Centre, by DSRA Architects & SNC-Lavalin (2019)

EAST HANTS AQUATIC CENTRE
Clockwise from top left: image of existing facility, early site plan of planned facility, three renderings of conceptual designs; next page: building cross section





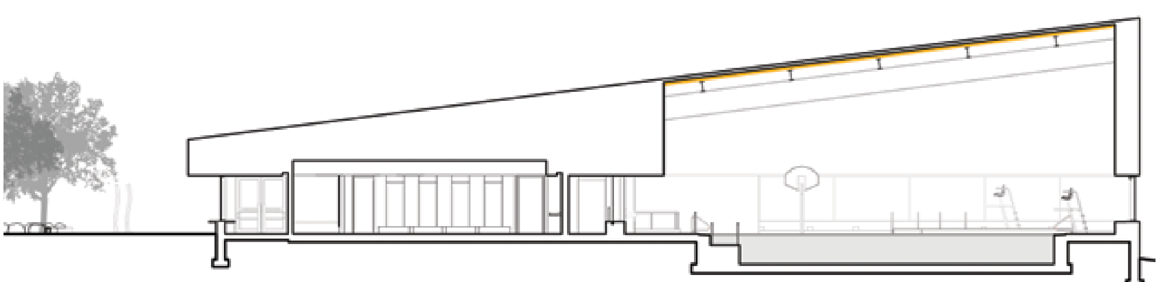
The East Hants Aquatic Centre replaced a pre-existing facility in Milford, which had reached the end of its useful life, required expensive repairs and had serious site limitations, preventing redevelopment.

A feasibility study was completed in 2015 to generate support for developing a new facility, in conjunction with a substantive community planning engagement (see Section 8). The new project was located in Elmsdale, with the intention of serving the largest number of residents in the surrounding area. Completed in 2020, the 29,063-sq.-ft. facility employs 30-40 staff and was built for a total budget of $19 million, with the federal government contributing $5.8 million and the municipality providing $13.2 million.

The East Hants Aquatic Centre is a particularly useful point of reference for this study. The facility is located very close to our service region and is comparable to what we would expect to build in terms of size, amenities and features. Its management is willing to share developmental and operational information that could help guide our own next steps and process. The project can therefore provide a helpful template for a public engagement process, ownership structure, budget, baseline space requirements and square footage for an aquatic centre in western Cape Breton (see further detail in Section 5).

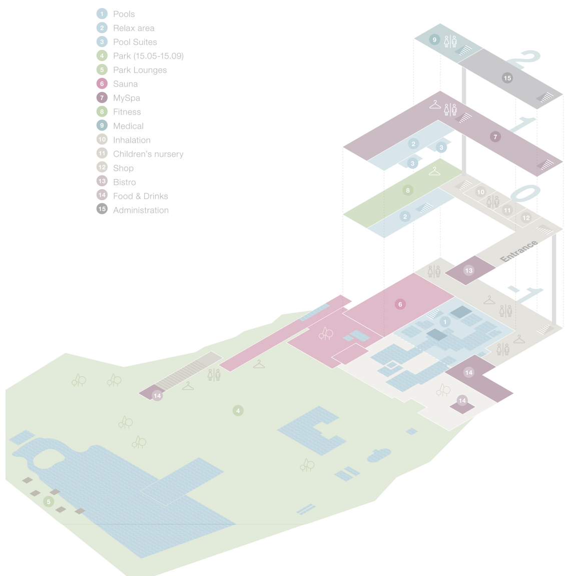
The East Hants Aquatic Centre includes the following features:

- 6-lane 25-metre lap pool
- accessible leisure spray pool
- lazy river resistance moving-water pool
- outdoor splash park
- water slide
- climbing wall
- large hot tub
- family and gendered lockers and change rooms
- community room
- kitchenette adjacent to a multi-purpose room
- public lobby
- pool viewing area



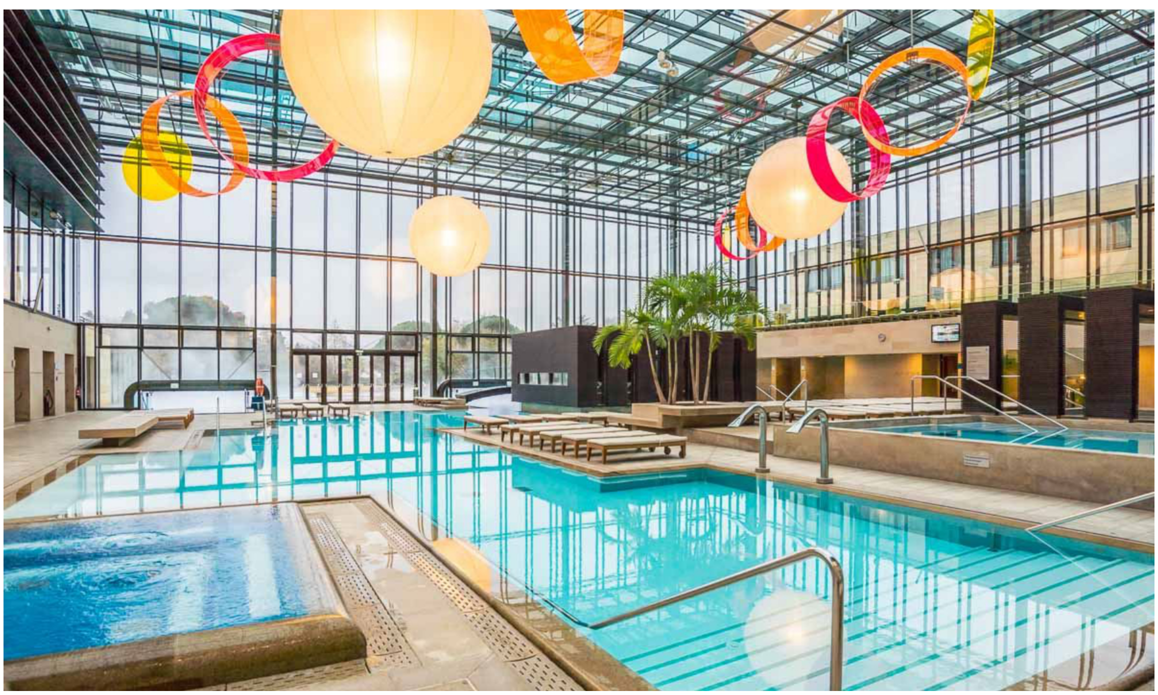
Building section A-A

1. All figures and image references for East Hants Aquatic Centre can be found on the municipal website https://www.easthants.ca
2. Drawings / Plans provided by East Hants Department of Recreation and https://www.wood-works.ca/atlantic



TERME MERANO
Right: axonometric diagram of building program; below: light-filled natatorium with various leisure pools

THERME MERAN
TERME MERANO



Case Study

TERME MERANO

Merano, Italy

Terme Merano, Italy,[1] is a health and wellness centre in South Tyrol that serves both local residents and visitors, boosting the regional economies of Burgraviato and South Tyrol as well as the national tourism sector. A 2017 economic analysis identified a $404-million impact on Italy's GDP and the spin-off creation of 3,170 secure local jobs.

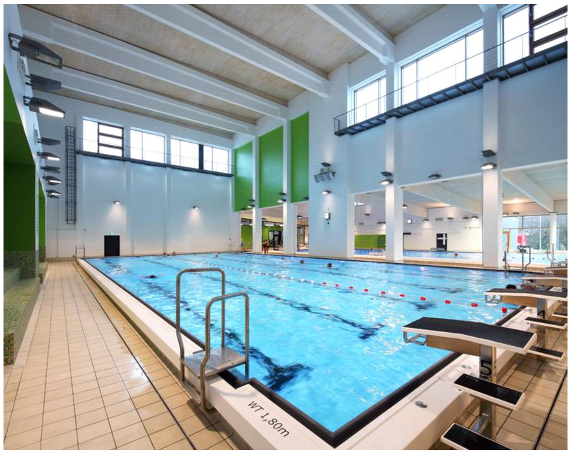
The facility is self-sustaining, with revenues exceeding operational costs, and partnerships with various institutions helping to attract customers from across the continent. Its elegant glass structure demonstrates the broad public appeal of compelling architectural design, and its profit margins and spinoff revenues model the potential tourism impact of a high-end aquatic facility, bolstering the local economy in a way that's comparable to the effect of the golf industry in Inverness.

The Terme Merano aquatic facility includes the following features:

- 6-lane 25-metre lap pool
- leisure pool with a "mushroom" combined with a lazy river
- tot's pool
- hot tub/swirl pool
- steam room
- saunas
- large spiral waterslide
- diving board
- aquatic basketball net
- climbing feature suspended from ceiling
- accessible ramp into the leisure pool
- male and female change rooms

TERME MERANO
Patrons in the outdoor hot tubs

1. All references for Therme Meran found at https://www.termemerano.it/en, and https://www.suedtirol.info/en/experience/terme-merano



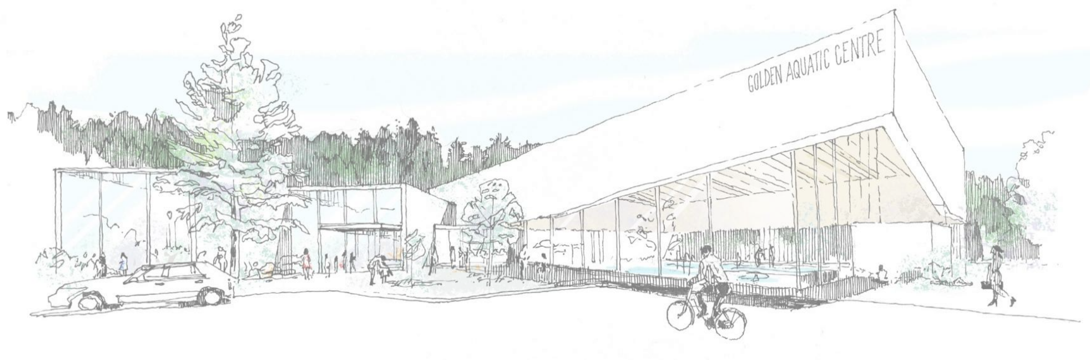
INNOVATIVE DESIGN/TECHNOLOGY EXAMPLES
Right: Bambados Pool in Bramberg, Germany and Lippe Bad Lunen Pool in Lunen, Germany - both built to Passivehaus standards; below: Polar Night Energy Sand Battery in KanKaanpaa, Finland

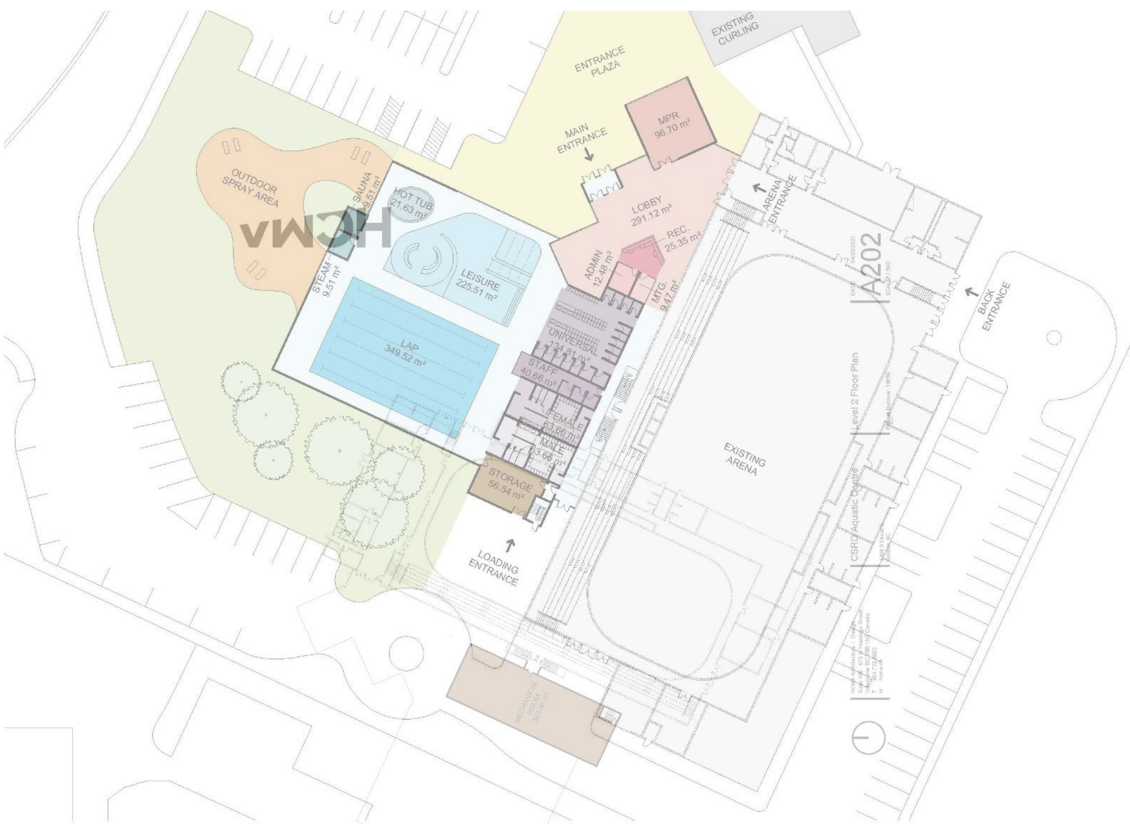
In addition to researching the above projects as case studies, we looked to specific examples of innovative technology use to inform our study.

The “passive house” design approach plans for the overall energy consumption of a building. Increased initial investment in higher quality building materials, thoughtful planning and efficiency measures can yield significant reductions in subsequent building operating costs. Two examples of passive-house aquatic centres in Germany are “Bambados” in Bramberg and the Lippe Bad Lünen Pool.

Researchers in Finland have constructed the world’s first commercial-scale sand battery, designed to store heat generated from renewable sources for months at a time in order to provide a year-round supply of energy. The battery consists of a tower of sand enclosed in a super-insulated silo that can accept, for example, surplus solar power in the summer, and then recover the heat when needed in the winter. The advantage of sand batteries is that sand is ubiquitous, relatively cheap and very stable.

1. https://passivehouse.com/05_service/03_literature/030306_indoor-swimming-pool.htm
2. https://passivehouse-international.org/upload/2015_12_15_Passive-House-Swimming-Pool_Bamberg_Press-Release.pdf
3. https://polarnightenergy.fi/sand-battery





GOLDEN AQUATIC CENTRE
Shown above are a schematic rendering and site plan of the proposed facility

Case Study

GOLDEN AQUATIC CENTRE (IN DEVELOPMENT)

Golden, B.C.

The relatively small community of Golden, B.C. is successfully developing an aquatic facility in a rural area comparable to western Cape Breton.

The community previously had an outdoor pool that was in need of upgrading or replacement, and in 2019 the Columbia Shuswap Regional District (CSRD) initiated a comprehensive series of feasibility studies, which continued until 2021 (please refer to Section 8 of this report for further discussion regarding the feasibility/community engagement process in Golden).

In October 2022, residents of the larger Golden district voted in favour of developing an indoor aquatic facility, with total capital costs estimated at $35 million. Fundraising will cover $17 million, and the other $18 million will be repaid over 30 years through property taxes by local residents. Average residential properties will pay approximately $150-$200 annually per household.

A preliminary operating budget for the facility was modelled on a similar-sized facility in the Kootenays, with estimated net annual operating costs of $519,332, which include projected revenue of $219,000. Timelines for the Golden development are dependent on successful fundraising. The project team anticipates completion of the architectural design in 2023-2024, with construction taking place over the following two years. The opening is expected sometime in 2026.

The project has been well documented and provides an incredible reference for other small communities with limited resources, such as ours, who are considering similar developments.

The Golden Aquatic Centre will include the following features:

- 6-lane 25-metre pool
- leisure pool, lazy river
- tots' area, spray features and beach entry
- sauna/steam room
- hot pool
- universal and gendered change rooms
- large multi-purpose room
- administration offices

1. All images and references for the Golden Aquatic Centre can be found at https://www.goldenondeck.ca/

REVELSTOKE AQUATIC CENTRE
From top to bottom: view from the exterior of the slide, and interior view of the Natatorium lazy river and lap pool in background.

Case Study:
REVELSTOKE AQUATIC CENTRE
Revelstoke, B.C.

Revelstoke served as one of the benchmark case studies for Golden and likewise provides an interesting comparison model for western Cape Breton. The facility serves the city of Revelstoke with a population of around 8000+ and draws from surrounding communities; it is the nearest indoor pool facility for Golden-area residents, who would drive 1.5 to 2 hours each way to access the aquatic centre, often facing adverse road conditions or closures.

Operated by the city Revelstoke, the Aquatic Centre was added to an existing community centre in 2005, and the pool switched from salt-water to chlorinated water in 2013. The pool and building are heated with heat pumps (and benefit from the city's renewable district energy system, which is fuelled by biomass). The air is dehumidified, and heat is extracted from the air, which is used to heat the pool water. It is a very efficient system, resulting in reduced energy costs. The facility has direct digital control that enables careful monitoring of the systems throughout the building.

In 2019, the facility's two major operational expenses were wages plus benefits at $595,756 and utilities at $250,636. Revenues totalled $506,048, wth a net operating cost for the facility of $596,854 (excluding some shared costs). Noted challenges in the 2022 Revelstoke Recreation Master Plan for the facility are acquiring funds to upgrade the pool locker and staff/operations areas, sauna and climbing feature.

The Revelstoke Aquatic Centre includes the following features:

- 6-lane 25-metre lap pool
- leisure pool with lazy river
- water slide
- hot tub
- sauna
- steam room
- climbing wall
- small fitness facility

1. All images and references for the Revelstoke Aquatic Centre can be found at http://www.cityofrevelstoke.com/131/Aquatic-Centre, and additional information found in Golden Aquatic Centre Feasibility study, Technical Memos 1&4

SUMMARY OF OBSERVATIONS

Strait Area Pool has integrated services and programming with the adjacent P-12 school and the Port Hawkesbury Civic Centre. Lessons can be learned from flaws in the planning process and difficulty integrating the facility into a larger school building, resulting in challenges around access, parking and changing room configuration.

The Cornerbrook Regional Recreation Centre has an effective partnership with Memorial University. The development process began with many years (2010-2019) of planning, feasibility study and design.

The East Hants Aquatic Centre is an accessible example of a modern facility with appropriate size and features to be used as a model for defining a carbon-neutral building. The development shows the important roles of the feasibility study and extensive community engagement.

Terme Merano proved to be an economic catalyst for the region and demonstrates the potential of aquatic centres to improve local quality of life while also bolstering the tourism industry. Their bold and attractive facility offers inspirational and aspirational ideas to inform design and spatial programming.

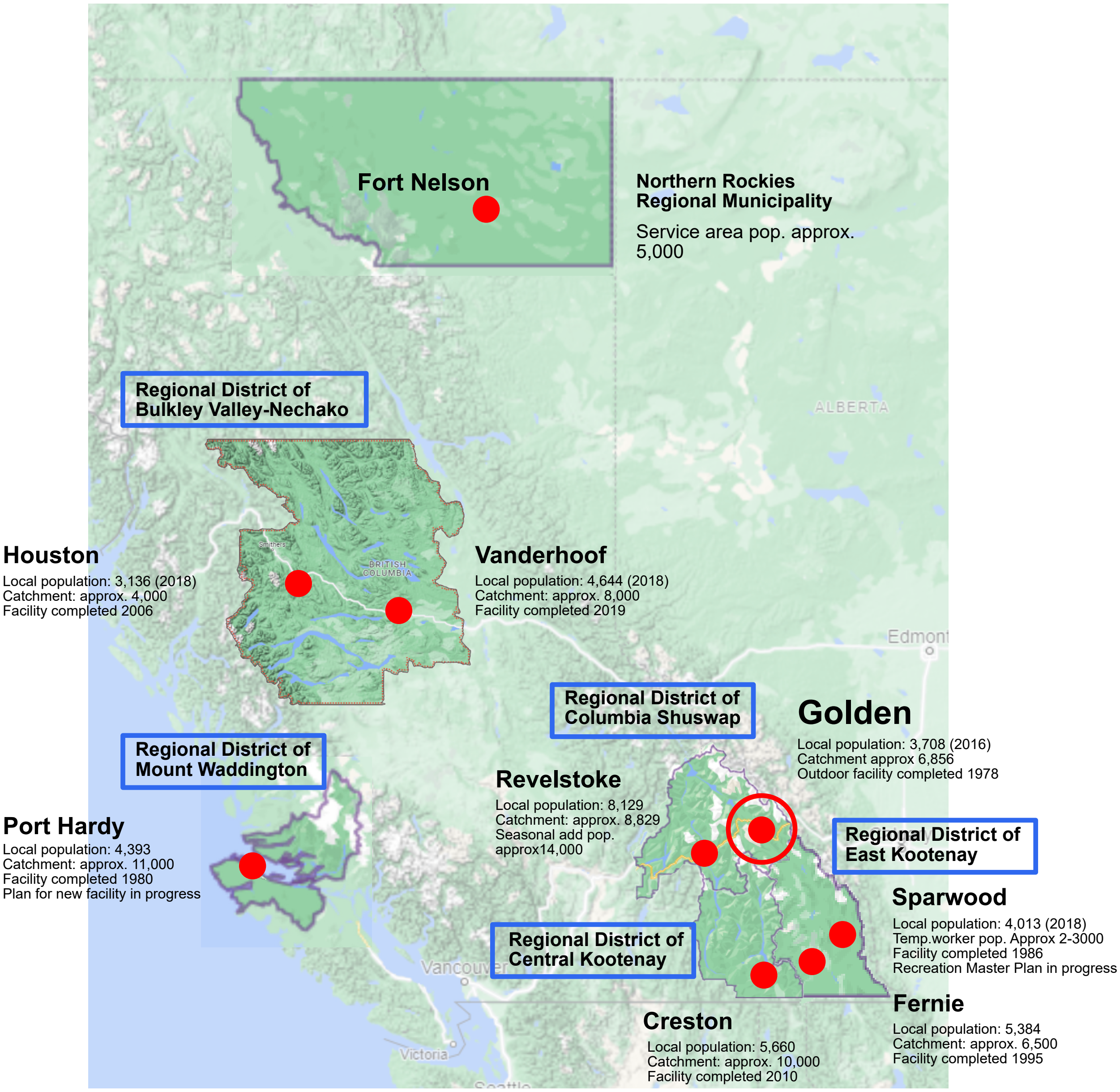
The Golden Aquatic Centre used extensive community engagement to secure public buy-in and consensus early in their development process. The documentation of this process is comprehensive and particularly valuable to smaller and more remote communities such as ours.

The Revelstoke Aquatic Centre and Golden Aquatic Centre prove that it is feasible to locate smaller pool facilities 1-2 hours apart in communities of 3,000-8,000 people.

Together, these case studies offer a baseline set of spatial characteristics, both essential and optional, and give us a general expectation of size, cost range and appearance.

4 Preliminary Site Considerations

SELECTED AQUATIC FACILITIES IN B.C.
Below are various comparative facilities reviewed
in the Golden, B.C., feasibility/engagement process



4 PRELIMINARY SITE

How do you determine the ideal location?

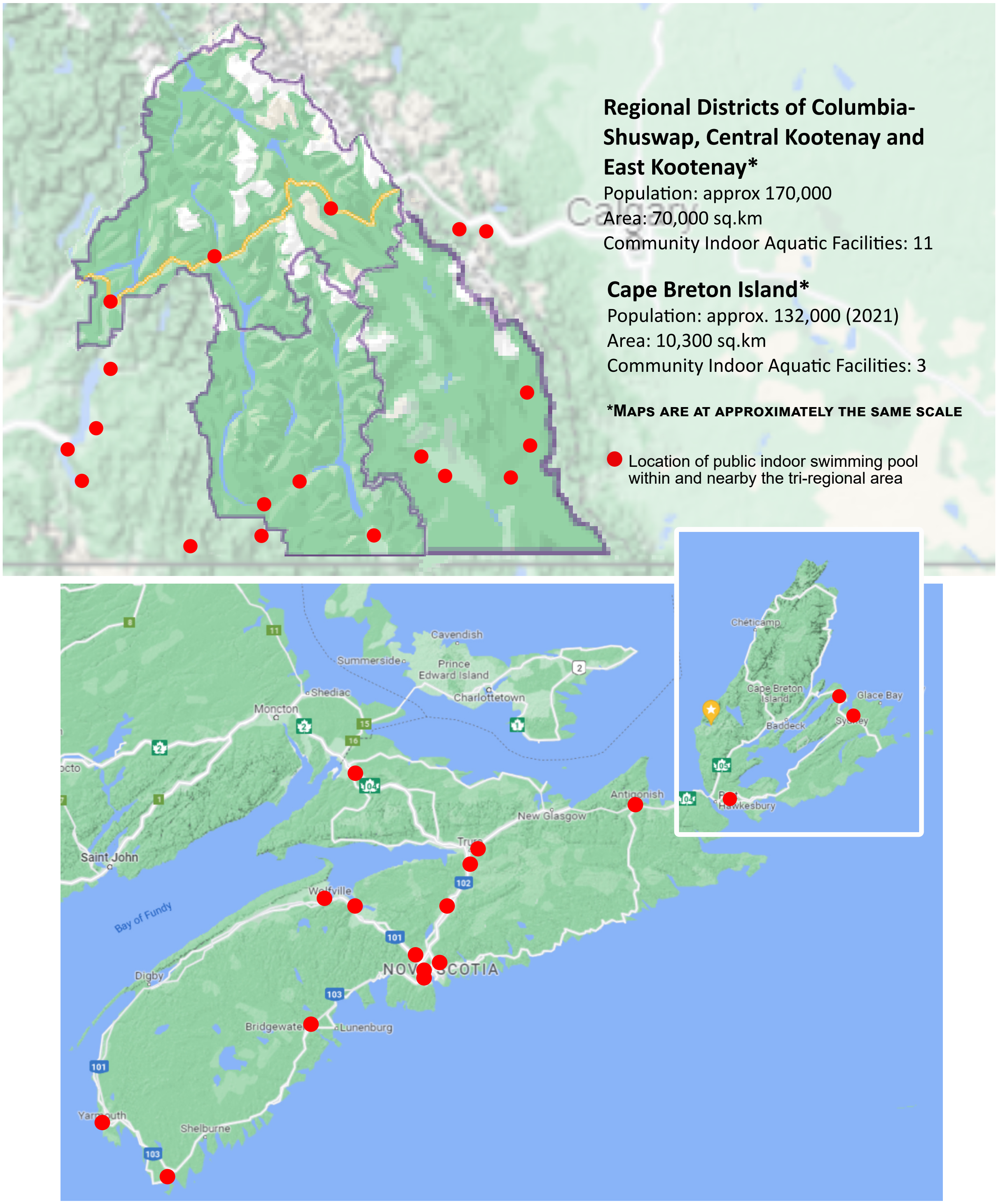
With a dozen communities in western Cape Breton needing convenient access to the aquatic centre, we first identify the location that is most central to the catchment area.

When rural communities are looking at developing infrastructure like an aquatic centre, a critical part of the process is determining not just a specific building site but also and especially its location within an expansive catchment area. Many communities face the question of whether to upgrade an existing aquatic centre, add on to another facility (like a community centre or school) or build an entirely new structure in a preferred location. In the case of Inverness County, there is no existing facility to update, and the region includes a number of smaller population clusters spread out over a large geographic area, posing the question, “What location would best serve the maximum number of residents, while remaining accessible to the most remote and underserved communities in the region?”

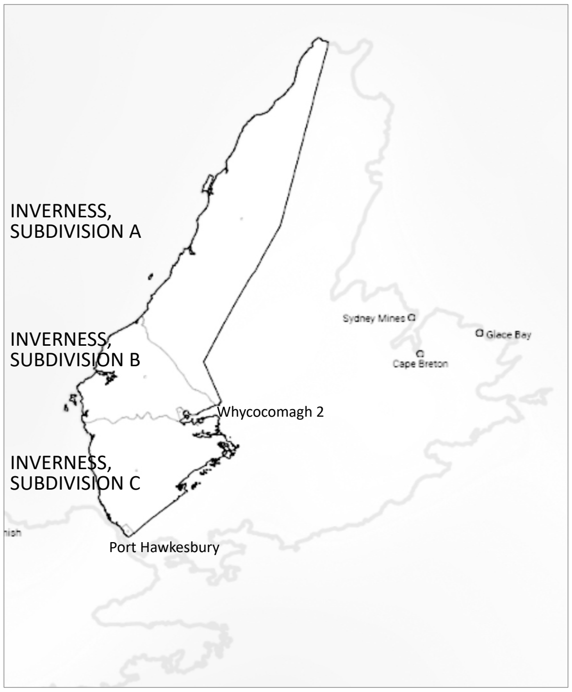
4.1 REGIONAL PERSPECTIVE

In our case studies, the development in Golden, B.C., provided compelling context to our own situation with respect to the proximity of other aquatic facilities in the province and the communities they serve. The following page shows a map of B.C., indicating the locations of various communities with comparable service populations to Cape Breton Island’s, each with its own aquatic facility.

By comparison, as depicted in the map of indoor aquatic centres located in Nova Scotia (following page), there is no aquatic facility in western Cape Breton. On all of Cape Breton Island, with a population of 130,000, there are only three indoor aquatic centres, while in a similar area in B.C., with a combined population of 170,000 people, there are 11 indoor aquatic centres. Residents of Golden, B.C., were in a similar situation to many residents in western Cape Breton, travelling between 1-2 hours each way to access the nearest aquatic centre, and they responded to this situation by developing their own facility.



Regional Districts of Columbia-Shuswap, Central Kootenay and East Kootenay*
Population: approx 170,000
Area: 70,000 sq.km
Community Indoor Aquatic Facilities: 11
Cape Breton Island*
Population: approx. 132,000 (2021)
Area: 10,300 sq.km
Community Indoor Aquatic Facilities: 3
*Maps are at approximately the same scale
Location of public indoor swimming pool within and nearby the tri-regional area
Cavendish
Summerside
Prince Edward Island
Charlottetown
Shediac
Moncton
Saint John
Bay of Fundy
New Glasgow
Antigonish
Digby
Lunenburg
Shelburne
Cheticamp
Cape Breton Island
Baddeck
Glace Bay



Name	Status	Population Estimate 2002-07-01	Population Estimate 2007-07-01	Population Estimate 2012-07-01	Population Estimate 2017-07-01	Population Estimate 2022-07-01
Inverness	**County**	**20,304**	**18,909**	**18,002**	**17,470**	**17,616**
Inverness 17,616 Population [2022] – *Estimate* 3,831 km² Area 4.598/km² Population Density [2022] 0.17% Annual Population Change [2017 → 2022]						
Inverness, Subdivision A	Subdivision of County Municipality	6,145	5,744	5,296	5,137	5,129
Inverness, Subdivision B	Subdivision of County Municipality	5,855	5,352	5,151	4,993	5,159
Inverness, Subdivision C	Subdivision of County Municipality	3,896	3,608	3,396	3,247	3,252
Port Hawkesbury	Town	3,754	3,535	3,336	3,247	3,262
Whycocomagh 2	First Nations Reserve	659	670	823	846	814
Nova Scotia	**Province**	**935,155**	**935,115**	**943,635**	**950,108**	**1,019,725**

Source: Statistics Canada (web).

Explanation: In contrast to census figures, population estimates are adjusted for underenumeration. 2022 figures based on the 2016 census.

https://www.citypopulation.de/en/canada/novascotia/admin/1215__inverness/

How far should we have to travel to an indoor aquatic centre?

4.2 MUNICIPAL PERSPECTIVE

As the map on the previous page illustrates, census populations by subdivision show that roughly 60% of Inverness County residents have to drive more than 80 km, round trip (exceeding a 60-minute drive even in optimal weather conditions) to access the nearest aquatic facility, the Strait Area Pool in Port Hawkesbury. It also shows that roughly 30% of Inverness County residents have to drive more than 180 km, round trip (from almost an hour and a half of driving to more than five hours of driving for the most remote communities).

The largest community in the Municipality of Inverness County is the Acadian village of Chéticamp. A seaside community, with many fishermen earning a living on the water and many families spending their summer leisure hours on the beach, Chéticamp is also home to the highest number of low-income seniors in our region. And yet, to travel to swimming lessons—to help increase the safety of fishermen and children spending time in and on the ocean—or for seniors and other community members to participate in aquatic exercise and water therapy, they must travel more than 270 km, round trip (or almost 3.5 hours of driving).

The distance, cost, and practical challenges of visiting their closest aquatic facility puts its services literally out of reach for many (if not most) Inverness County residents, depriving them of the myriad benefits in terms of safety, physical and mental health, and quality of life.

We therefore sought a geographic location that accounts for the distribution of population across Inverness County, which would work with the existing Strait Area Pool facility to ensure almost all Inverness County residents have access to an aquatic facility that is within a 30-45-minute drive.

This turned our attention to North/Central Inverness County, where the majority of our population resides and are at the greatest distance from the Strait Area Pool at the southern end of Inverness County. We identified Margaree Forks as an ideal community to base the facility in within this target area.

Why Margaree Forks?

The map on the following page illustrates how Margaree Forks is accessibly located between the various rural population clusters of North/Central Inverness County, and a facility located there would greatly reduce travel time for both the central and more northern communities.

Margaree Forks has historically been a regional hub, a crossroads for visitors passing through en route to other, larger destinations, and a vibrant centre serving the smaller local communities comprising the Margarees. Traffic

Pleasant Bay
78 km (65 min.)

Cheticamp
37 km (29 min.)

Grand Etang
27 km (21 min.)

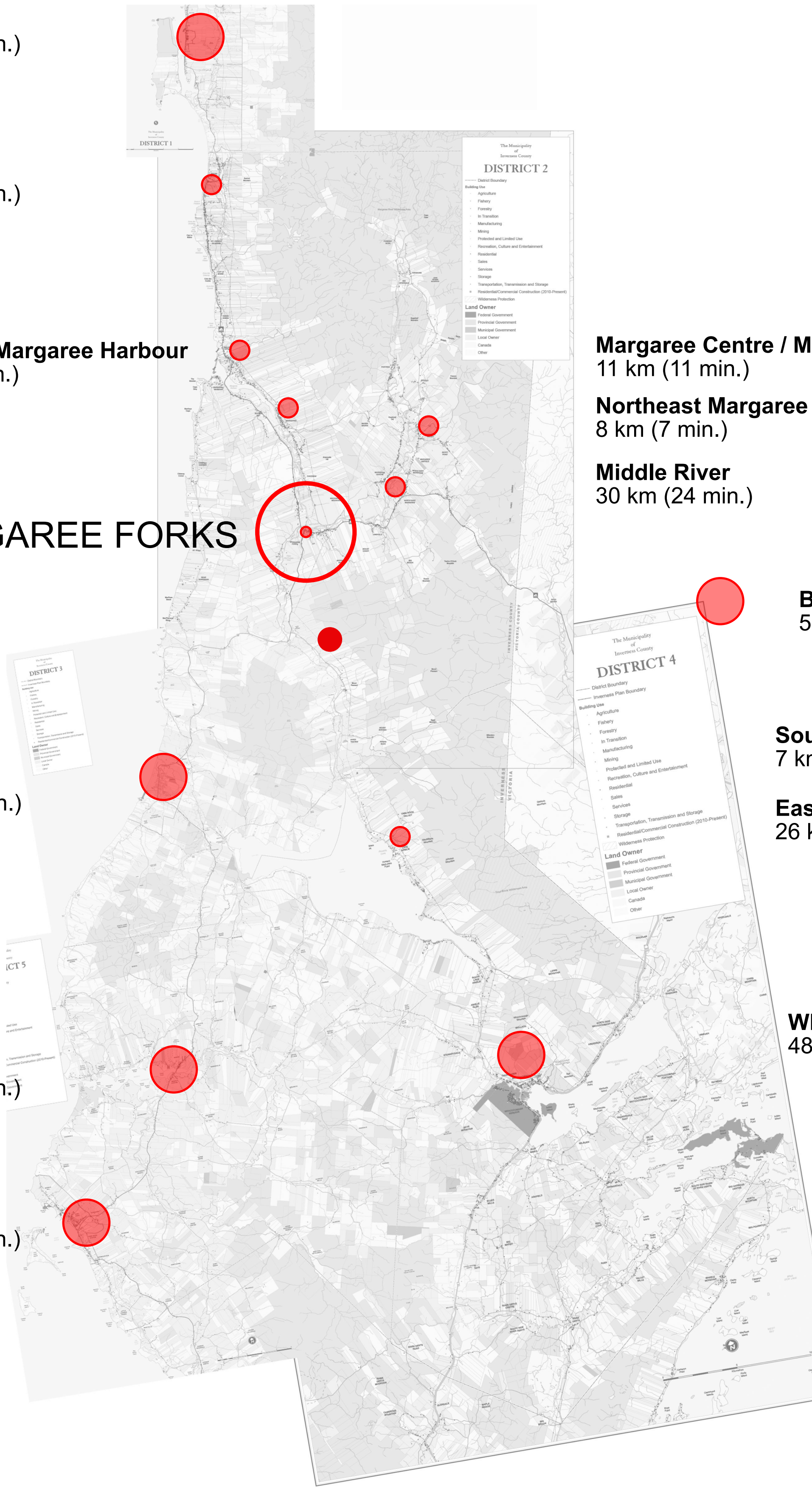
Belle Cote / Margaree Harbour
14 km (11 min.)

Margaree Centre / Margaree Valley
11 km (11 min.)

Northeast Margaree
8 km (7 min.)

Middle River
30 km (24 min.)

MARGAREE FORKS



Baddeck
52 km (46 min.)

Southwest Margaree
7 km (6 min.)

East Lake Ainslie
26 km (20 min.)

Inverness
26 km (20 min.)

Whycocomagh
48 km (38 min.)

Mabou
48 km (38 min.)

Port Hood
60 km (50 min.)

around and through this community remains heavy. Building an aquatic centre in Margaree Forks would have a positive impact on this local community, while also providing convenient facility access for visitor traffic from other communities.

Later in this report, in Section 8, we will take a look at the Municipality's demographic profile in greater detail, identifying critical metrics in support both of building this type of facility and of locating it in the Margaree Forks area.

AQUATIC FITNESS
Below: image of seniors aquatic fitness programming at the East Hants Aquatic Centre (https://www.easthants.ca/residents/aquatics/aquatic-fitness-classes)

4.3 LOCAL PERSPECTIVE

What properties in Margaree Forks may be suitable for the Cape Breton West Aquatic Centre ?

Considering site options in the Margaree Forks Area, three potential properties were identified as possible locations for this development, along with a fourth site, the Cape Breton Highlands Education Centre & Academy in nearby Terre Noire, with its opportunities for partnership with the P-12 school. (Note, these options are intended to provide a basis to help explore some of the challenges and considerations for a future project, but there may be other potential sites to investigate in subsequent project phases.)

ABOVE
Map of stretch between Margaree Forks and Margaree Harbour/Belle Cote. Noted is the location of the Cape Breton-Highlands Education Centre & Academy. Highlighted is the Margaree Forks area

LEFT
Close-up of Margaree Forks, with locations of the former high school, old soccer field, existing library commons, fishing pools, firehall and co-op

SITE #1:

Former Margaree Community Soccer Field

This property was recently purchased by an investment group from Ontario. The site is prominently located on a beautiful landscape, and has history as the former community soccer field. The site borders the Cabot Trail with easy vehicular access, and is in close proximity to the junction of the North East and South West branches of the Margaree River, a key destination for recreational tourism.

SITE #2:

Former Margaree Forks District School Site

This property has also been purchased fairly recently by a local developer. Approximately 3.7 acres in size, it is the site of the former Margaree Forks District High School, which opened in 1962 and was demolished after closing in 2000. The aerial photograph shows the former bus loop that surrounded the old building. The location is on Route 19, close to the Cabot Trail. This site is considerably smaller than site #1.

SITE #3:

Former Margaree Lodge

This property was recently purchased by Cabot Cape Breton. The potential site for the aquatic centre is part of the old golf course area to the north of the Lodge buildings, adjacent to the Cabot Trail and the South West branch of the Margaree River.

ABOVE
Property of the old community soccer field, with highlighted 7-acre area for potential development

BELOW
former Margaree Lodge site (3), and adjacent lot of the former Margaree Forks District High School (2)

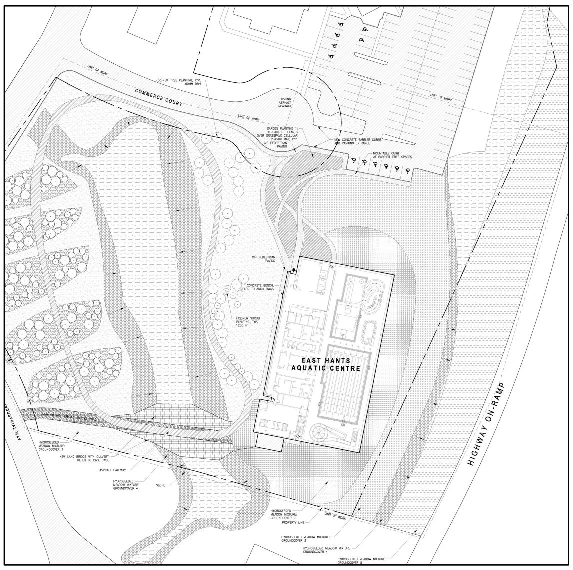
SITE #4:

Cape Breton Highlands Education Centre & Academy (CBHECA)

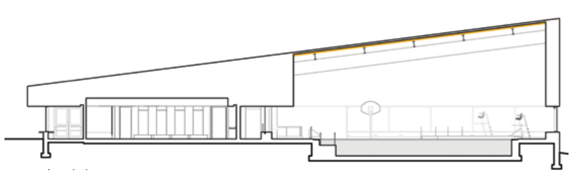
This property is located in Terre Noire, just north of Belle Cote, about 16 km from Margaree Forks, which is a bit farther north than ideal. However, the potential association between the Cape Breton Highlands Education Centre & Academy and the aquatic centre that this site offers makes it an important option to consider.

BELOW
Site of Cape Breton Highlands Education Centre & Academy

3



5 Concept Modelling



5 CONCEPT MODELLING

How do we design a sustainable, carbon-neutral indoor aquatic centre that can serve the needs of our rural communities?

First, we select an existing modern aquatic centre that can provide a model for our study. Then we study its structure and operations, determine the net annual energy required and calculate the potential energy savings if we applied conservation measures. Finally, we ascertain the feasibility of generating as much renewable energy as the building and its operations will consume.

5.1 SPOTLIGHT on the EAST HANTS AQUATIC CENTRE

In major public developments such as indoor aquatic centres, sustainable design and building measures all too often drop down the priority list, amidst efforts to reduce up-front construction costs. But these cost calculations frequently fail to account for the potential long-term operational and maintenance savings of sustainable design. Many communities are now coming to recognize that we must be willing to make short-term investments in sustainability if we hope to address longer-term challenges of climate change and increasing energy costs. A major goal of this study is to demonstrate that low-carbon, net-zero targets are a feasible and necessary part of the sustainability solution.

Resolving an architectural design for the Cape Breton West Aquatic Centre does not fall within the scope or timeframe of this study, and is an integral part of more comprehensive engagement in subsequent stages of the development process. Therefore, to calculate the potential impact and savings of the sustainability measures we are proposing, our approach was to choose an existing aquatic centre to study: one that is relatively new and includes a spatial configuration that we anticipate would meet many of our own region's needs.

The MEA team identified the East Hants Aquatic Centre as an ideal model facility for this study, for the following reasons: It is relatively close to our own project's proposed location (three hours away), was completed

quite recently (2020) and includes a modest spatial program that can serve as a template for a potential facility in this region. The East Hants Recreation Department has also been very willing to discuss their experiences before, during and after construction and has shared detailed data on the costs and operations of the facility.

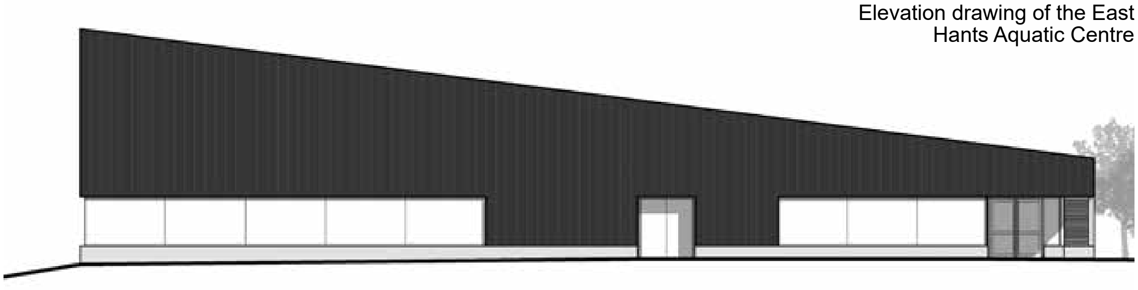
Spatial program

The architectural term spatial program *refers to the various rooms, spaces, services and functions that the proposed building will be designed to contain, therefore helping to determine its size, shape, layout, site requirements, energy needs and costs.*

What spatial program might we imagine for an aquatic facility in our municipality? In the precedents reviewed in Section 3, all facilities include a 6-lane 25-metre lap pool and a leisure pool. All but one facility have a hot tub, and the modern facilities feature family and gender-inclusive change rooms. Additional amenities such as water slides, fitness rooms, saunas and climbing walls, are found in many of the case studies.

From this review, we concluded that the West Cape Breton Aquatic Centre should include, at a minimum, the following features:

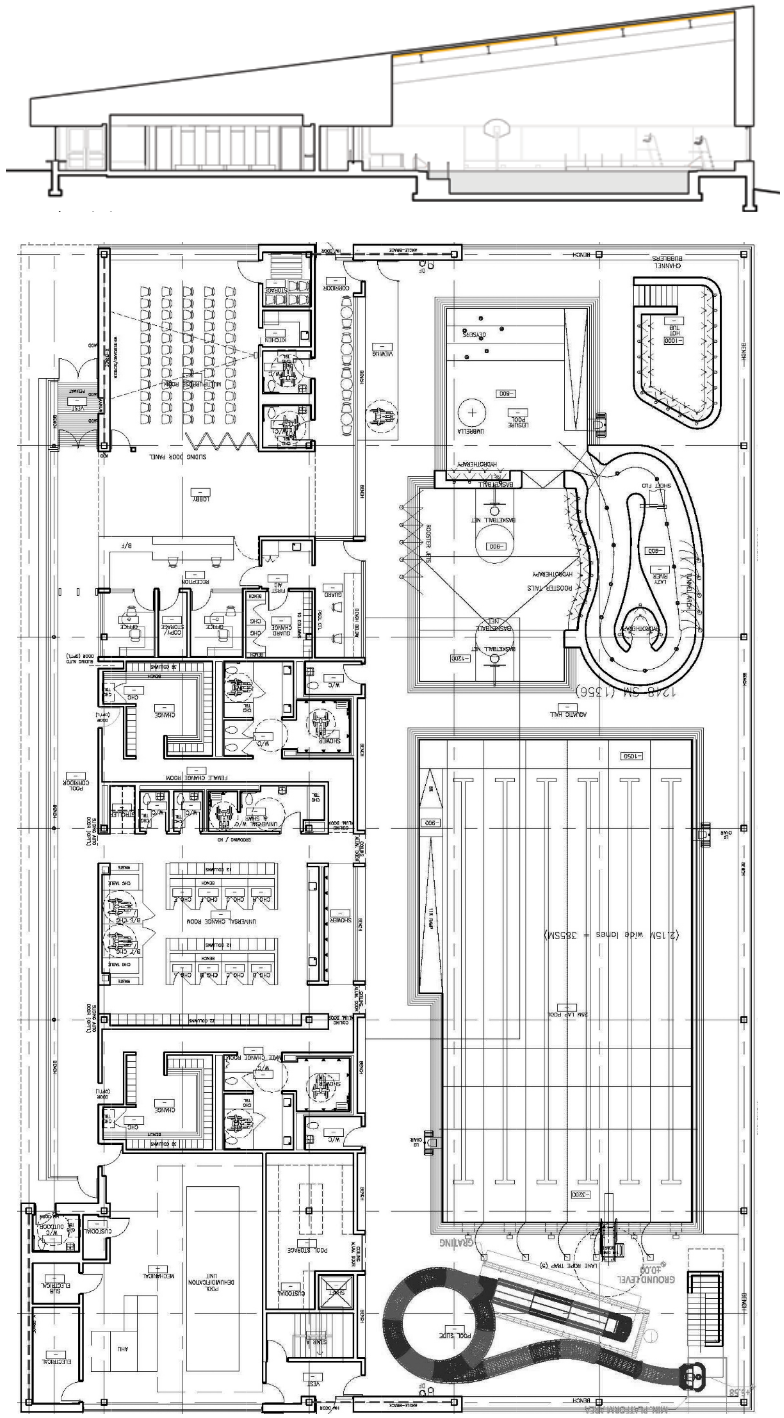
- shallow warm pool for younger children and seniors
- 6-lane, 25-metre pool or lap tank
- leisure body of water with accessible zero entry
- women's, men's, accessible/gender-inclusive and family washrooms and change rooms
- recreation and administration area, staff and building support spaces
- multi-purpose room (capacity for 50) with storage
- kitchenette adjacent to multi-purpose room
- public lobby with a pool viewing area
- pool and building mechanical room



BELOW
Elevation drawing of the East Hants Aquatic Centre

SPATIAL PROGRAM FOR THE EAST HANTS AQUATIC CENTRE (PROPOSED)
Feasibility Study, 2015

		Units	Unit SM	Net SM	Unit SF	Net SF
1.1 Aquatics Natatorium (Total Bather Load: +/- 400)						
1.1.1	Lap Pool 25m - 6 Lane	1	375	375	4037	4037
1.1.2	Leisure Pool	1	350	350	3768	3768
1.1.3	Teach Pool and Ramp	0	0	0	0	0
1.1.4	Spa Hot Pool with Ramp	1	30	30	323	323
1.1.5	Waterslide Tower and Run-out	1	35	30	377	323
1.1.6	Pool Deck Area	1	550	550	5921	5921
1.1.7	Parents Viewing Area	1	20	20	215	215
	Sub-Total			**1355**		**14587**
1.2 Aquatics Ancillary Spaces						
1.2.1	Lifeguarding Control Room	1	15	15	161	161
1.2.2	Steam Room	1	11	11	118	118
1.2.3	First Aid Room	1	9	9	97	97
1.2.4	Pool Storage	1	35	35	377	377
1.2.5	Lifeguards Unisex LockerRoom	1	14	14	151	151
1.2.6	Chemical Storage (with Pool Mech'l.)	1	7	7	75	75
	Sub-Total			**91**		**980**
1.3 Family Change Rooms						
1.3.1	Universal / Family Change Cubicles (w. Shower)	8	5	40	54	431
1.3.2	Disabled Assisted Change Cubicles and WC	2	6.5	13	70	140
1.3.3	Full-Height Locker Columns and Aisle (60 columns)	60	0.8	48	8.6	517
1.3.4	Vanity Stations	1	3	3	32	32
1.3.5	Stroller / Wheelchair Area	1	3	3	32	32
	Sub-Total			**107**		**1152**
1.4 Gender Locker Rooms						
1.4.1	Women's Locker Room (105 columns, 150 lockers)	105	0.7	73.5	8	791
1.4.2	Women's WCs, Showers, Vanities (3 of each)	12	2.5	30	27	323
1.4.3	Men's Locker Room (105 columns, 150 lockers)	105	0.7	73.5	8	791
1.4.4	Men's WCs, Showers, Vanities (3 of each)	12	2.5	30	27	323
	Sub-Total			**207**		**2228**
1.5 Administrative and Staff Areas						
1.5.1	Reception / Control Desk	1	17	17	183	183
1.5.2	Pool Manager and Programmers Offices	2	11	22	118	237
1.5.3	Staff Meeting / Lunchroom (capacity 6)	1	17	17	183	183
1.5.4	Custodial Storage	1	3	3	32	32
1.5.5	Maintenance Workbench (in Mech'l. Room)	1	3	3	32	32
	Sub-Total			**62**		**667**
1.6 Community Activity Room						
1.6.1	Multi-Purpose Room (sub-dividable; capacity 50)	1	140	140	1507	1507
1.6.2	Servery Kitchen	1	22	22	237	237
1.6.3	Multi-Purpose Storage	1	7	7	75	75
	Sub-Total			**169**		**1819**
1.7 Common Entry, Control and Support Spaces						
1.7.1	Entry Lobby (Major Circulation)	1	90	90	969	969
1.7.2	Lounge and Table and Chairs	1	15	15	161	161
1.7.3	Vending Machines	1	4	4	43	43
	Sub-Total			**109**		**1173**
Assigned Area Sub-Total				**2100**		**22607**
	Circulation Allowance (corridors, vestibule)			50		538
	Building Mechanical / Electrical 5%			100		1077
	Pool Mechanical 30% of Water Surface Area			210		2261
	Walls and Structure 2.5%			50		538
Facility Gross Area Total				**2510**		**27000**



RIGHT
Schematic building section and floor plan of the East Hants Aquatic Centre

With the above requirements in mind, we determined that the East Hants case study provides the closest match for those features and chose its spatial program as a model for this study until our public and stakeholder engagement takes place, when a spatial program shaped by our own community needs can be articulated. At that time, the public may choose additional features to add (such as additional fitness, multi-purpose and/or office spaces; daycare facilities; or therapeutic and preventative health and wellness services). But for the purposes of this study, the East Hants Aquatic Centre provides a comparable facility model to study as is, and then explore how we can make it function more efficiently and effectively.

The previous pages provide both a detailed breakdown of a spatial program developed for East Hants in its feasibility study, as well as illustrations of a cross section of the main space and floor plan of the East Hants facility. Their design team used the spatial program to develop initial schematic designs, which they revised as necessary for various function, performance and cost reasons, as the design progressed.

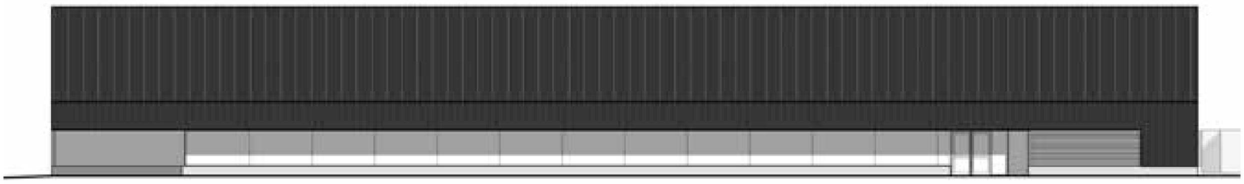
Building Performance

The building performance of the proposed Cape Breton West Aquatic Centre is critical to its feasibility and success. As discussed above, the long-term sustainability of this development revolves around balancing energy consumption with renewable energy production, so that building operation is carbon-neutral. This goal will guide decision-making at all stages of development, from initial conception through to detail design.

The MEA team contracted the engineering firm CBCL of Halifax to conduct energy modelling of the East Hants Aquatic Centre facility if it were located on one of our selected site options, before and after accounting for the impact of new efficiency measures, in order to calculate the amount of renewable energy production necessary to render the building carbon-neutral.

After determining the East Hants Aquatic Centre's base-line energy performance, CBCL identified the energy savings and new energy requirements of proposed upgrades to the building envelope and its systems. The

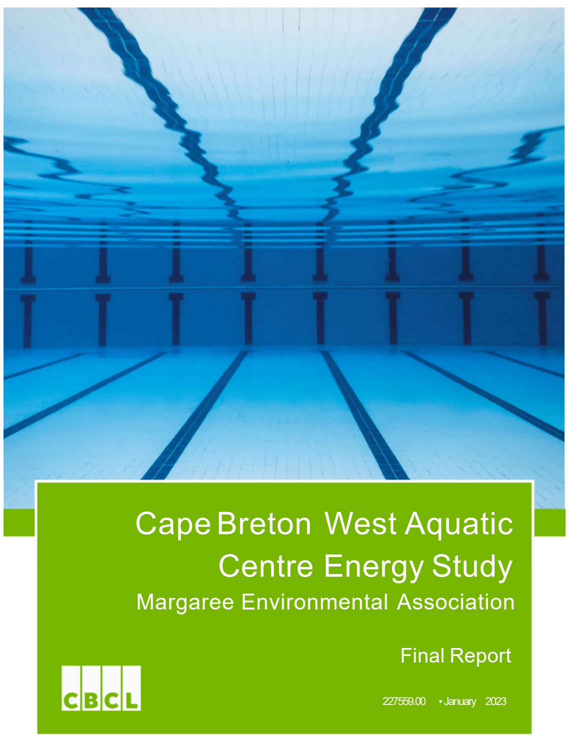
BELOW
Schematic building elevation drawing of the East Hants Aquatic Centre



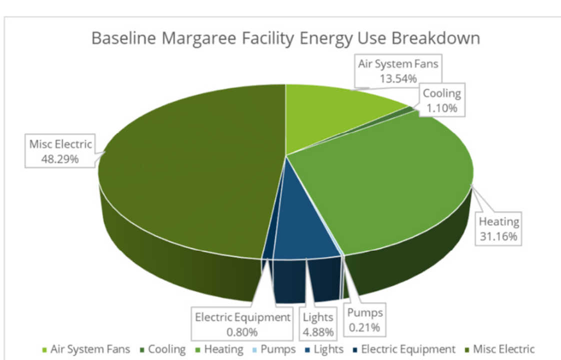
resultant analysis provides valuable insights to inform future design phases, identifying the ideal site's photo voltaic power generation potential and determining the required size of the solar panel array: to achieve carbon neutrality, the site and building must be able to accommodate the required array.

CBCL was able to determine that indeed it is feasible to build a carbon-neutral aquatic centre at all four of our selected site options.

The following section presents an Executive Summary of the CBCL report. The full report appears in Appendix A.



6 Energy Study



Executive Summary

CBCL Limited (CBCL) was engaged by the Margaree Environmental Association (MEA) to complete a carbon-zero (or net-zero) study for a aquatic facility that is planned to be located in Inverness County, NS. The MEA has received funding through the Nova Scotia Low Carbon Communities Program in support of research needed to determine the viability of establishing an aquatic recreational fitness facility in the Margaree Valley.

MEA agreed to use the East Hants Aquatic Centre (EHAC) as a reference facility from which the baseline energy usage of the Cape Breton West Aquatic Centre was estimated, The East Hants Aquatic Centre provided the projected annual electricity and oil costs from 2022, as well as the current operating hours. From this data, the energy consumption was estimated using the following average electricity and oil rates including tax:

- Electricity Rate: $0.1725/kWh
- Heating Oil Rate: $1.29/Litre

Based on these assumptions, the energy use intensity of 2.2 GJ/m2 or 5537.8 GJ/year for the baseline Cape Breton West Facility was calculated. Utilizing this information, a baseline building energy model was created in Carrier's Hourly Analysis Program (HAP).

To achieve net-zero energy, where all energy consumed by the facility is produced from renewable energy sources, the annual energy usage of the facility would have to be reduced to be below the potential PV production for the site. A series of potential energy efficiency measures were analysed to determine their potential energy consumption reduction for the proposed facility including:

- Upgrading the Building Envelope
- Shower Drain Water Heat Recovery
- Air Source Heat Pump
- Heat Pump Hot Water Heater
- Solar Water Heating
- Solar Air Heating
- Occupancy Demand Pump
- High Efficiency Energy Recovery Ventilation
- Daylighting Lighting Controls
- Pool Cover

The implementation of these measures allows for an annual energy usage of 680,257, kWh/yr (2,448.9 GJ), a reduction of 60% from the baseline facility. Based on the annual energy requirements, the facility would need a 600-610 kWpDC PV onsite system) to render the building net zero energy. This is assuming that a net metering arrangement could be set up with the utility. **The net metering requirement would allow the facility to produce surplus renewable energy during the spring and summer months when solar PV productivity is highest and export it to the NS Power grid and receive full credit for all energy produced against future electricity consumption during periods of the year when solar PV is less productive and the building energy consumption is highest. New legislation in Nova Scotia is intended to permit electricity customers that utilize a tariff with a demand charge to be able to install up to 1 MWpDC of capacity under a net metering arrangement. Given the potential consumption of the facility, a demand charge tariff is certain meaning that the 600 Kw system requirement will be within the net metering limit.**

There are four potential sites to be considered for the construction of the aquatic centre for Inverness County. These sites are:

- Site 1: Old Margaree Community Soccer Field
- Site 2: Former Margaree Forks District School
- Site 3: Former Margaree Lodge Golf Course
- Site 4: Cape Breton Highlands Education Centre Academy

All four potential sites have the required footprint to accommodate the facility and the PV system.

A life cycle cost analysis was completed for the net zero ready building as well as the four sites considering energy and maintenance costs.

The financial parameters considered in the LCCA are:

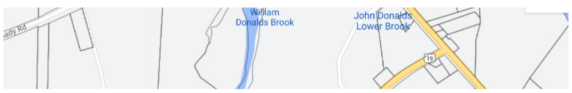
Assumptions	Values
Project Horizon (yr)	25
Equity ratio	100% Equity
Capital cost inflation (%/yr)	5.00%
O&M escalation (%/yr)	5.00%
Fuel and Electricity cost escalation (%/yr)	5.00%
Expected lifespan (yr)	Varies per item.
Discount rate (%)	2.22%
Straight line depreciation	Initial cost / expected lifespan
Note: Items that are due for replacement at year 25 are showing a $0 salvage value	

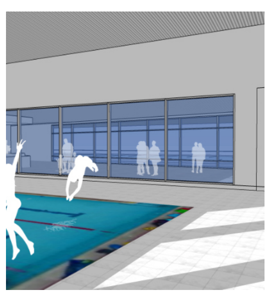
Carbon Tax: $50/ton in 2022, increased by $15/ton/yr until 2030. Then, assuming lineal increases to $300/ton by 2050. NS grid emission intensity factor 0.602 kg Co2/kWh for 2022 according to NSPI. The carbon emission intensity factor estimated between 2023 and 2030 is based on data from: Environment and Climate Change Canada, Strategic Policy Branch, Economic Analysis Directorate, Analysis and Modelling Division. Recommended Average Emissions Intensities (tonnes/MWh)

All four sites showed a LCC about 22% and 23% lower than the baseline and net zero ready building accordingly, even though all the sites will require additional initial investment to install the PV system and efficiency improvements, higher maintenance costs and equipment replacement expenses over a 25-year period, the benefit of not purchasing energy from the grid and reducing carbon taxes, results in lower NPVs. Also, the NPV for the baseline and NZR buildings is almost even, despite the additional investment required to implement the recommended energy efficiency measures.

LCC	Baseline	Net Zero Ready	Site 1	Site #2	Site #3	Site #4
LCC (NPV$)	$7,259,512	$7,368,492	$5,683,916	$5,643,916	$5,673,916	$5,633,916
LCC compared to baseline	N/A	1.5%	-21.7%	-22.3%	-21.8%	-22.4%
LCC compared to NZR Building	N/A	N/A	-22.9%	-23.4%	-23.0%	-23.5%
Annual cost savings based on Baseline ($/yr)	N/A	$121,997	$246,478	$246,478	$246,478	$246,478
Simple payback	N/A	26.23	18.09	17.93	18.05	17.89

Sites #1 and #2 seem to offer the most favorable conditions to house the new aquatic centre and PV array and offer the best LCC. This does not take into account the purchase price or availability of any of the sites. As has been shown in the analysis any of the sites could potentially house the proposed facility and allow for net zero energy operation. The proposed new net metering regulations will be key to permitting this to happen . Additional facility planning in the future could further refine the facility requirements and operating hours which could reduce further the expected energy consumption and self generation requirements which should have a positive impact on the project cost and financial analysis.





7 Preliminary Design Concepts

BELOW
Map of three potential site locations

OPPOSITE PAGE, BELOW
Schematic site concept of proposed aquatic centre

7 PRELIMINARY DESIGN CONCEPTS

7.1 SCHEMATIC CONCEPTS

SITE LOCATION

For this preliminary exercise, these early schematics are based on the project being developed on the former site of the Margaree Forks District High School. Of the two sites highlighted in the Energy Study as preferred, this site has already been disturbed and the potential build site appears safely elevated. The old school has been demolished and the circulation routes are still visible in the landscape.

An illustration shows the potential building footprint and surrounding hard surfacing for a development on this site. Not shown is the potential PV array on the ground or roof of the development.

The site location advantages and existing assets may support additional planning opportunities such as the following:

- Connecting to nearby outdoor recreation assets like the Margaree River network (eg. fishing, boating, tubing tourism) and the community trails network (ATV, snowmobiles, cycling)
- Facilitating seasonal/outdoor equipment rentals (a service provided in other locations by the municipality) to support local/visitor recreational needs
- Showcasing the pastoral setting and serving growing youth population with a community natural playground
- Linking (with pathways and/or programming) with other local amenities, such as the Margaree Community Commons and the Drs. Coady & Tompkins Memorial Library

ABOVE
Schematic concept exterior renderings
of the proposed aquatic centre

SPATIAL PROGRAM

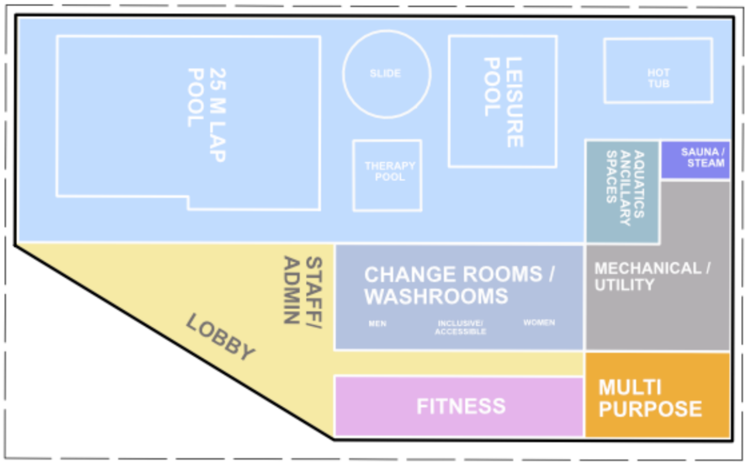
Based on our overview of various case studies and related population demographics, we've outlined a baseline spatial program for the proposed development, noting that this is only a starting point and subject to inclusions and omissions at various stages of community/ stakeholder engagement.

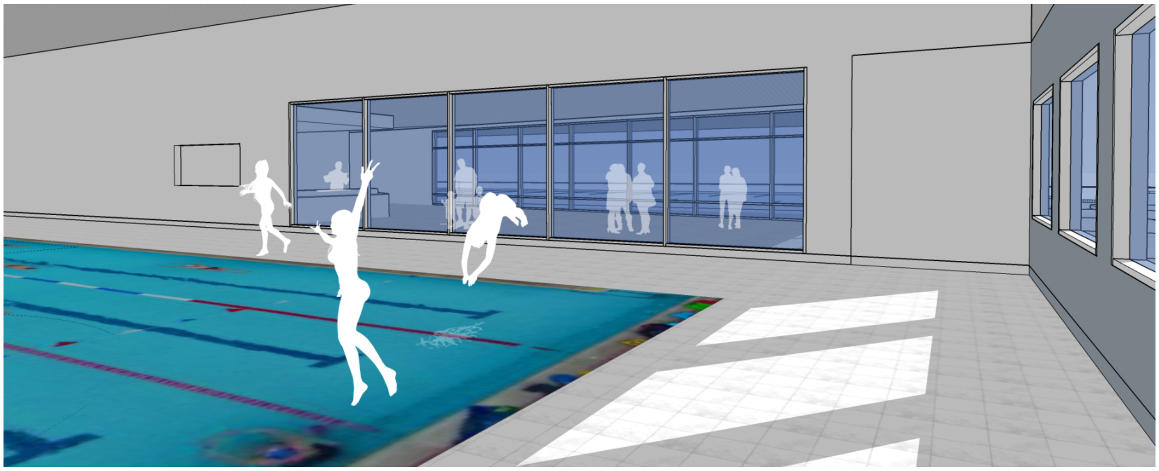
- Shallow warm pool for younger children and seniors
- 6-lane, 25-metre program or lap tank
- Leisure body of water with zero-entry handicapped accessible entry
- Women's, men's and gender-inclusive change rooms
- Family change room
- Reception and administration area, staff and building support spaces
- Multi-purpose room (capacity for 50) with storage
- Kitchenette adjacent to multi-purpose room
- Public lobby with a pool viewing area
- Pool and building mechanical room

There are a number of other programmatic features that may become part of the facility's spaces, if identified as a priority during the community engagement process—some of them were shared already during the Public Information Session held on February 22, 2023 (see Section 8). Some of those inclusions could be (but are not limited to) the following.

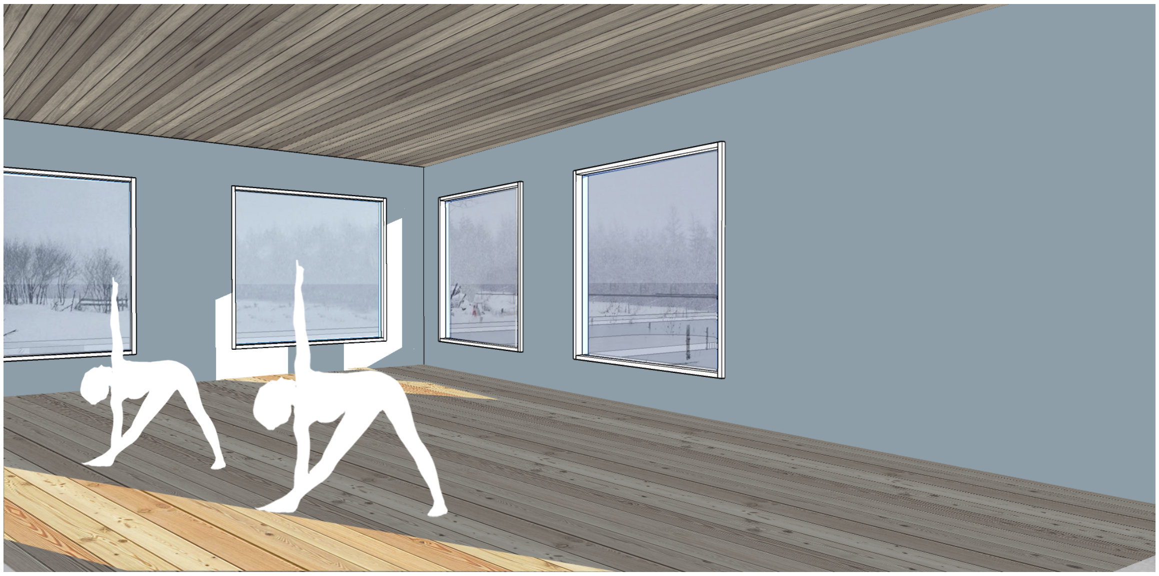
- Daycare
- Library (or connectivity to)
- Climbing gym
- Rescue training
- Visitor centre / Information
- Archive / Interpretive centre

BELOW
Schematic spatial program illustration of proposed aquatic centre



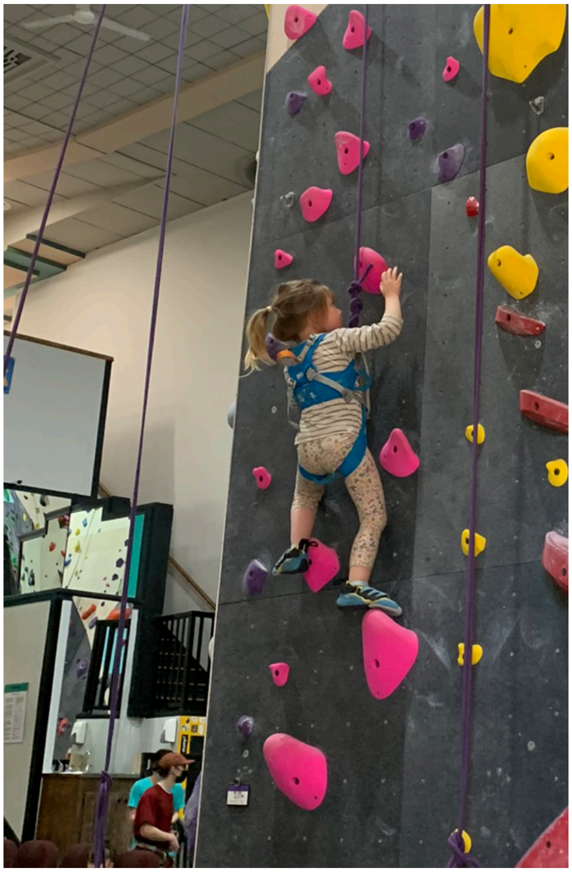


ABOVE
Schematic concept interior renderings of entrance lobby and lap pool of the proposed aquatic centre



ABOVE
Interior rendering of yoga session in community room of the proposed aquatic centre.

RIGHT
Climbing gyms are popular and a possible element to consider in the facility as part of the fitness offerings



BUILDING PERFORMANCE

Based on the Energy Study in Section 6, we've identified the following measures to maximize the performance of the building, reducing its energy consumption.

- Building envelope: increase insulation value by 15%; upgrade to triple glazed windows
- Shower drain water heat recovery; recover 25% of waste water heat
- Air source heat pump
- Heat pump hot water heater
- Solar water heating; reduce energy to heat water by 27%
- Solar air heating
- Occupancy demand pump; reduce pump energy consumption by 38.5%
- High efficiency energy recovery ventilation
- Daylight lighting controls; save 20% of lighting cost in areas with windows and/or skylights
- Pool cover usage; save 13.5% of pool heating load

8 Community Engagement

8 COMMUNITY ENGAGEMENT

How will we engage the people of our communities in the planning process for the Cape Breton West Aquatic Centre?

An extensive public and stakeholder engagement process will identify the needs and aspirations of our communities and guide the direction of development. This process begins with public information sessions, followed by the formation of a citizens' steering committee to ensure public input at all subsequent development stages. The public will have opportunities to contribute ideas, opinions and concerns throughout the planning and design process.

What does a meaningful community engagement process entail?

Compared to private developments, community projects can anticipate much longer timelines, primarily because they involve public funding of capital costs and ongoing operational costs, therefore requiring a much greater degree of accountability to and input from the communities they serve. As we can observe from the case studies in Section 3, substantial community engagement, consensus building and advocacy to all levels of government is necessary to generate the momentum for this kind of project. That process allows project leaders to gain a better understanding of the needs and demands of stakeholder communities, helping to determine what features and services the facility should include, from aquatic infrastructure to complementary programs and spaces. It is also an opportunity for everyone involved to listen, learn and explore a wide range of possibilities before the project gets defined and designed.

Public engagement is typically a complicated though rewarding process, and each community faces its own unique circumstances, dynamics and potential points of tension. Depending on government support and funding availability, the process can take more than five years from the feasibility phase to completion of the facility.

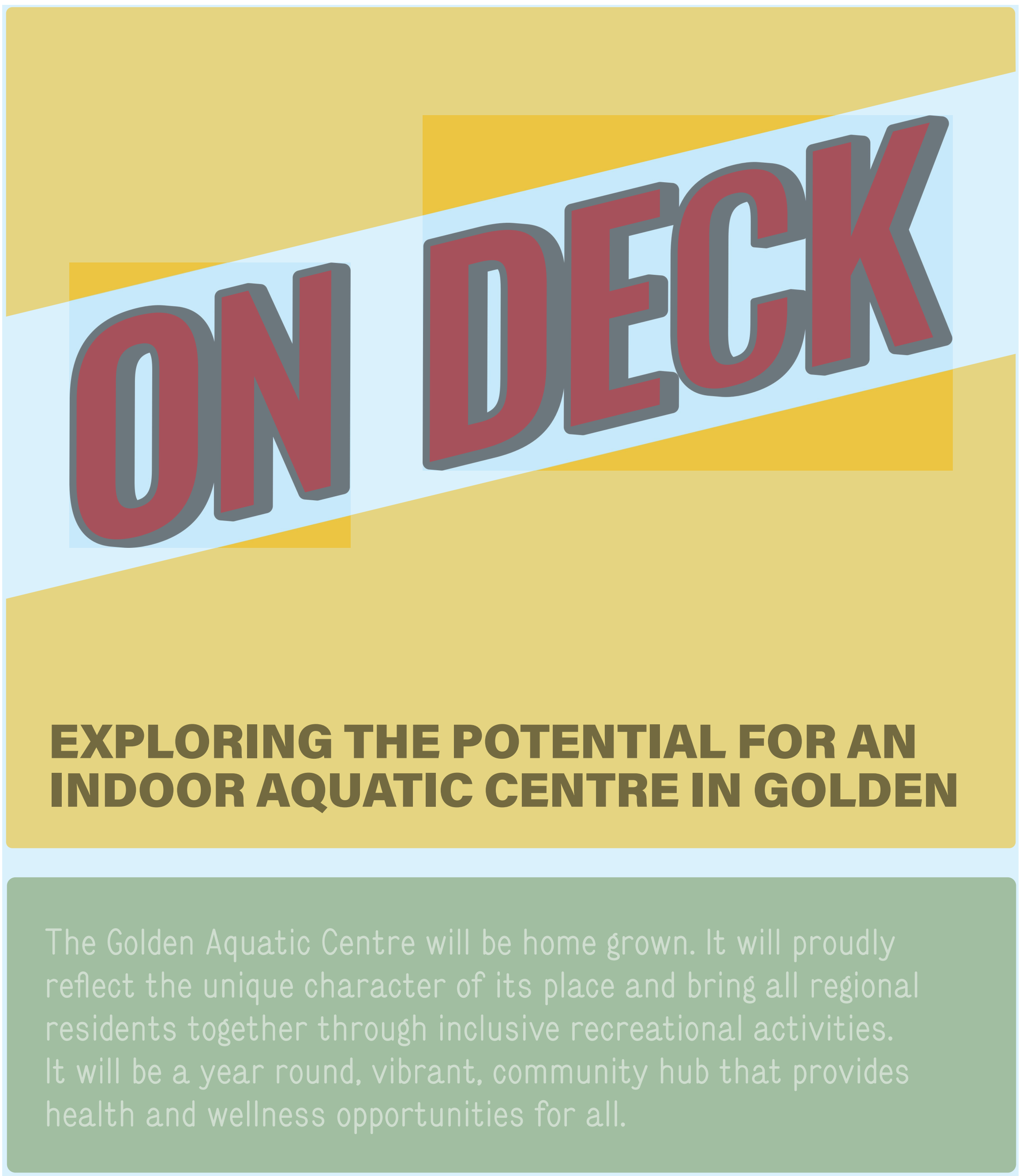
8.1 LEARNING OPPORTUNITIES

Two of the case studies in Section 3 provide particularly useful precedents for community engagement approaches to aquatic centre development. For the same reasons the East Hants Aquatic Centre was selected to provide our energy analysis and spatial program model, it serves well here: It is recently built, near our own region and similar to our anticipated facility in size and scope. The second point of reference is the Golden Aquatic Centre, which is still in development, because its team has recently completed an extensive community engagement process and successfully advanced to the fundraising stage.

CASE EXAMPLES OF ENGAGEMENT PROCESS IN OTHER COMMUNITIES

East Hants Aquatic Centre

A substantial degree of community engagement preceded and continued throughout the development of the East Hants Aquatic Centre. In 2014, the municipality began its "Community Plan Review," which included eight community-level design workshops as part of the "Plan East Hants" process. In addition, the municipality held three visioning workshops and circulated a "Community Goals" survey. Almost 70% of



ABOVE
Graphic illustration from the Golden community engagement process. "On Deck" was developed as part of their branding exercise to encourage greater participation and inclusion

survey respondents listed the creation of more parks and recreation facilities as one of their top three development priorities.

The new aquatic facility development process officially began in 2015 when the municipality hired a consultant to conduct an initial feasibility study focusing on the community's needs. The study concluded that there was sufficient support to proceed with the project.

Early in 2016 the Municipality engaged in community consultations on the project that helped determine the program requirements for the facility, and property was purchased later that summer.

The 2015 feasibility study provided a foundation for more focussed community engagement concerning recreation in 2017. From May to July 2017, the Department of Parks, Recreation and Culture held a series of 21 roundtable meetings with various key recreation stakeholders regarding the delivery of recreation programs. The East Hants Recreation Survey was then made available online, followed by three open-house sessions in the fall.

Design development of the project also began in 2017, went to tender in 2018 and was under construction for almost two years. The municipality completed its Recreation Master Plan in 2019, and in 2020, the facility opened.

Golden Aquatic Centre

The Golden Aquatic Centre project is spearheaded by the Columbia Shuswap Regional District (CSRD), who have shared an extensive amount of information on-line regarding their community engagement approach. The district retained a consultant group to lead a multi-phased process of community engagement, consulting them throughout the development of feasibility studies and schematic designs. Additionally, early in the process, a project advisory committee was established that is made up of community members from Golden and surrounding Electoral Area A.

Engagement Phase 1
Purpose: Establish an accurate assessment of the needs and desires of the community for the proposed new facility
Actions: Explore possible aquatic and non-aquatic building features though a series of public ideas fairs, an on-line survey and a workshop
Outcome: Use community feedback to develop a refined list of aquatic facility options with associated cost estimates

Engagement Phase 2
Purpose: Identify the community's top priorities from the refined list of options
Actions: Use a robust and interactive community survey tool to solicit feedback, offering participants the opportunity to learn about the various options, provide input and discover the cost implications of each decision.
Outcome: Proceed with the combination of features that has the most community support.

The outcomes from the above community engagement strategy not only enabled the project team to identify and prioritize various options, but also fostered a greater sense of public inclusion, helping to facilitate consensus building among the community in support of the development and the financial commitments it entails. The Golden Aquatic Centre is now in the fundraising stage, with approved schematic designs ready to take the project to the next phase of design development.

8.2 ENGAGING OUR OWN COMMUNITY

COMMUNITY ENGAGEMENT: FIRST STEPS

As this report documents, the Western Cape Breton Aquatic Centre community engagement process is already underway. With the support of the Nova Scotia Department of Natural Resources & Renewables' Low Carbon Communities Fund, the Margaree Environmental Association has undertaken the development of this preliminary blueprint for a zero-carbon year-round highly efficient public aquatic facility in western Cape Breton, sharing the findings at a public information session.

Meanwhile, in 2022 the Municipality of the County of Inverness (MCI) commissioned a consultant group to develop a Municipal Recreation Master Plan, which involves a substantial review of all municipal assets and infrastructure, as well as a resident survey. With the completion of the feasibility study contained in this report, and the anticipated completion and approval of the Municipal Recreation Master Plan sometime this spring, there will be a substantial platform of information poised to serve subsequent stages of development. A foundation has been laid to engage community stakeholders in formal discourse to ascertain its needs and demands in detail and to build critical support for developing the Cape Breton West Aquatic Centre.

What have we learned so far about our community and its needs?

Current Population & Demographic Trends

As part of their work, consultants for the Municipal Recreation Master Plan released a 2022 background report on the municipality, titled "State of Recreation," which provides a snapshot of our community profile, and key demographic indicators that support the case for development of a western Cape Breton aquatic centre.

After decades of steady decline, MCI saw a slight population increase for the first time in 2021. There is a historic trend of out-migration, particularly among young adults, for work or school, and among the elderly, for medical services and accommodations. Recently, there are signs of increased in-migration of working adults in the 30-39 age bracket, which is also a demographic that may be raising young children and often uses year-round resources like aquatic facilities. What remains consistent is the overall median age of our population, which is aging and in need of better health supports.

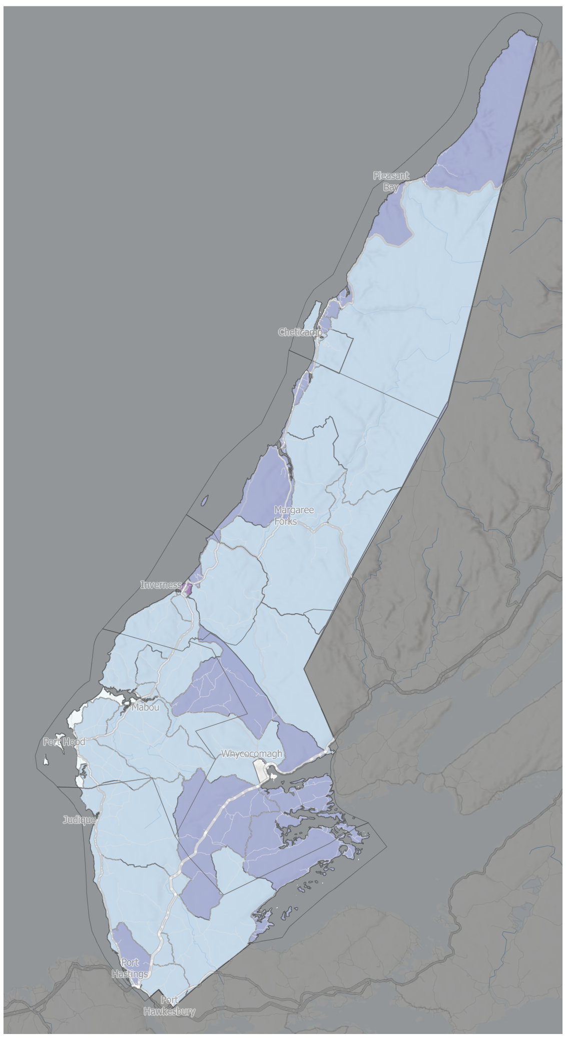
At the time of the Municipality's study, limited data was available to provide more detailed and current population projections. The COVID pandemic and surging real estate market also created significant upheaval with unknown impact on prevailing population trends. However, the data that exists suggests we may see a significant transformation and potential influx of new residents in the coming years.

Household incomes factor significantly in determining the feasibility of this proposed development, in terms of whether and how frequently it will be used. Some key data worth noting from the "State of Recreation" report are that while the number of low-income residents and overall median income in our area are relatively at par with the rest of Nova Scotia (unemployment is actually lower), more than twice the percentage of our population resides in subsidized housing.

Looking more closely at various communities in the municipality, the number of low-income residents is greatest in the Margarees, Map 1. Proportion of Population in Low Income (2016)

- 0 - 10%
- 10 - 15%
- 15 - 25%
- 25 - 35%
- 35 - 45%

Electoral District

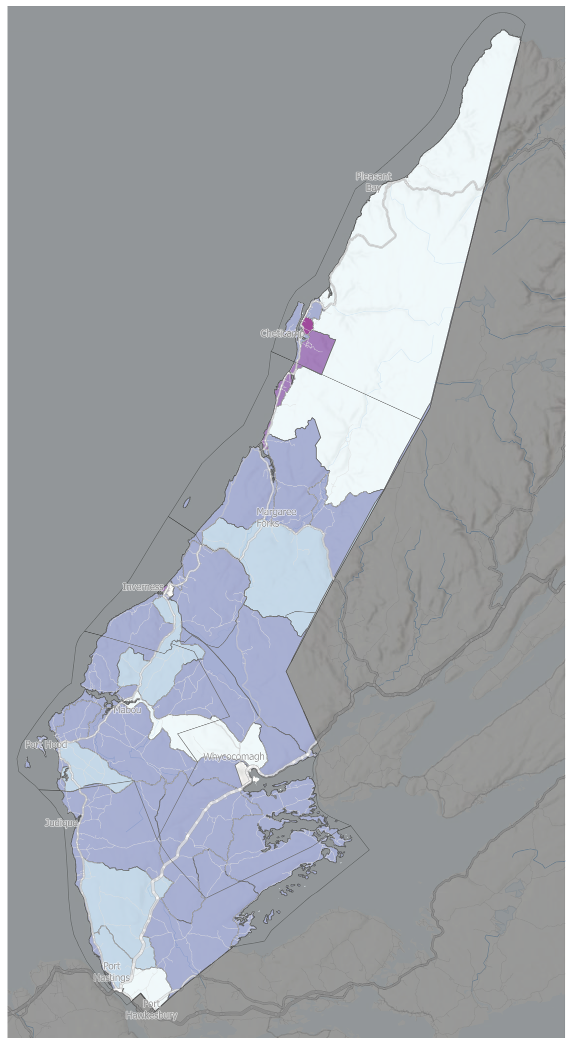


State of Recreation - Background Report, Municipality of the County of Inverness Recreation Master Plan, June 2022

Map 3. Proportion of Seniors (65+) in Low Income (2016)

- 0 - 10%
- 10 - 15%
- 15 - 25%
- 25 - 35%
- 35 - 45%

Electoral District



Chéticamp, West Lake Ainslie, Whycocomagh, Marble Mountain/East Bay, Port Hastings and northern areas. Also of note is that, as observed in Section 4, a disproportionate number of low-income seniors reside in the northern region, particularly the Acadian communities of St-Joseph-du-Moine and Chéticamp.

Examining these statistics, we can conclude that the probability of residents facing income barriers to accessing services increases as we travel into the northern part of the county. Coupled with a geographic position that situates them farther away from the nearest aquatic recreation facilities, located at the southern end of the county in Port Hawkesbury, this means that residents in the northern part of Inverness County are less likely to participate in existing aquatic health and recreational programs.

Community Recreational Needs & Barriers

The consultant team that developed the Municipal Recreation Master Plan sought community input via two on-line surveys: one for adults (214 responses) and the other for youth aged 13-19 (23 responses). Input was also gathered through a series of individual and group interviews with Municipal Council, municipal staff, and various community and recreation groups. Below are some key highlights from that feedback related to this study. (Additional information, including demographics of survey respondents, can be viewed in a document of survey responses found on the municipal website.)

Lack of facilities

Not surprisingly, a key issue identified by respondents is our municipality's **lack of recreational facilities**, in particular facilities that can be accessed and used year-round.

Respondents expressed a desire for facilities that have multiple uses and can be accessed equitably by all members of the community.

Urgent need for aquatic centre

Both surveys overwhelmingly identified an **indoor swimming pool as a top priority** for recreational development in our municipality. This opinion was echoed in interviews with municipal representatives. Respondents noted the importance of having closer access to such programming as **swimming lessons for children and youth**, not only for recreation but also as **an essential and potentially life-saving skill that all residents should have**. The "State of Recreation" report notes that swimming is one of the top two sports among youth aged 13-17. It cited a 2014 report that listed **swimming as the most popular sport in Canada**, with over 1.1 million Canadian children active in a swimming program. Considering how little access we have to this type of facility in western Cape Breton, we face a staggering vacancy in a region that is trying to stimulate growth and attract young families.

Barriers to participation

A majority of respondents in both surveys indicated the following five factors as the greatest barriers to accessing recreational opportunities:

- lack of programs & classes
- lack of facilities
- distance
- unsure of what is available
- cost

Regional Health & Wellness Conditions

A driving force behind this feasibility study is the health needs of the people of western Cape Breton. Health care delivery in rural Nova Scotia is expensive, and in many ways, current services are unable to meet the overall health needs of the population.

While certainly not a substitute for adequate medical care, recreational physical activity is an effective strategy to boost health, improve quality of life, prevent illness and diminish the impact of conditions that afflict many Nova Scotians—like diabetes, arthritis and heart disease—while reducing overall healthcare costs.

According to Canadian Fitness and Lifestyle research, 62% of Nova Scotians are far too inactive. Cancer Care Nova Scotia reports that the highest rates of obesity and sedentary lifestyle are found in Atlantic Canada[1]. It also states that as we age, we tend to become less active. For decades, Cape Breton has reported a growing senior population, however, it is not only seniors who are too sedentary. Among children and youth in Nova Scotia, physical inactivity is rampant and a contributing factor to chronic disease.[2]

[1]. Cancer Care Nova Scotia, Cost of obesity in Canada 2000

[2]. Chronic conditions in Nova Scotia, 2004, Nova Scotia Department of Health

Inactivity contributes to conditions such as stroke, cancer and osteoporosis. More than two thirds of Nova Scotians aged 12 and over report having a chronic condition, and 79% of Nova Scotians who report having a stressful life also have a chronic condition, and the burden of chronic diseases in any population comes with a high economic cost. In Nova Scotia, **the cost of physical inactivity is estimated at $354 million annually**.[3]

In Inverness County, where our population is aging, and where weather can be a barrier to outdoor leisure activity for most months of the year, a year-round, indoor aquatic facility would provide the opportunity for all residents to pursue an active, healthy lifestyle. Participants in the surveys and interviews conducted for Inverness County's Municipal Recreation Master Plan corroborated the desire for an indoor aquatic facility and urged the municipality to make this a priority.

Historic out-migration of younger Inverness County residents to more prosperous provinces has limited the opportunities, resources and inspiration to build new infrastructure to meet the recreational needs of our communities. Fortunately, with the recent reversal of a long-time population decline, young families are now moving back to rural areas, further increasing the need for recreational facilities.

Public access to an aquatic centre in western Cape Breton Island would be a "win-win" for both the health care system and the community members it serves, reducing health care costs and making the population safer, healthier and happier.

[3]. Colman, Robert, PhD, & Hayward, K. (2002) *The Cost of Physical Inactivity in Nova Scotia. Halifax, Nova Scotia: Recreation Nova Scotia and Sport Nova Scotia.*

HEALTH BENEFITS OF AQUATIC EXERCISE

Aquatic exercise is highly recommended for management of a number of conditions. Low-impact activity takes the pressure off bones, joints and muscles, and offers natural resistance to help increase strength. Water aerobics can improve heart health. It can lower blood pressure and "bad" LDL cholesterol, while raising "good" HDL cholesterol. For people with diabetes, water aerobics can help shed extra weight.

Swimming can also help mitigate arthritis. The body's natural buoyancy in water makes this exercise easier on joints. By exercising in water, one can improve mobility, muscle strength and cardiovascular health, the benefits of which continue out of the pool. Following joint replacement surgery, the hydrostatic pressure of water has a positive effect on reducing swelling, helping to regain more range of motion and reducing pain.

(Healthy Lifestyle/fitness, Mayo Clinic 2007)

COMMUNITY ENGAGEMENT: NEXT STEPS

MEA PUBLIC CONSULTATION

On February 22, 2023, a public meeting was held at the Drs. Coady & Tompkins Memorial Library in Margaree Forks. The Margaree Environmental Association presented the findings of its low-carbon feasibility study of the proposed Cape Breton West Aquatic Centre. There were more than 90 people in attendance. After the presentation, the audience was invited to express their reactions to the proposal, ask questions, offer suggestions and share concerns. MEA had prepared four general questions to guide the conversation:

- Is a year-round indoor aquatic and recreation centre something you want?
- Is Margaree Forks a good location for the aquatic centre?
- In addition to a pool, what features would you like to see in the facility?
- Would you be willing to sit on a citizen's advisory committee to help direct the development?

The responses from the audience were unanimously in support of the proposed Cape Breton West Aquatic Centre. Some people elaborated on how important this facility would be in their lives; others described features they would like to see in the aquatic centre. There were suggestions on building construction and location; people pointed out problems that would have to be solved; and many pledged their support and interest in on-going involvement. Three of the Inverness County councillors, Claude Poirier of Cheticamp, Blair Phillips of Margaree, and Deputy Warden, Catherine Gillis were present, and there were people from Cheticamp, Baddeck, Inverness, Middle River, Port Hood, Judique and Mabou, all of whom contributed positively to the discussion.

Some examples of the public feedback are listed below.

- There is a lot of social isolation in rural communities, especially in the winter months. Loneliness is being recognised as a health concern, especially among seniors, and an aquatic centre like this would provide valuable social opportunities.
- We need to identify land with a good water supply. The four sites identified have water of poor quality and inadequate quantity.
- We could solve the water problems by recycling water, and by collecting rainwater in cisterns.
- We usually have more snow than the rest of Cape Breton, and we should connect crosscountry skiing and snowshoeing trails with the aquatic centre.
- We used to have community swimming lessons, which taught hundreds of children to swim in backyard pools. We don't have this anymore; how wonderful it would be to have an aquatic centre in western Cape Breton to offer swimming lessons to our children!
- Children with special needs, such as autism, need to learn to swim in a controlled environment. Taking autistic children to the beach is too dangerous, as they don't understand the dangers.
- We need an on-line site where everyone can learn about this exciting project.
- Our governments have been preoccupied with building arenas so that every child can learn to skate. We need to extend this thinking to every child has the right to learn to swim.
- We need childcare in our communities, and an aquatic centre would be an excellent location for a daycare facility.

- And further about childcare: A Margaree initiative to establish a daycare facility did not materialize because of staffing costs and location costs; we will have to solve these problems in this aquatic centre, as well.
- There are alternative building systems that are cheaper and more flexible than conventional systems.
- We should include a “float house,” which is a therapeutic Epsom salt pool.
- We need an indoor walking track for people who don’t like swimming.
- We should be talking to people in Victoria County. Many drive to North Sydney for swimming and would prefer to go to Margaree.
- A person who moved here from rural B.C. said she always had a community pool that offered programs to children with disabilities and special needs, as well as a range of play activities. The pool was always a central community focus.

At the end of the meeting, a letter from the chair of the Student Advisory Council and the Principal of the Middle River Consolidated School was given to the Margaree Environmental Association. The letter expressed strong support of the Cape Breton West Aquatic Center, and stated that they are “fully committed to work with other community leaders to make this initiative a reality.”

The Forming of an Advisory Committee

At the public meeting held in Margaree Forks, 21 people signed up to sit on an advisory committee to help direct the work going forward, and following the meeting an additional 12 people volunteered by email. The membership of this committee isn’t complete; the goal is to have representatives of community and stakeholder groups, as well as the three levels of government, and the private sector.

Where Do We Go From Here?

The MEA team proposes that the next steps in the development of the Cape Breton West Aquatic Centre be directed by the advisory committee and that they address the issues of ownership and funding. If the Municipality of the County of Inverness agrees to own and operate the facility, the advisory committee can work with the Municipality to resolve the details of development and operations, and to ensure that community needs are met and that the demands of planning a carbon-neutral, highly efficient facility are satisfied. Working with the Government of Canada and the Province of Nova Scotia as active partners, the advisory committee can pursue all available federal and provincial funding programs to source substantial support of capital costs. With public health and environmental sustainability currently a priority for all levels of government, this is an optimal time to proceed with the next steps to define the ownership structure and secure the funding.

"The school recognizes that academic learning alone is not enough to foster a well-rounded education and extracurricular activities can help students develop important skills such as leadership, teamwork, and time-management. One barrier to providing students in our area these opportunities has been a lack of facilities. The building of an aquatic centre would provide access to activities that would promote the development of new skills, improve self-confidence as well as strengthen a sense of community. We are confident that an aquatic centre would be a valuable addition to our community, and we are fully committed to working with other community leaders to make this initiative a reality."

Heidi Morrison,
Middle River Consolidated School Student Advisory Council Chair

Ryan Cordy,
Middle River Consolidate School Principal

9 CONCLUSION

It is clear that there is strong public support for an aquatic facility to serve the communities highlighted in this report, and this study shows that carbon neutrality can help make it feasible to develop this type of long-term sustainable community asset. The population of western Cape Breton needs year-round opportunities to exercise, learn to swim, access therapeutic health programs and have fun.

Our society needs to address the causes of climate change, and we need to construct buildings that don't burn carbon for energy and that use high-efficiency materials and equipment to lower operational costs. The proposed Cape Breton West Aquatic Centre has the potential to serve as a model for other public buildings, and to help envision the healthy, low-carbon communities that our future depends upon.

"There has never been a time when the mental and physical health of our citizens has been more important, and I wish the Margaree Environmental Association the best of luck as they pursue their plans for an aquatic facility which will serve as a community centre for Inverness County."

Allan MacMaster,
MLA for Inverness &
Deputy Premier & Minister of Finance,
Province of Nova Scotia

"A new, year-round aquatic recreational facility would be transformational for the west side of Cape Breton Island and surrounding communities, for residents and tourists alike. I have no doubt that the facility would be thoughtfully and creatively designed to best serve its users, addressing physical and mental health needs, while contributing to the grid to create surplus power."

Mike Kelloway, MP
Cape Breton-Canso

10 APPENDIX

List of Studies/Reports:

Quite a number of reports were reviewed over the course of this study. Some more relevant than others, and of those only some applied more directly to this study. Below is an abbreviated list of the more frequently viewed documents.

Mariners Centre Expansion Feasibility Study. Final Report, January 2017. dmA Planning & Management Services and Architecture 49.

Sou'West Recreation Complex Advisory Committee Pool Study. AW Consulting (2020?)

A Review of the Sou'West Recreation Complex Advisory Committee Pool Study. Chris Frotten & Misty James. June 3, 2020

Municipality of the County of Kings. RFP 21-10: Consultant Services for Regional Recreation Facility Feasibility Study, Issued June 18, 2021.

Analysis of Indoor Pool Options – Municipality of North Grenville. Sierra Planning and Management. Draft Report (April 2022).

Current State of Recreation, Physical Activity and Recreation Master Plan. Municipality of the County of Inverness. Upland & REConsultant Group. March 2022.

What We Heard Report, Physical Activity and Recreation Master Plan. Municipality of the County of Inverness. Upland & REConsultant Group. June 2022.

Rural Recreation Strategy – Public Consultation Results. Halifax Regional Municipality, Standing Committee Report. April 2022.

Drayton Valley Aquatic Centre – Net Zero Study. The Town of Dayton Valley, AB. Revolve Engineering, May 2017.

Aquatics Facility Feasibility Study, Greater Fredericton Region. Sierra Planning and Management with Perkins + Will Architects and Lydon Lynch Architects. Final Report, November 2020.

Feasibility Study for a New Future Aquatic Facility, Municipality of East Hants, N.S. David Hewko Planning + Program Management. February 2015.

Summerland Recreation Centre Feasibility & Site Fit Study, District of Summerland. Carscadden Stokes McDonald Architects, in partnership with MAD Studios, Lees & Associates, Sierra Planning and Management and LTA Consultants. http://www.summerland.ca/rec-and-health-centre. February 2022.

Parks and Recreation Master Plan, City of Revelstoke, B.C. June, 2022.

Web References:

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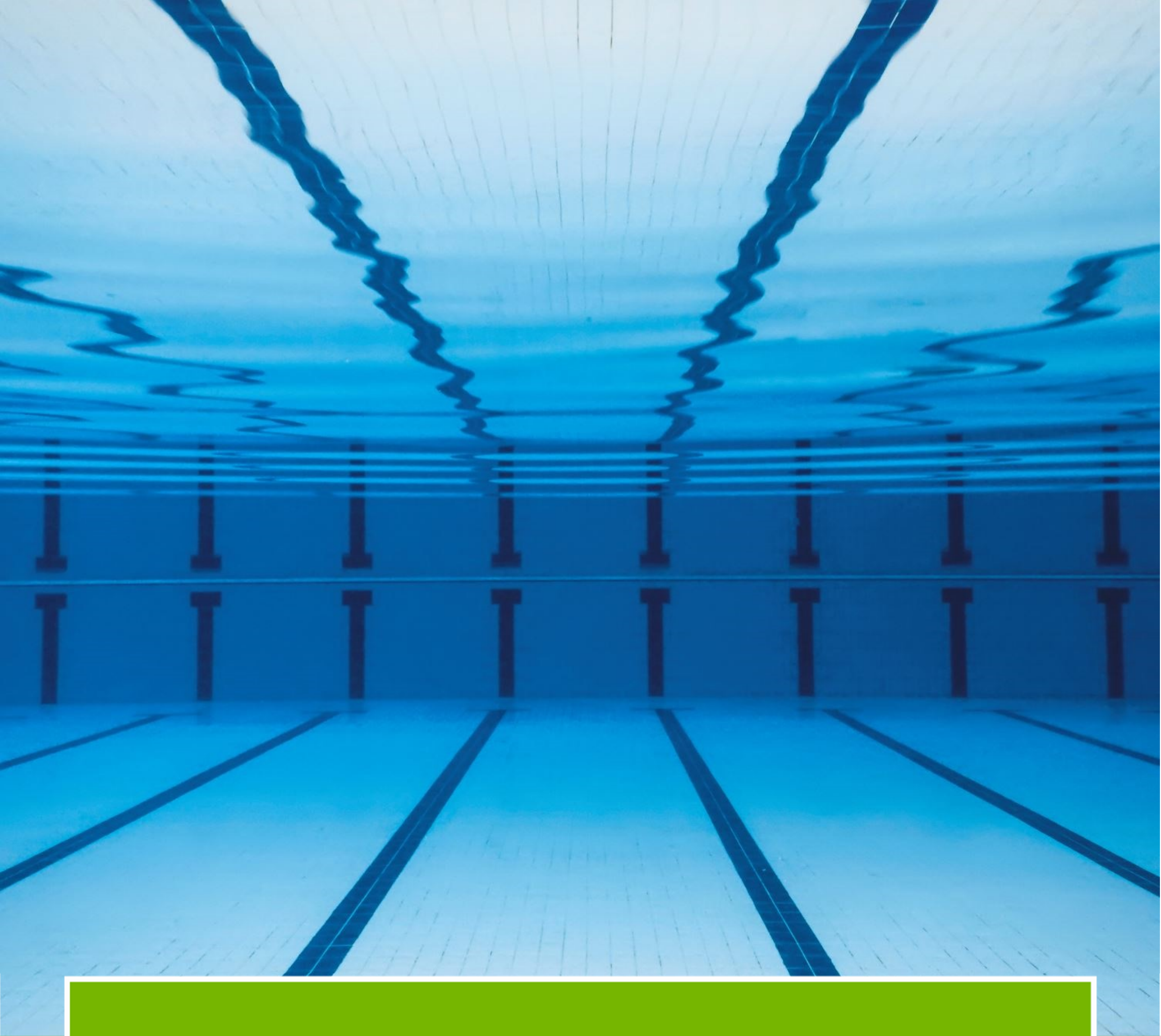

Cape Breton West Aquatic Centre Energy Study

Margaree Environmental Association

Final Report

CBCL

227559.00 • January 2023

0	Final Report	D Lea	30-Jan-2023	N. Downing
A	Draft Review	D. Lea	20-Jan-2023	N. Downing
Rev.	Issue	Reviewed By:	Date	Issued By:

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Project No. 227559.00

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CANADA BEST MANAGED COMPANIES
Platinum member

January 30, 2023

Neal Livingston
Margaree Environmental Association
PO Box 55
Mabou, NS, B0E 1X0
Email: neall@ns.sympatico.ca

Dear Mr. Livingston:

RE: Cape Breton West Aquatic Centre Energy Study – Final Report

CBCL Limited (CBCL) is pleased to present the final report for the Cape Breton West Aquatic Centre Energy Study.

Please do not hesitate to contact the undersigned if you should have any questions.

Yours very truly,

CBCL Limited

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Project No.: 227559.00

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Executive Summary

CBCL Limited (CBCL) was engaged by the Margaree Environmental Association (MEA) to complete a carbon-zero (or net-zero) study for a aquatic facility that is planned to be located in Inverness County, NS. The MEA has received funding through the Nova Scotia Low Carbon Communities Program in support of research needed to determine the viability of establishing an aquatic recreational fitness facility in the Margaree Valley.

MEA agreed to use the East Hants Aquatic Centre (EHAC) as a reference facility from which the baseline energy usage of the Cape Breton West Aquatic Centre was estimated, The East Hants Aquatic Centre provided the projected annual electricity and oil costs from 2022, as well as the current operating hours. From this data, the energy consumption was estimated using the following average electricity and oil rates including tax:

- Electricity Rate: $0.1725/kWh
- Heating Oil Rate: $1.29/Litre

Based on these assumptions, the energy use intensity of 2.2 GJ/m2 or 5537.8 GJ/year for the baseline Cape Breton West Facility was calculated. Utilizing this information, a baseline building energy model was created in Carrier's Hourly Analysis Program (HAP).

To achieve net-zero energy, where all energy consumed by the facility is produced from renewable energy sources, the annual energy usage of the facility would have to be reduced to be below the potential PV production for the site. A series of potential energy efficiency measures were analysed to determine their potential energy consumption reduction for the proposed facility including:

- Upgrading the Building Envelope
- Shower Drain Water Heat Recovery
- Air Source Heat Pump
- Heat Pump Hot Water Heater
- Solar Water Heating
- Solar Air Heating
- Occupancy Demand Pump
- High Efficiency Energy Recovery Ventilation
- Daylighting Lighting Controls
- Pool Cover

The implementation of these measures allows for an annual energy usage of 680,257, kWh/yr (2,448.9 GJ), a reduction of 60% from the baseline facility. Based on the annual energy requirements, the facility would need a 600-610 kWpDC PV onsite system) to render the building net zero energy. This is assuming that a net metering arrangement could be set up with the utility. **The net metering requirement would allow the facility to produce surplus renewable energy during the spring and summer months when solar PV productivity is highest and export it to the NS Power grid and receive full credit for all energy produced against future electricity consumption during periods of the year when solar PV is less productive and the building energy consumption is highest. New legislation in Nova Scotia is intended to permit electricity customers that utilize a tariff with a demand charge to be able to install up to 1 MWpDC of capacity under a net metering arrangement. Given the potential consumption of the facility, a demand charge tariff is certain meaning that the 600 Kw system requirement will be within the net metering limit.**

There are four potential sites to be considered for the construction of the aquatic centre for Inverness County. These sites are:

- Site 1: Old Margaree Community Soccer Field
- Site 2: Former Margaree Forks District School
- Site 3: Former Margaree Lodge Golf Course
- Site 4: Cape Breton Highlands Education Centre Academy

All four potential sites have the required footprint to accommodate the facility and the PV system.

A life cycle cost analysis was completed for the net zero ready building as well as the four sites considering energy and maintenance costs.

The financial parameters considered in the LCCA are:

Assumptions	Values
Project Horizon (yr)	25
Equity ratio	100% Equity
Capital cost inflation (%/yr)	5.00%
O&M escalation (%/yr)	5.00%
Fuel and Electricity cost escalation (%/yr)	5.00%
Expected lifespan (yr)	Varies per item.
Discount rate (%)	2.22%
Straight line depreciation	Initial cost / expected lifespan
Note: Items that are due for replacement at year 25 are showing a $0 salvage value	

Carbon Tax: $50/ton in 2022, increased by $15/ton/yr until 2030. Then, assuming lineal increases to $300/ton by 2050. NS grid emission intensity factor 0.602 kg Co2/kWh for 2022 according to NSPI. The carbon emission intensity factor estimated between 2023 and 2030 is based on data from: Environment and Climate Change Canada, Strategic Policy Branch, Economic Analysis Directorate, Analysis and Modelling Division. Recommended Average Emissions Intensities (tonnes/MWh)

All four sites showed a LCC about 22% and 23% lower than the baseline and net zero ready building accordingly, even though all the sites will require additional initial investment to install the PV system and efficiency improvements, higher maintenance costs and equipment replacement expenses over a 25-year period, the benefit of not purchasing energy from the grid and reducing carbon taxes, results in lower NPVs. Also, the NPV for the baseline and NZR buildings is almost even, despite the additional investment required to implement the recommended energy efficiency measures.

LCC	Baseline	Net Zero Ready	Site 1	Site #2	Site #3	Site #4
LCC (NPV$)	$7,259,512	$7,368,492	$5,683,916	$5,643,916	$5,673,916	$5,633,916
LCC compared to baseline	N/A	1.5%	-21.7%	-22.3%	-21.8%	-22.4%
LCC compared to NZR Building	N/A	N/A	-22.9%	-23.4%	-23.0%	-23.5%
Annual cost savings based on Baseline ($/yr)	N/A	$121,997	$246,478	$246,478	$246,478	$246,478
Simple payback	N/A	26.23	18.09	17.93	18.05	17.89

Sites #1 and #2 seem to offer the most favorable conditions to house the new aquatic centre and PV array and offer the best LCC. This does not take into account the purchase price or availability of any of the sites. As has been shown in the analysis any of the sites could potentially house the proposed facility and allow for net zero energy operation. The proposed new net metering regulations will be key to permitting this to happen . Additional facility planning in the future could further refine the facility requirements and operating hours which could reduce further the expected energy consumption and self generation requirements which should have a positive impact on the project cost and financial analysis.

Contents

Appendices

1 Introduction

The Margaree Environmental Association (MEA) has received funding through the Nova Scotia Low Carbon Communities Program in support of research needed to determine the viability of establishing an aquatic recreational fitness facility in the Margaree Valley. A portion of this funding is intended to determine the potential of constructing and operating the proposed facility in a sustainable manner with as minimal an environmental impact as possible. This report is to develop a study demonstrating how such a facility could be developed and operated in this manner. This study will demonstrate some potential enhancements to a standard aquatic facility design, which could reduce the annual energy consumption of the facility to such an extent that it could then be rendered as a net zero energy facility through the use of on-site renewable generation. In order for this to occur, the building is assumed to be all electric with no other forms of energy used to operate it.

The energy consumption for the proposed facility was estimated based on the existing East Hants Aquatic Centre. The new aquatic center is estimated to consume about 680,000 kWh/yr when considering the implementation of energy efficiency measures. This consumption is 55% less compared to the same baseline building without any energy efficiency measures. This estimated level of electricity consumption was used to estimate the capacity of an onsite solar PV system that can provide a sufficient amount of energy on an annual basis to render the facility net-zero. This is assuming that a net metering arrangement could be set up with the utility. **New legislation in Nova Scotia is intended to permit electricity customers that utilize a tariff with a demand charge to be able to install up to 1 MWpDC of capacity under a net metering arrangement. Given the potential consumption of the facility, a demand charge tariff is certain meaning that the 600 Kw system requirement will be within the net metering limit.**

Four sites identified by MEA were reviewed and each was deemed to be able to accommodate the facility and the required solar PV capacity. Sites #1 and #2 seem to offer the most favorable conditions to house the new aquatic centre and PV array and offer the best LCC.

2 Baseline Development

2.1 East Hants Aquatic Centre

To establish a target for sustainability for the proposed facility, the East Hants Aquatic Centre has been selected to be the baseline facility from which to determine a baseline energy usage and subsequent energy and carbon emission reduction targets. The East Hants Aquatic Centre provided the projected annual electricity and oil costs from 2022 as well as the current operating hours. From this data, the energy consumption could be estimated using the following average electricity and oil rates including tax:

- Electricity Rate: $0.1725/kWh
- Heating Oil Rate: $1.29/Litre

Table 2-1: East Hants Aquatic Centre Annual Energy Usage

East Hants Aquatic Centre 2694.2 m^2	Annual
Electricity	
Annual Electricity Cost ($)	$180,000
Annual Electricity Consumption (kWh)	1,043,478.3
Annual Electricity Consumption (GJ)	3,756.5
Percentage of Total Energy (%)	57.7%
Heating Oil	
Annual Heating Oil Cost ($)	$91,500
Annual Heating Oil Consumption (L)	71077.4
Annual Heating Oil Consumption (GJ)	2750.7
Percentage of Total Energy (%)	42.3%
Summary – Total	
Annual Energy Costs ($)	$271,500
Annual Energy Consumption (GJ)	6,507.2
Percentage of Total Energy (%)	100.00%
Energy Use Intensity (GJ/m^2)	2.4

As part of the intention to operate in as sustainable manner as possible , the proposed Cape Breton West Aquatic Centre will be run solely on electricity, so the difference between the efficiencies of electric heating and oil heating, estimated to be 100% and 80%

respectively, had to be considered. The energy of heating oil consumed was reduced by 20% to account for this resulting in a lower energy use intensity of 2.2 GJ/m2. This , along with preliminary functional programming information that established a proposed building size , were used as references to determine energy consumption in the baseline Margaree facility as seen in Table 2.2

Table 2-2: Cape Breton West Aquatic Centre Baseline Energy Usage

Margaree Aquatic Centre- Baseline 2510 m^2 Electricity	
Energy Use Intensity (GJ/m^2)	2.2
Annual Electricity Consumption (kWh)	1,538,276
Annual Electricity Consumption (GJ)	5537.8

2.2 MAC Preliminary Needs Analysis and Program Report

Central/Northern Inverness County has little opportunity for its citizens to access year-round indoor aquatic recreational and fitness facilities, while its population is suffering higher than provincial and national rates of chronic disease. For decades various groups and individuals have proposed the development of an indoor aquatic center in Central Inverness County, only to be rejected due to the high operating and maintenance costs of swimming pools. With current alternative energy technology, together with government focus on developing low carbon infrastructure, and building healthy communities, there are new opportunities to build and maintain a sustainable indoor recreational centre to meet the health and recreational needs of Central Inverness County. Developing a program space list for the Cape Breton West Aquatic Centre was outside their scope of funding for this project so the East Hants facility was used as a reference, program requirements defined by that municipality for the development of the East Hants Aquatic Centre include:

- Shallow warm pool for younger children and for seniors
- Six-lane, 25-meter program or lap tank
- Leisure body of water with zero-beach handicapped accessible entry
- Women's and men's change rooms
- Family change room
- Reception and administration area, staff and building support spaces
- Multi-purpose room capable of holding up to 50 people, with storage
- Kitchenette adjacent to the multi-purpose room
- Public lobby with a pool viewing area
- Pool and building mechanical room

2.3 Baseline Energy HAP Model

A building energy model was created in Carrier's Hourly Analysis Program (HAP) using information provided by the client. The building area for the proposed Cape Breton West facility was assumed to be 2510m^2. This floor area, along with the floor plans provided of the East Hants Aquatic Centre, allowed us to assume for modelling purposes a rectangular building of dimensions 38.1m by 65.8m. Similar to EHAC a sloped roof was assumed, with a 10% slope oriented south, resulting in a minimum building height of 3m and a maximum of 6.8m. NECB 2017 guidelines were followed to determine the insulation R-value of the building envelope, maximum allowable fenestration area, lighting and plug loads.

Occupancy patterns for the building were modelled off the East Hants facilities hours of operation and the occupancy rates described in the East Hants feasibility report, which estimated 2000 visitors per week, with peak periods occurring between 4-9pm on weekdays and 9am-9pm on weekends. Most of the energy used by this facility, with the except of service water, is not occupant dependent. The major contributors to the energy usage of the building include the pool heating and zone heating, if the occupancy rate is an over estimation, it will not have a significant impact on annual energy usage.

The HVAC system modelled for the baseline facility consisted of electric resistance baseboard heating and heating recovery ventilation, with a thermostatic setpoint of 21C during occupied periods, and 18C when unoccupied for all spaces except the pool area and the steam room. Following ASHRAE guidelines, the pool area had a static thermostat setpoint of 28C. A dehumidification system was implemented with a relative humidity set point of 60% for all spaces.

The annual energy usage for the pools heating and pumping loads were estimated using an Energy Star calculation method[1]. They were applied as a miscellaneous power load to the system. Additional miscellaneous loads included electricity consumption of the hot tub and steam room. Within the pool space to ensure an accurate load on the dehumidification system an evaporative latent load was calculated and added to the space.

The energy model was calibrated based on the estimated baseline energy consumption calculated from East Hants Aquatic Centre billing data. Baseline results can be seen in Appendix B, which allowed us to estimate the energy use breakdown shown in Figure 2.1 below.

[1] Source: Swimming Pools and the ENERGY STAR Score in the United States and Canada (nrcan.gc.ca). 2023-1-07

- The loads to operate the pools and hot tubs, including heating and pumping the water, as well as the steam room represent approximately 48% of the electrical load within the baseline model.
- The second highest category for energy consumption within the facility is space heating at a 31.7%
- The air systems within the building account for 13.54% of electricity consumption.
- The remaining 7% is a combination of lighting, cooling, electrical equipment and service water pumping.

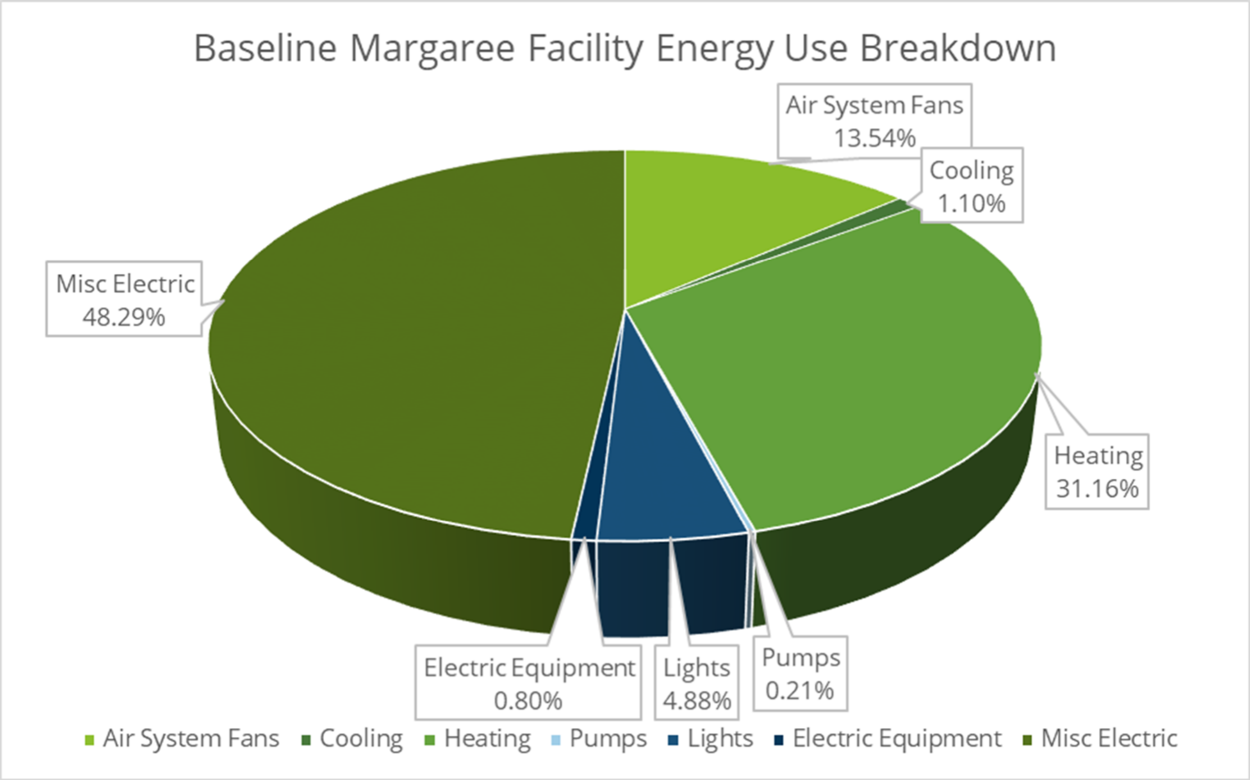

Figure 2.1 Baseline Cape Breton West Aquatic Centre Energy Usage Breakdown

2.4 National Energy Intensity Averages and Comparison with MAC Baseline

The energy use per area or energy use intensity (EUI) for the baseline facility is 2.2 GJ/m². According to the Energy Star Portfolio Manager for Canada[2], the average EUI for an indoor public swimming pool is 1.51 GJ/m². Currently, the EUI for the baseline case is 1.5 times

[2] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf 2023-01-15

higher than the national average. To be able to reach the average EUI for swimming pools, Cape Breton West Aquatic Centre will need to reduce its baseline energy consumption by 31%. We understand that the baseline numbers being based on a very busy facility like EHAC may be one of the reasons why the baseline is significantly higher than the national average. Some rationalization of occupancy and operating hours in future facility planning studies may permit this baseline number to be lowered.

3 Potential Sites

The MEA Aquatic Centre Feasibility Study includes four potential sites to be considered for the construction of the aquatic centre for Inverness County. These sites are:

Site #1 - The Old Margaree Community Soccer Field. Based on the feasibility study, some characteristics of this site are:

- Owned by Hallman Developments
- Area of field approximately 7 acres; development area about 4 acres
- Central location at Margaree Forks
- Borders on Margaree River, a designated Canadian Heritage River

Figure 3.1 Site #1 The Old Margaree Community Soccer Field

Site #2 - Former Margaree Forks District School site (1962-2000). Based on the feasibility study, some characteristics of this site are:

- Owned by Aymes Mustard
- Total area of 3.7 acres
- Central location at Margaree Forks
- As an old school building site would resonate with community

Figure 3.2: Site #2 -Former Margaree Forks District School site

Site #3 - Former Margaree Lodge Golf Course. Based on the feasibility study, some characteristics of this site are:

- Owned by Cabot Cape Breton
- Total area 5-7 acres; development area about 4 acres
- Central location at Margaree Forks
- Adjacent to SW Margaree River, a designated Canadian Heritage River

Figure 3.3: Site #3 Former Margaree Lodge Golf Course

Site #4 -Cape Breton Highlands Education Centre Academy. Based on the feasibility study, some characteristics of this site are:

- Owned by NS Department of Education
- Development area about 4 acres
- Located in Terre Noir, just north of Belle Cote
- Adjacent to operating P-12 school

Figure 3.4: Site #4 Cape Breton Highlands Education Centre and Academy

3.1 Criteria for Comparison and Recommendation

3.1.1 Site and PV Potential Comparison

The four sites will be compared based on the conditions of the site, site access, onsite PV potential, required on site PV capacity, the possibility of accommodating the building and the PV system and electrical distribution system. The availability of area for both ground and roof-top PV for the four sites will be examined, PV covered parking will only be considered if there is not sufficient space for a ground mounted system due to significant cost differentials.

- Site and PV Potential Comparison

The following table compares the four sites based on the conditions listed above, with the exception of the electrical distribution system.

Table 3-1: Site PV Potential

PV Potential	Site #1	Site #2	Site #3	Site #4
Site conditions	The terrain seems to be flat, which would result is less effort when preparing the terrain to install a ground mounted PV system. The lot is free of trees and the vegetation on the perimeter of the lot should not cause sharing issues on ground mounted PV system, as long as an adequate set back is allowed. The terrain seems to be at a higher elevation than the flood plain. However, it is recommended to confirm this with the	The site for the former school is cleared of trees and seems to be leveled. These conditions will facilitate the installation of a ground mounted solar PV. the vegetation on the perimeter of the lot should not cause sharing issues on ground mounted PV system, as long as an adequate set back is allowed. The terrain seems to be at a higher elevation than the flood plain. However, it is recommended to confirm this with the completion of a flood study.	The terrain shows small terraces at different levels. Most of the existing buildings on the lot are on the highest elevation. The terrain slopes towards the south-east, west and north. The norther part of the terrain might be prone to flooding due to its proximity to the river. However, it is recommended to confirm this with the completion of a flood study. A PV system should be strategically laid out to avoid shading issued from trees. It is likely that the terrain would	The identified available land is located at the back of the Cape Breton Highlands education Center, north of the soccer field. Most of the lot is forested and will required clearing, leveling, and grading to the construction of the facilities, including a PV system. The lot does not seem to be on a floodplain. However, it is recommended to confirm this with the completion of a flood study.

	completion of a flood study.		require grading work to be able to install a ground mounted PV system.	
Site access	The lot is right on the Cabot Trail, so access to the lot should not be an issue	The lot is right on NS Trunk 19, so access to the lot should not be an issue	The lot is right on NS Trunk 19, so access to the lot should not be an issue	The lot is right on the Cabot Trail. The lot would require an independent access of the lot could be connected to existing road in the campus so it can be accessed from the school entrance.
Onsite PV potential (kWpDC)	The site has the capacity to accommodate about 953 kWpDC of solar PV, which would generate about 1,049 MWh/yr. About 405 kWpDC roof mounted and 548 kWpDC ground mounted	The site has the capacity to accommodate about 928 kWpDC of solar PV, which would generate about 1,070 MWh/yr. About 405 kWpDC roof mounted and 523 kWpDC ground mounted	The site has the capacity to accommodate about 1,548 kWpDC of solar PV, which would generate about 1,703 MWh/yr. About 405 kWpDC roof mounted and 1,143 kWpDC ground mounted	The site has the capacity to accommodate about 991 kWpDC of solar PV, which would generate about 1,146 MWh/yr. About 405 kWpDC roof mounted and 586 kWpDC ground mounted
Required onsite PV capacity (kWpDC)	605			
Required onsite PV generation potential (kWh/yr)	680,257			

Can the site accommodate onsite generation (PV) to meet the net zero energy target? kWp on the roof? kWp on the ground?	There is sufficient space for enough self generation for net zero. The required onsite PV capacity can be accommodated onsite. 405 kWpDC can be placed on the facility roof and 200 kWpDC can be installed on the ground. The ground mounted array would require about 2,250-2,350 m2. The site would have enough space for future expansion of the facilities or the solar system

3.1.2 Electrical Distribution System Comparison

Using projections for similar facilities, we anticipate that with electric heating (using heat pumps), the electrical service required will be approximately 400A at 600V, requiring a padmounted transformer from Nova Scotia Power (NSP) rated 500kVA. With the local substation being located nearby at South West Margaree, and a visual inspection estimating the capacity of the overhead line to be approximately 13,000kVA (this may be limited by the substation size itself), there do not appear to be any limitations on this amount of connected load at any of the three potential sites at Margaree Forks. Connected to the same substation and circuit (after stepping the local voltage from 25 to 12.47kV), the fourth site at Terre Noire is more limited in its maximum capacity but should still be more than adequate for a 500kVA service.

All four sites offer a more complex issue on their capacity to accept power flowing back onto the grid, requiring a feasibility study to be performed by (NSP). Until 2017, however, a 660kW wind turbine was connected to the NSP grid at Grand Étang. While connected to a different substation, there was provision to switch its connection point to the South West Margaree circuit, implying that the area does have the capacity to accept at least 500kW of power injected onto the grid.

Of the four sites, Site 2 and Site 4 would afford the lowest installation costs (these estimates do not include the facility wiring costs, or modifications required to the NSP substation or protection systems to accommodate behind-the-meter power, all of which should be common to the four sites):

- Site 1 (the former community soccer field) has a single-phase overhead line run along the Cabot Trail on its western edge that would require approximately 600m of upgrade to three-phase line, including an assessment of the required construction over the South West Margaree River, on the order of $50,000 (final costs contingent on the findings of the assessment).
- Site 2 (the former Margaree Forks District High School lot) already has a three-phase overhead line installed all the way to the southernmost corner of the property, at most requiring replacement of approximately 140m of conductor across Route 19, on the order of $10,000, at most.
- Site 3 (the Margaree Lodge Golf Course) has three=phase power run along the east edge on Route 19, and single-phase power along the north-east edge on the Cabot Trail. Cost for connection would vary depending on the placement of the facility on the

property, ranging from slightly more than the school property, to slightly less than the soccer field property, approximately from $10,000-40,000.

- Site 4 (Cape Breton Highlands Academy/Education Centre) is already serviced by three-phase power, so no line extensions or upgrades are required. While detailed design is required, it is noted that the existing building has an above-grade septic system that would likely need to be duplicated for the new facility and may increase the size of the electrical service requirement slightly.

3.2 Onsite Generation Potential

The following assumptions were considered to estimate the onsite PV capacity and generation potential

- Building footprint of 2,500 m2.
- Only 80% (to account for walkways, and rooftop equipment) of the building roof area will be available for PV, allowing area for potential HVAC equipment and exhaust fans located on the roof.
- Ground mounted systems with panels facing due south and 40 degrees with an estimate capacity density for roof top PV systems of about 0.21 kWpDC/m2.
- Available ground area.
- To account for setbacks, parking , well , and septic field only 70% of available ground area was considered available for PV.
- Ground mounted systems with panels facing due south and 40 degrees slope with an estimate PV capacity density of 0.07 kWpDC/m2.

The onsite PV capacity and generation potential is shown in the table below.

Table 3-2: Onsite PV Capacity and Generation Potential

PV Potential	Site #1	Site #2	Site #3	Site #4
Available PV capacity on the roof (kWpDC)	**405**	**405**	**405**	**405**
Available PV capacity on the ground (kWpDC)	548	523	1143	586
Onsite PV potential (kWpDC)	953	928	1548	991
Onsite PV generation potential (kWh/yr)	1,048,501	1,070,399	1,702,879	1,146,080

4 Net Zero Ready Upgrade Requirements

4.1 List of Upgrade Measures and Results of Analysis

After examining the construction and systems for the East Hants facility and understanding the mandate of this study to determine what potential enhancements to that design could allow for significant reductions in energy consumption, a series of potential energy efficiency measures were analysed to determine their potential to reduce the energy consumption of the proposed facility below the assumed baseline.

4.1.1 Upgrade Building Envelope

The building envelope can provide an opportunity for heating energy losses into the environment, by increasing the insulation these loses can be reduced, reducing energy consumption and heating costs. The baseline facility created using NECB standard for building insulation. It is recommended to reduce space heating requirements that the insulation values for the exterior walls, floors and roof be increased by 15% from the NECB 2017 standard. Furthermore, the windows should be upgraded to a triple glazed window which have an average R-value of between 7-8 ft2·°F·h/BTU, a minimum 250% increase from NECB 2017 which requires R3.

4.1.2 Shower Drain Water Heat Recovery

Aquatic Centres have a high service water heating load, due to the large consumption of hot water by the showers. Each person entering the swimming area is required to shower prior to entering to maintain the cleanliness of the water. There is the opportunity to recover heat from the waste hot water to preheat cold supply water entering the hot water tank and reduce energy costs. A drain water heat recovery pipe is a simple but effective tool to recover approximately 25% of wastewater energy. It works by having incoming supply water run through a series of coils wrapped around your wastewater pipe before entering the domestic hot water tank.

4.1.3 Air Source Heat Pump

The baseline for the building utilizes electric resistance heating which has a nominal efficiency of 100%. High efficiency split air source heat pumps can provide the same heating output at an average efficiency during the heating season of 200-250% (SEER 28) and peak efficiencies of 300-350%, depending on the outdoor conditions. The warmer the outdoor air during the heating season, the more heat is available and the higher the heat pump efficiency. The implementation of an air source heat pump into the facility would provide a large opportunity for energy savings, as facility heating makes up 13.7% of the building's electricity usage.

4.1.4 Heat Pump Hot Water Heater

The baseline facility models an electric hot water tank serving the entire building with an efficiency of 100%. Heat pump water heaters use electricity to move heat from one place to another instead of generating heat directly, such as the electric resistance elements in an electric hot water tank. Therefore, heat pump hot water tanks can be two to three times more energy efficient than conventional electric resistance water heaters. Standalone air-source heat pump water heaters pull heat from the surrounding air, upgrade it and transfer it, at a higher temperature, to heat water in a storage tank. A standalone heat pump water heating system can be purchased as an integrated unit with a built-in water storage tank and backup resistance heating elements. Heat pump water heaters require placement in a space with a minimum volume (as per manufacturer's recommendations) to avoid overcooling/over-drying the area in which it was installed. The utilization of a heat pump hot water heater would allow for savings for both the service hot water as well as the water used for the pool area.

4.1.5 Solar Water Heating

Pool water heating alone represents approximately 42.7% of the baseline facility's energy consumption. Pool heating would be produced by electric boilers. Currently, there are alternative technologies that would help to reduce electricity consumption when producing hot water. Depending on the case, and a variety of conditions, such equipment could preheat the supply water or generate water at the required hot water supply temperature. Solar hot water systems (SHWS) can provide part of the hot water demand and also preheat the make-up water before it reaches the boiler. A SHWS for this facility would include a set of flat plate or evacuated tube solar collectors, circulating pump, temperature sensors, heat exchanger, and storage tank. The implementation of this system would contribute to the reduction of electricity consumption at the facility for pool water heating. Additionally, the load on the heating boilers would be reduced, which results in less wear and tear on the equipment.

4.1.6 Solar Air Heating

The heating load in the proposed baseline Cape Breton West facility represents 13.7% of the electricity usage of the building. There are alternative technologies that would help reduce the electricity used for space heating. A solar air heating system is a passive heating technology which use solar energy to preheat air before it enters the HVAC system, allowing for reduced electrical consumption and load on the HVAC system.

4.1.7 Occupancy Demand Pump

A variable speed pump that increases and decreases speed with occupancy rates could be used as an energy reduction measure. The recirculation of pool water through the filtration system can be varied based upon the number of people using the pool. It is estimated that on average that the pump speeds would be reduced by 15% using a variable speed pump compared to the baseline constant speed pump. This 15% reduction in pump speed would reduce pump energy consumption by close to 40%.

4.1.8 High Efficiency Energy Recovery Ventilation

Energy recovery ventilation (ERV) is a method of heat recovery that extracts both sensible and latent energy from air exhausted out of the building, several methods exist that operate passively in the HVAC system. Energy recovery systems typically have an efficiency between 60-80%. The baseline model estimates a heat recovery efficiency of 74%. To maximize the amount of waste energy recovery and minimize the energy usage of the HVAC system, the proposed building should have an ERV with a minimum efficiency of 80%.

4.1.9 Daylighting Lighting Controls

Daylighting is an energy efficiency measurement which adjusts interior lighting based on the available natural daylight, the more daylight available the less the building would rely on electric lighting. A daylighting control with multiple step dimming can save on average 20% of lighting costs in spaces with windows or skylights.

4.1.10 Pool Cover Usage

Pools lose heat through a variety of ways; evaporative and conductive losses are the largest contributors to pool energy usage. The use of a pool cover during unoccupied hours is an effective way to reduce these losses, through the minimization of evaporation of water the energy needed to reheat and replace it is diminished. Cover use also reduces the air velocity over the water reducing sensible heat lost to the space. It is estimated that this would reduce the pools heating load by approximately 13.5%.

4.1.11 Implementation Costs

The premium capital cost to upgrade the baseline building to the proposed building incorporating all of the above efficiency measures is estimated be an additional $3.2 million. A confirmation of capital cost is still required as we are waiting to hear from vendors and contractors.

4.1.12 Results of Analysis

The baseline HAP was modified to be able to estimate the building's performance considering the efficiency measures listed above.

- Replacement of Electric resistance heaters with air source heat pumps
- Replacement of service water electric water heater with a heat pump water heater
- Increase of building envelope insulation to 15% higher than NECB 2017 recommended values and R7 windows
- Lighting intensities for spaces modelled with windows were reduced by 20% to represent savings from daylighting measures
- The efficiency of the ERV in the baseline model was raised from 74% to 80%

Measures affecting pool heating and pumping were determined separately and the savings percentage found were applied to the miscellaneous loads and incorporated into HAP. These measures include:

Solar Water Heating: The solar water heating savings for heating the leisure pool and lap pool were calculated by modelling the individual measure in RETScreen Expert as seen in Appendix B, the model assumed a water temperature of 26.6°C, air temperature of 27.7°C and relative humidity of 60%. Both pools were assumed to have an average depth of 5'. The measure was found to have an estimated a reduction 27% in electricity needed to heat both pools compared to the baseline. This savings was applied to the baseline evaporative and convection pool heating loads.

Pool Cover Usage: The savings associated with the implementation of a pool cover during unoccupied hours for the leisure pool and lap pool were calculated by modelling the individual measure in RETScreen Expert as seen in Appendix B, the model assumed a water temperature of 26.6°C, air temperature of 27.7°C and relative humidity of 60%. Both pools were assumed to have an average depth of 5'. Using EHAC operating hours, there was on average 10.2 unoccupied hours per day, this found a 13.5% savings in pool heating energy. This savings was applied to the baseline evaporative and convection pool heating loads.

Pool Heat Pump Hot Water Heater: The savings for this measure were calculated assuming that the heat pump hot water heater implemented has a COP of 1.8, therefore the energy output is 180% the size of the energy input. The electricity usage for pool heating, found after the reductions from both the solar water heater and the pool cover usage had been applied, was reduced by a factor of 1.8 to determine the energy input needed using a heat pump hot water heater to meet the pools heating demands. The results of this were incorporated into the miscellaneous load applied in HAP.

Occupancy Demand Pump: Savings for this measure were calculated by assuming an average of 15% reduction in pump speed, using pump affinity laws the pumping energy savings could be determined to be approximately 38.5%. This savings was applied to the baseline pumping load.

Measures that were not able to be incorporated into the HAP model were subtracted from the energy model totals found from HAP

Solar Air Heating: The energy savings for implementing a solar air heating system for heating the pool area were calculated by modelling the individual measure in RETScreen Expert as seen in Appendix B. The model assumed an air temperature of 27.7°C, maximum delivered air temperature of 12.8 °C and a constant design air flow rate of 27715.3 cfm which meets ASHRAE's recommend 6 air changes an hour for a pool area. The percentage of energy savings was applied to proposed building's heating load for just pool space to find a energy savings in kWh. This value was subtracted from the HAP model output to calculate building energy usage with this measure implemented.

Shower Drain Water Heat Recovery: The wastewater heat recovery savings for were calculated by modelling the individual measure in RETScreen Expert as seen in Appendix B. It was assumed that each of the estimated 2000 visitors per week would take 2-minute shower on average prior to entering the pool area. The average shower temperature was estimated to be 45C. The efficiency of the wastewater heat recovery device is approximately 25% leading to an estimated savings of 12,971 kWh per year. This value was reduced from the proposed HAP model output to determine the building energy usage utilizing this measure.

The implementation of these measures to the Cape Breton West facility would result in a reduction of energy consumption from the baseline of 858,019 kWh of electricity per year. Figures showing the energy savings are included in Appendix B.

4.2 Estimated Net Zero Ready Building Energy Use

The implementation of all measures previously listed results in a large energy savings compared to the baseline Cape Breton West facility as seen in Table 4-1. The proposed building has an annual energy consumption of 680257 kWh, costing approximately $117,344 a year. This is a savings of $148,008 a year compared to the baseline. The energy usage intensity was reduced from 2.2GJ/m^2 to 0.98 GJ/m^2, making the proposed facility 35% below the national energy intensity average for this type of building.

Table 4-1: Energy Savings between Proposed Cape Breton West Aquatic Centre and Baseline

Cape Breton West Aquatic Centre 2510 m²	Annual
Baseline	
Annual Electricity Cost ($)	$265353
Annual Electricity Consumption (kWh)	1,538,276
Annual Electricity Consumption (GJ)	5537.8
Energy Usage Intensity	2.2
Proposed	
Annual Electricity Cost ($)	$117344
Annual Electricity Consumption (kWh)	680257
Annual Electricity Consumption (GJ)	2448.9
Energy Usage Intensity	0.98
Energy Savings	
Annual Energy Costs ($)	148008.3
Annual Energy Consumption (GJ)	3088.9

4.3 Onsite Generation Requirements

The estimated energy consumption for the building, including the implementation of the energy efficiency measures, resulted in 680,257 kWh. This annual consumption is about 55% lower compared to the baseline building with the same energy use intensity as the East Hants facility.

Based on the annual energy requirements, the facility would need a 600-610 kWpDC PV onsite system (assuming a PV capacity density of about 0.15-0.20 kWpDC/m2) to render the building net zero energy. This is assuming that a net metering arrangement could be set up with the utility and there is not a battery energy storage system (BESS) onsite. Due to the high cost of BESS, the net metering arrangement is the most feasible option. The use of an energy storage system, whether thermal or electrical, is not recommended in the event the facility could instead take advantage of the new Net Metering legislation Implemented by Nova Scotia Power Inc. (NSPI). For energy storage to be deemed economically feasible, the facility must experience short periods of Peak Electrical Demand, resulting in high demand costs. These periods of peak demand can be tapered through the supplementation of stored energy. For the case of the proposed Cape Breton West Aquatic Centre, the demand curve is relatively flat and would therefore not benefit. Economic benefits would be seen if the facility was eligible for time-of-day rates, which allow for reduced energy prices at off-peak times and reduce the cost of charging such a system. However, NSPI does not offer this incentive to commercial buildings. **The net metering requirement would allow the facility to produce surplus renewable energy during the spring and summer months when solar PV productivity is highest and export it to the NS Power grid and receive full credit for all energy produced against future electricity consumption during periods of the year when solar PV is less productive and the building energy**

consumption is highest. New legislation in Nova Scotia is intended to permit electricity customers that utilize a tariff with a demand charge to be able to install up to 1 MWpDC of capacity under a net metering arrangement. Given the potential consumption of the facility , a demand charge tariff is certain meaning that the 600 Kw system requirement will be within the net metering limit.

About 405 kWp can be accommodated on the building roof and 200 kWp on the ground. The combine PV capacity of 605 kWpDc would generate just over 681,000 kWh/yr. The installation cost could be around $1,210,000. Appendix A includes the PVSyst report.

The following figures show the areas than can be occupied by the building, parking & landscaping, and the ground mounted PV system. The purpose of these figures is to demonstrate that the sites can accommodate the building, parking, and PV systems. The areas designated as building could also include PV on up to 80% of the roof area.

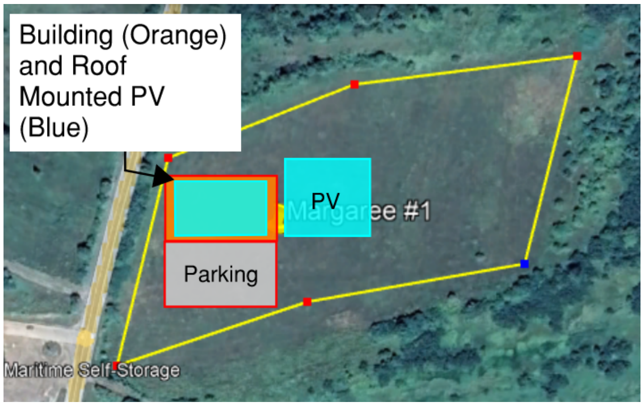

Figure 4.1: Site #1 With Building, Parking and PV

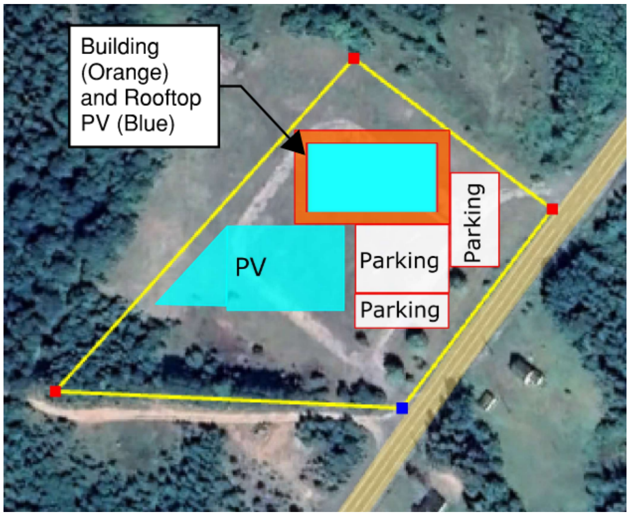

Figure 4.2: Site #2 with Building, Parking and PV

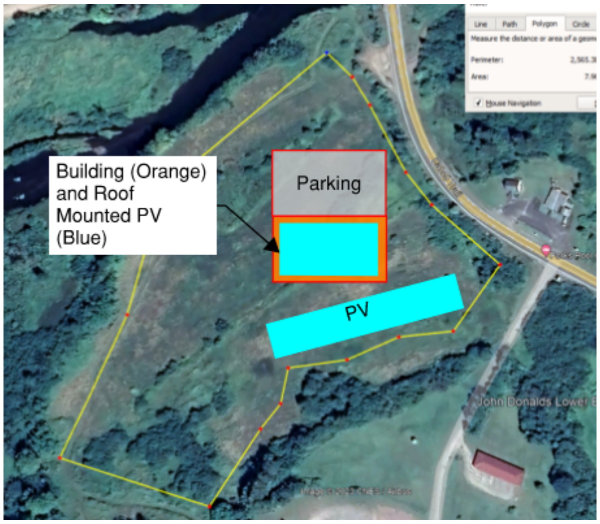

Figure 4.3: Site #3 with Building, Parking and PV

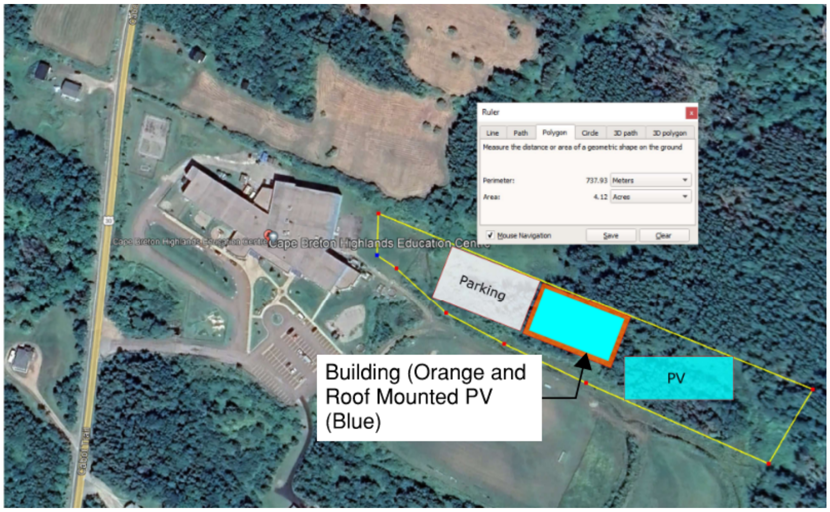

Figure 4.4: Site #4 With Building Parking and PV

4.4 Estimated Capital Costs and Life Cycle Costs Compared to Baseline

A life cycle cost was completed for the net zero ready building as well as the four sites considering energy and maintenance costs. Some of the assumptions in the analysis are:

- Baseline annual energy consumption 1,533,889 kWh/yr.
- Baseline annual energy cost $265,353/yr.
- Proposed annual energy consumption 680,257 kWh/yr.
- Proposed PV system capacity 605 kWp DC.
- Proposed PV system production 680,257 kWh/yr.
- Estimated cost for the PV system: $1,210,000.
- PV system maintenance cost: 0.5% of capital cost/yr, so $6,050/yr.

- Building maintenance cost. Annual maintenance cost was estimated considering an average cost per square foot maintenance value according to ASHRAE Handbook 2021 Applications, Chapter 38. The maintenance cost from chapter 38 was for 2004, therefor that value was inflated at a rate of 2.5%/yr to estimate the maintenance cost for 2023. $30,292 and a 25% increase for the net zero ready and for all four options.
- PV modules lifespan 25 years.
- String inverters lifespan 10 years and replacement cost of 10% of the initial system capital cost.

The financial parameters considered in the LCCA are presented in Table 4-2: Financial Parameters.

Table 4-2: Financial Parameters

Assumptions	Values
Project Horizon (yr)	25
Equity ratio	100% Equity
Capital cost inflation (%/yr)	5.00%
O&M escalation (%/yr)	5.00%
Fuel and Electricity cost escalation (%/yr)	5.00%
Expected lifespan (yr)	Varies per item.
Discount rate (%)	2.22%
Straight line depreciation	Initial cost / expected lifespan
Note: Items that are due for replacement at year 25 are showing a $0 salvage value	
Carbon Tax: $50/ton in 2022, increased by $15/ton/yr until 2030. Then, assuming lineal increases to $300/ton by 2050. NS grid emission intensity factor 0.602 kg Co2/kWh for 2022 according to NSPI. The carbon emission intensity factor estimated between 2023 and 2030 is based on data from: Environment and Climate Change Canada, Strategic Policy Branch, Economic Analysis Directorate, Analysis and Modelling Division. Recommended Average Emissions Intensities (tonnes/MWh)	

A building energy model was created in HAP (Hourly Analysis Program) to estimate the annual energy consumption for this facility. Annual maintenance cost was estimated considering and average cost per square foot maintenance value according to ASHRAE Handbook 2021 Applications, Chapter 38. The maintenance cost from chapter 38 was for 2004, therefore that value was inflated at a rate of 2.5%/yr to estimate the maintenance cost for 2022.

The high relative humidity, set point temperature and evaporative loads that occur within an aquatic centre lead to the formation of condensation on cooler surfaces specifically exterior walls and windows, due to the presence of chlorine in this condensation is acidic. An increase of 15% in the insulation R-value from NECB 2017 standards for the building envelope, as well as an upgrade from double- to triple-glazed windows would allow the interior surface of the exterior wall to be at a higher temperature than the baseline, this would reduce the condensation that could form and the associated damages. This has the potential to save 0.5% in maintenance costs per year for the proposed facility.

The LCCA considers the effect of carbon taxes over the 25-year period in accordance with the assumption stated in the previous table.

The LCCA for the baseline, baseline building enhancements and the four site options are presented below. The analysis includes, maintenance cost, energy consumption cost and premium cost to implement the recommended energy efficiency measures ($3.2M [to be confirmed]). All four sites showed a LCC about 22% and 23% lower than the baseline and net zero ready building accordingly.

It was noticed that, even though all the sites will require additional initial investment to install the PV system and efficiency improvements, higher maintenance costs and equipment replacement expenses over a 25-year period, the benefit of not purchasing energy from the grid and reducing carbon taxes, results in lower NPVs. Also, the NPV for the baseline and NZR buildings is almost even, despite the additional investment required to implement the recommended energy efficiency measures. Appendix C includes the LCC calculations.

Table 4-3: Life Cycle Costs

LCC	Baseline	Net Zero Ready	Site 1	Site #2	Site #3	Site #4
LCC (NPV$)	$7,259,512	$7,368,492	$5,683,916	$5,643,916	$5,673,916	$5,633,916
LCC compared to baseline	N/A	1.5%	-21.7%	-22.3%	-21.8%	-22.4%
LCC compared to NZR Building	N/A	N/A	-22.9%	-23.4%	-23.0%	-23.5%
Annual cost savings based on Baseline ($/yr)	N/A	$121,997	$246,478	$246,478	$246,478	$246,478

LCC	Baseline	Net Zero Ready	Site 1	Site #2	Site #3	Site #4
Simple payback	N/A	26.23	18.09	17.93	18.05	17.89

4.5 Estimated GHG Emission Reduction Compared to Baseline

Considering an electricity carbon emission factor of 0.6029 kG CO2/kWh[3] the GHG emissions for the baseline and proposed buildings are shown in the table below. The GHG emission reduction is estimated to be 151 ton CO2/yr, which represents a 56% reduction compared to the baseline. It is worth mentioning that both, baseline and proposed building only consume electricity.

Table 4-4: GHG Emissions

Energy and GHG Emission	Baseline	Proposed
Energy consumption (kWh/yr)	1,538,276	680,257
GHG emissions (ton CO2/yr)	927	410
GHG emission reduction (ton CO2/yr)	N/A	517

[3] Source: https://www.nspower.ca/cleanandgreen/air-emissions-reporting. Retrieved: 2022-01-09

5 Conclusion

Sites #1 and #2 seem to offer the most favorable conditions to house the new aquatic centre and PV array and offer the best LCC. This does not take into account the purchase price or availability of any of the sites. As has been shown in the analysis any of the sites could potentially house the proposed facility and allow for net zero energy operation. The proposed new net metering regulations will be key to permitting this to happen . Additional facility planning in the future could further refine the facility requirements and operating hours which could reduce further the expected energy consumption and self generation requirements which should have a positive impact on the project cost and financial analysis.

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APPENDIX A

PVSyst Report

Version 7.3.0

PVsyst - Simulation report

Grid-Connected System

Project: 227559.00 Margaree Aquatic Centre

Variant: MAC 405 kWpDC and Ground Array 208 kWpDC

Building system

System power: 613 kWp

Margaree Forks - Canada

Author

CBCL Limited (Canada)

Project summary

Geographical Site	Situation		Project settings	
Margaree Forks	Latitude	46.34 °N	Albedo	0.20
Canada	Longitude	-61.09 °W		
	Altitude	6 m		
	Time zone	UTC-4		

Meteo data
Margaree Forks
Meteonorm 8.0 (1991-2013), Sat=100% - Synthetic

System summary

Grid-Connected System — **Building system**

PV Field Orientation		Near Shadings	User's needs
Fixed plane		Linear shadings	Unlimited load (grid)
Tilt/Azimuth	38.7 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	1426 units	Nb. of units	11 units
Pnom total	613 kWp	Pnom total	550 kWac
		Pnom ratio	1.115

Results summary

Produced Energy	739529 kWh/year	Specific production	1206 kWh/kWp/year	Perf. Ratio PR	89.73 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation		**Sheds configuration**		**Models used**	
Fixed plane				Transposition	Perez
Tilt/Azimuth	38.7 / 0 °			Diffuse	Perez, Meteonorm
				Circumsolar	separate

Horizon	**Near Shadings**	**User's needs**
Free Horizon	Linear shadings	Unlimited load (grid)

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	Jinkosolar	Manufacturer	SMA
Model	JKM-430N-54HL4	Model	Sunny Tripower STP50-40-Core1
(Original PVsyst database)		(Original PVsyst database)	
Unit Nom. Power	430 Wp	Unit Nom. Power	50.0 kWac
Number of PV modules	1426 units	Number of inverters	11 units
Nominal (STC)	613 kWp	Total power	550 kWac
Array #1 - PV Array			
Number of PV modules	483 units	Number of inverters	4 units
Nominal (STC)	208 kWp	Total power	200 kWac
Modules	21 Strings x 23 In series		
At operating cond. (50°C)		Operating voltage	188-800 V
Pmpp	192 kWp	Pnom ratio (DC:AC)	1.04
U mpp	675 V	Power sharing within this inverter	
I mpp	285 A		
Array #2 - Sub-array #2			
Number of PV modules	943 units	Number of inverters	7 units
Nominal (STC)	405 kWp	Total power	350 kWac
Modules	41 Strings x 23 In series		
At operating cond. (50°C)		Operating voltage	188-800 V
Pmpp	375 kWp	Pnom ratio (DC:AC)	1.16
U mpp	675 V	Power sharing within this inverter	
I mpp	556 A		
Total PV power		**Total inverter power**	
Nominal (STC)	613 kWp	Total power	550 kWac
Total	1426 modules	Number of inverters	11 units
Module area	2785 m²	Pnom ratio	1.11

Array losses

Thermal Loss factor		**Module Quality Loss**		**Module mismatch losses**	
Module temperature according to irradiance		Loss Fraction	-0.8 %	Loss Fraction	2.0 % at MPP
Uc (const)	20.0 W/m²K				
Uv (wind)	0.0 W/m²K/m/s				

Strings Mismatch loss

Loss Fraction 0.1 %

Array losses

IAM loss factor

Incidence effect (IAM): Fresnel, AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array

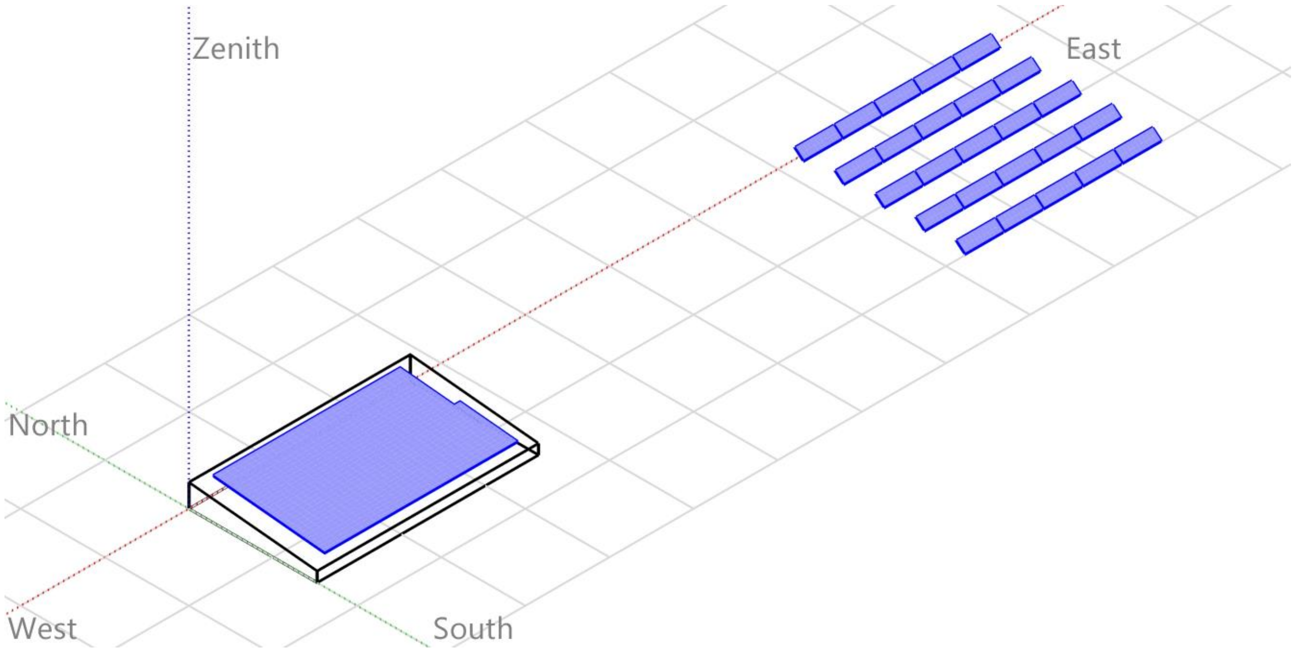
Global array res. 39 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2

Global array res. 20 mΩ
Loss Fraction 1.5 % at STC

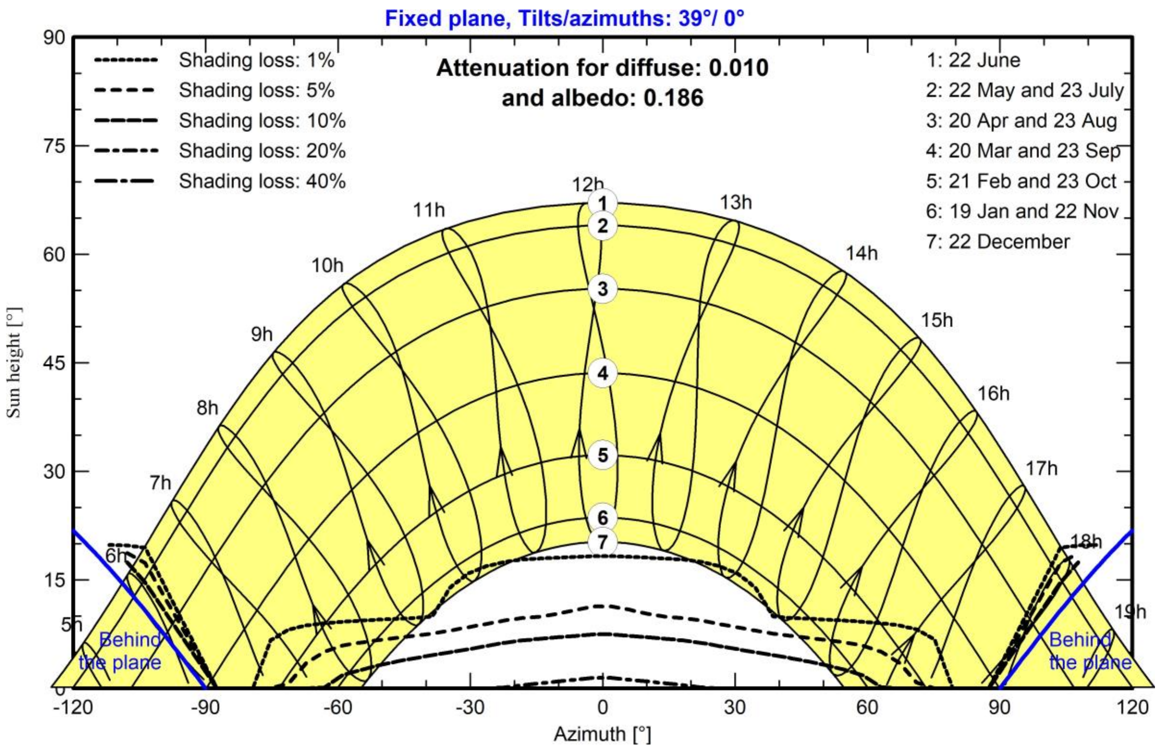
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

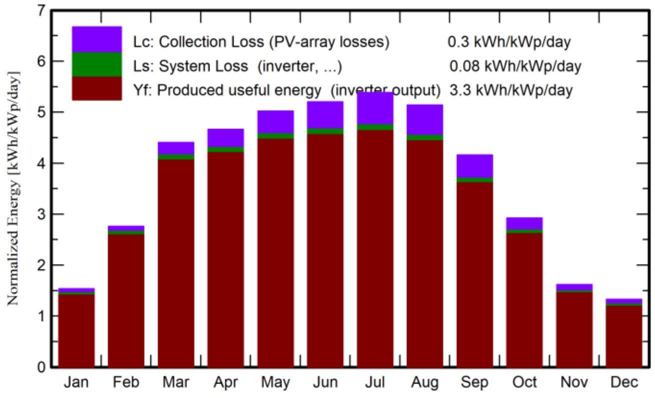


Main results

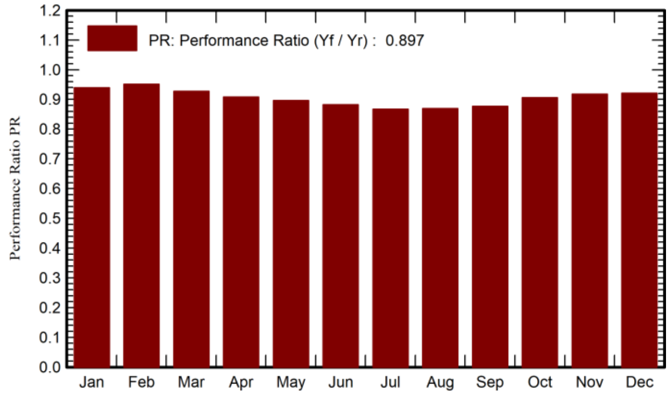
System Production

Produced Energy	739529 kWh/year	Specific production	1206 kWh/kWp/year
		Performance Ratio PR	89.73 %

Normalized productions (per installed kWp)



Performance Ratio PR



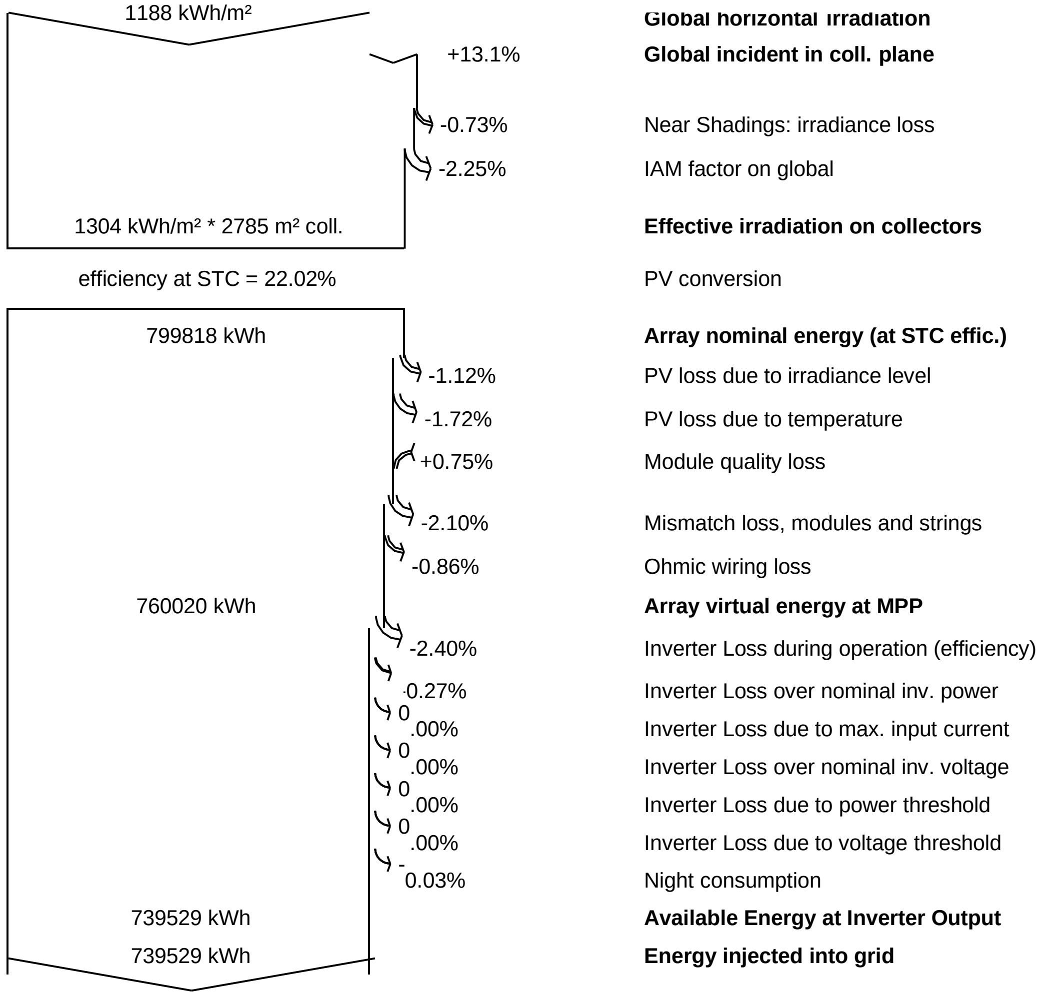
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	29.2	18.75	-4.83	47.6	46.3	28232	27398	0.939
February	53.0	32.22	-5.48	77.2	75.5	46161	45004	0.951
March	101.9	45.63	-2.45	136.6	133.3	79656	77713	0.928
April	127.4	66.77	2.15	139.9	135.6	79796	77877	0.908
May	157.6	82.05	7.28	155.6	150.6	87585	85488	0.896
June	167.9	84.97	12.48	156.0	150.6	86471	84433	0.882
July	174.3	86.52	18.12	167.0	161.5	90883	88765	0.867
August	152.1	78.67	18.75	159.3	154.3	86918	84921	0.869
September	103.1	50.10	14.97	124.7	121.2	68662	67028	0.876
October	65.9	37.89	9.63	90.6	88.4	51634	50372	0.906
November	31.8	22.02	4.48	48.4	47.2	28056	27264	0.918
December	23.8	15.92	-0.95	41.2	39.9	23995	23267	0.921
Year	1188.1	621.52	6.25	1344.1	1304.3	758050	739529	0.897

Legends

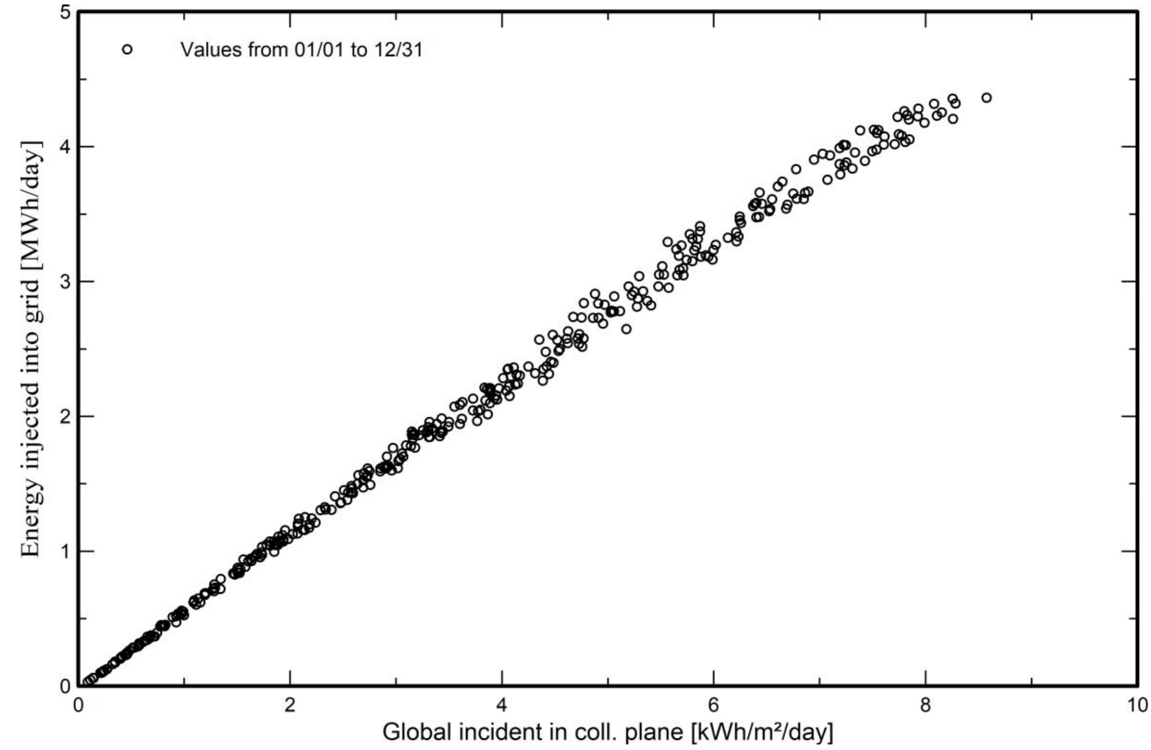
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

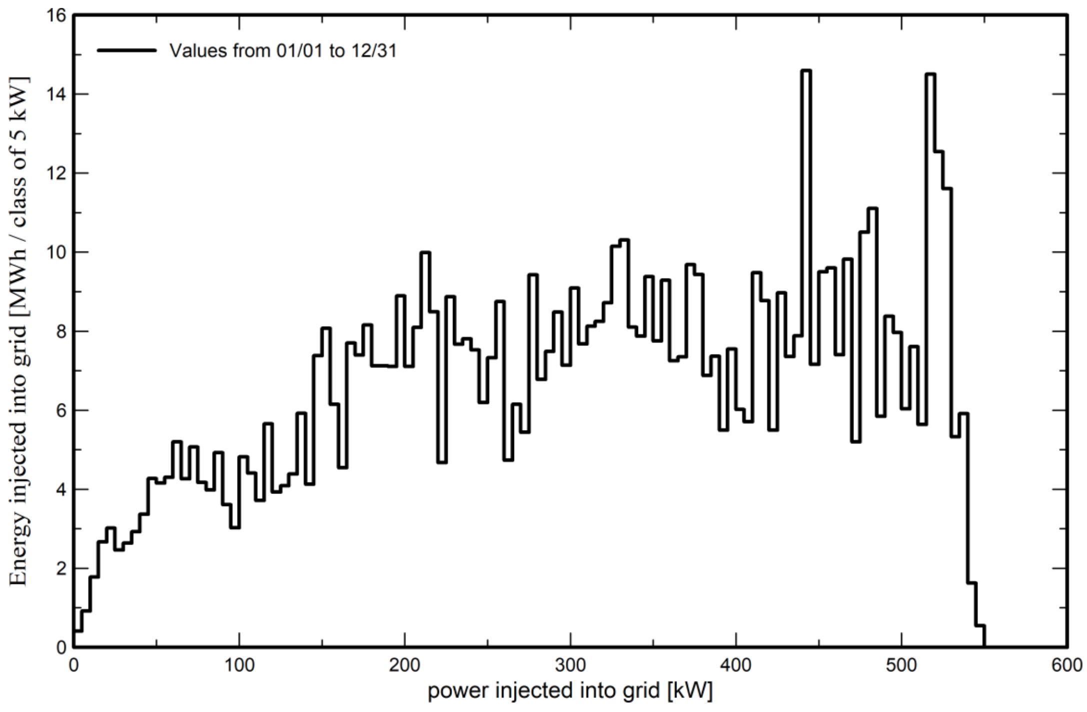


Predef. graphs

Daily Input/Output diagram

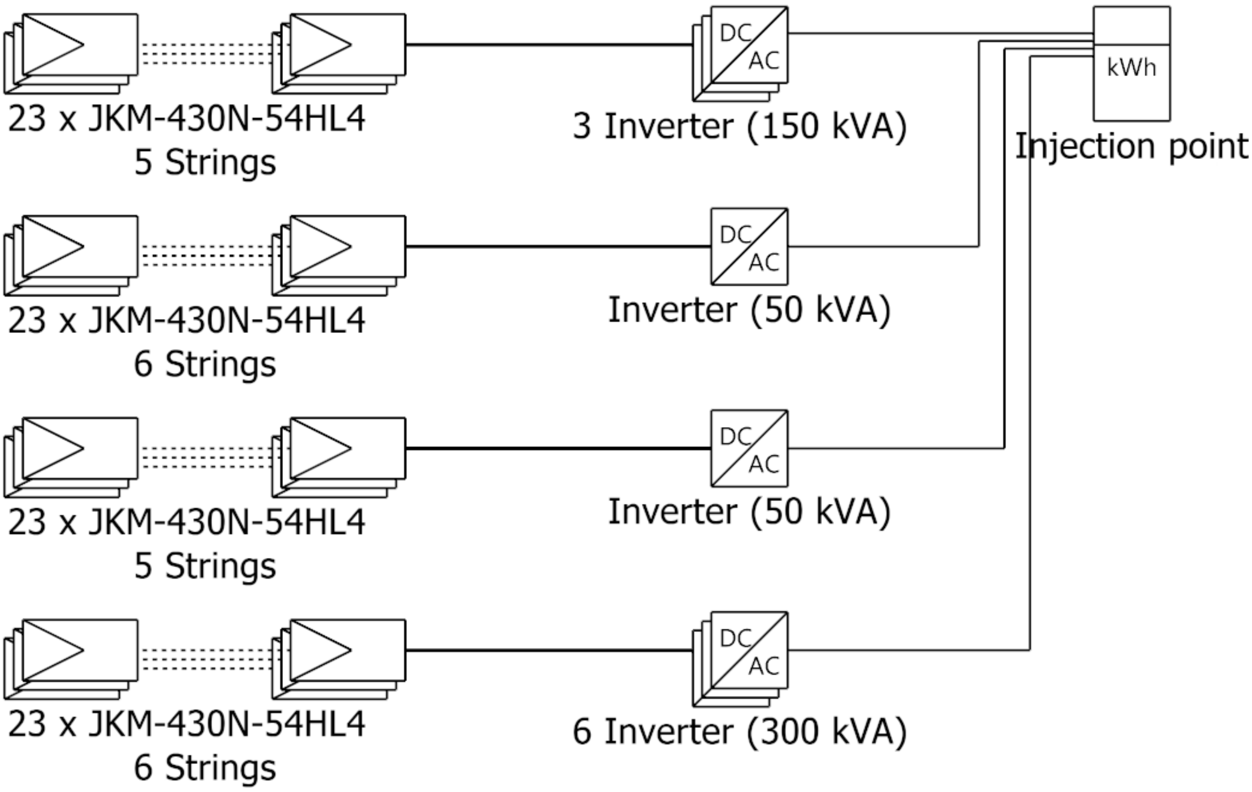


System Output Power Distribution



Single-line diagram

PVsyst V7.3.0
VC7, Simulation date:
01/20/23 10:40
with v7.3.0



PV module	JKM-430N-54HL4
Inverter	Sunny Tripower STP50-40-Core1
String	23 x JKM-430N-54HL4

	227559	CBCL Limited (Can
	VC7 : MAC 405 kWpDC and Ground Arr ay 208 kWpDC	01/20/23

APPENDIX B

Energy Model Reports

Table 1. Annual Costs

Component	Baseline Margaree ($)	Proposed Margaree ($)
HVAC Components		
Electric	121,608	56,870
Natural Gas	0	0
Fuel Oil	0	0
Propane	0	0
Remote HW	0	0
Remote Steam	0	0
Remote CW	0	0
HVAC Sub-Total	**121,608**	**56,870**
Non-HVAC Components		
Electric	142,637	63,203
Natural Gas	0	0
Fuel Oil	0	0
Propane	0	0
Remote HW	0	0
Remote Steam	0	0
Non-HVAC Sub-Total	**142,637**	**63,203**
Grand Total	**264,245**	**120,073**

Table 2. Annual Energy Consumption

Component	Baseline Margaree	Proposed Margaree
HVAC Components		
Electric (kWh)	704,975	329,682
Natural Gas (na)	0	0
Fuel Oil (na)	0	0
Propane (na)	0	0
Remote HW (na)	0	0
Remote Steam (na)	0	0
Remote CW (na)	0	0
Non-HVAC Components		
Electric (kWh)	826,883	366,393
Natural Gas (na)	0	0
Fuel Oil (na)	0	0
Propane (na)	0	0
Remote HW (na)	0	0
Remote Steam (na)	0	0
Totals		
Electric (kWh)	1,531,857	696,074
Natural Gas (na)	0	0
Fuel Oil (na)	0	0
Propane (na)	0	0
Remote HW (na)	0	0
Remote Steam (na)	0	0
Remote CW (na)	0	0

Table 3. Annual Emissions

Component	Baseline Margaree	Proposed Margaree
CO2 Equivalent (lb)	0	0

Table 4. Annual Cost per Unit Floor Area

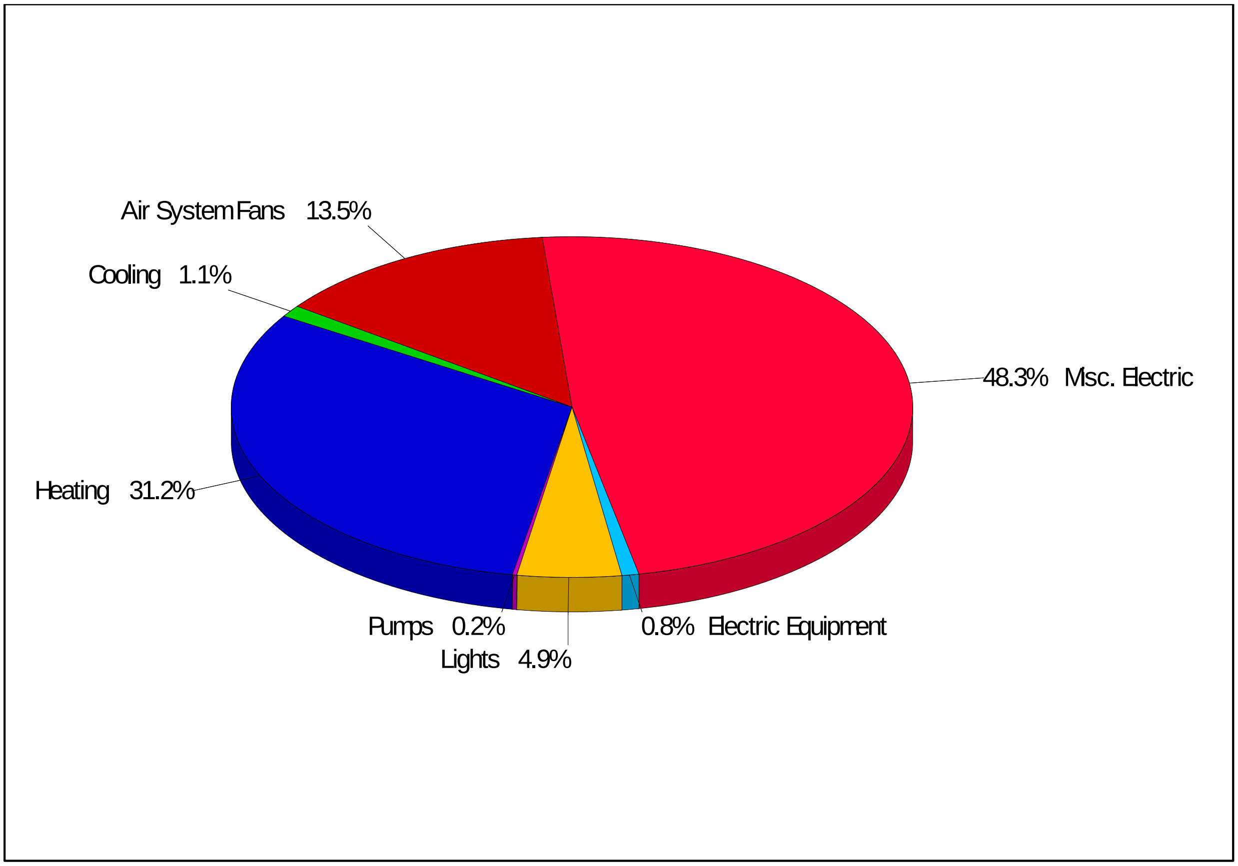
Component	Baseline Margaree ($/ft²)	Proposed Margaree ($/ft²)
HVAC Components		
Electric	4.592	2.148
Natural Gas	0.000	0.000
Fuel Oil	0.000	0.000
Propane	0.000	0.000
Remote HW	0.000	0.000
Remote Steam	0.000	0.000
Remote CW	0.000	0.000
HVAC Sub-Total	**4.592**	**2.148**
Non-HVAC Components		
Electric	5.386	2.387
Natural Gas	0.000	0.000
Fuel Oil	0.000	0.000
Propane	0.000	0.000
Remote HW	0.000	0.000
Remote Steam	0.000	0.000
Non-HVAC Sub-Total	**5.386**	**2.387**
Grand Total	**9.979**	**4.534**
Gross Floor Area (ft²)	26481.0	26481.0
Conditioned Floor Area (ft²)	26481.0	26481.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 5. Component Cost as a Percentage of Total Cost

Component	Baseline Margaree (%)	Proposed Margaree (%)
HVAC Components		
Electric	46.0	47.4
Natural Gas	0.0	0.0
Fuel Oil	0.0	0.0
Propane	0.0	0.0
Remote HW	0.0	0.0
Remote Steam	0.0	0.0
Remote CW	0.0	0.0
HVAC Sub-Total	**46.0**	**47.4**
Non-HVAC Components		
Electric	54.0	52.6
Natural Gas	0.0	0.0
Fuel Oil	0.0	0.0
Propane	0.0	0.0
Remote HW	0.0	0.0
Remote Steam	0.0	0.0
Non-HVAC Sub-Total	**54.0**	**52.6**
Grand Total	**100.0**	**100.0**

Annual Component Costs - Baseline Margaree

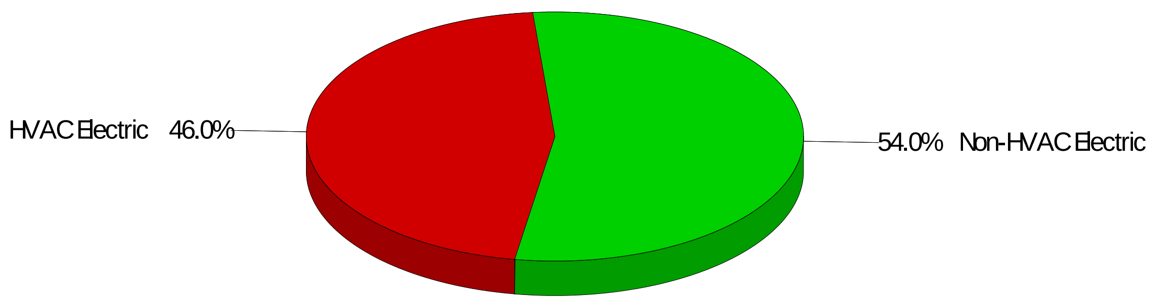


1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	35,779	1.351	13.5
Cooling	2,918	0.110	1.1
Heating	82,342	3.110	31.2
Pumps	567	0.021	0.2
Heat Rejection Fans	0	0.000	0.0
HVAC Sub-Total	**121,607**	**4.592**	**46.0**
Lights	12,903	0.487	4.9
Electric Equipment	2,124	0.080	0.8
Misc. Electric	127,613	4.819	48.3
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**142,640**	**5.386**	**54.0**
Grand Total	**264,247**	**9.979**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²



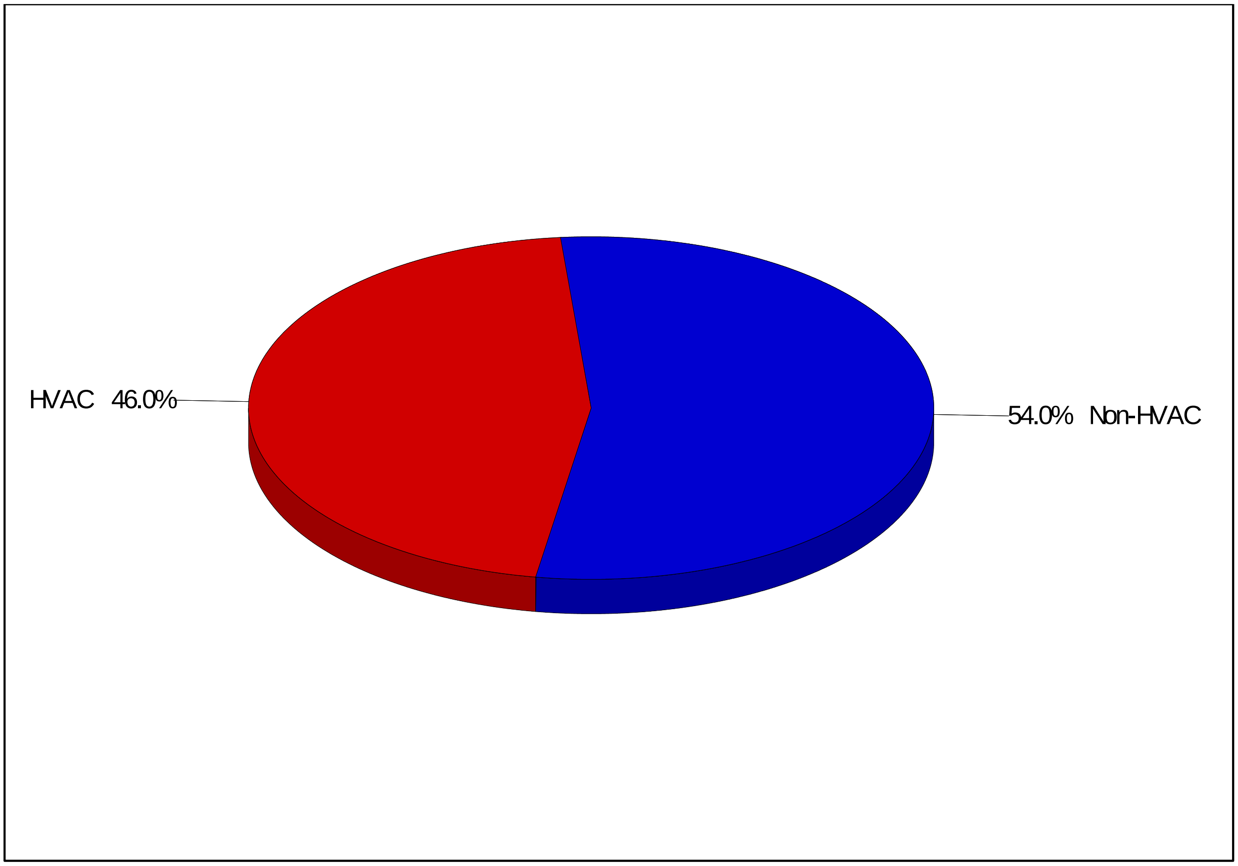
1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	121,608	4.592	46.0
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**121,608**	**4.592**	**46.0**
Non-HVAC Components			
Electric	142,637	5.386	54.0
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**142,637**	**5.386**	**54.0**
Grand Total	**264,245**	**9.979**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²

Annual HVAC & Non-HVAC Cost Totals - Baseline Margaree



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	121,607	4.592	46.0
Non-HVAC	142,640	5.387	54.0
Grand Total	**264,247**	**9.979**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	431,818	16.307
Heating Coil Loads	1,303,650	49.230
Grand Total	**1,735,468**	**65.536**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	707,694	26.725	2,527,478	95.445
Cooling	57,722	2.180	206,151	7.785
Heating	1,628,705	61.505	5,816,804	219.660
Pumps	11,222	0.424	40,080	1.514
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**2,405,343**	**90.833**	**8,590,513**	**324.403**
Lights	255,214	9.638	911,477	34.420
Electric Equipment	42,019	1.587	150,069	5.667
Misc. Electric	2,524,151	95.319	9,014,823	340.426
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**2,821,384**	**106.544**	**10,076,370**	**380.513**
Grand Total	**5,226,727**	**197.377**	**18,666,882**	**704.916**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26481.0** ft²
   Conditioned Floor Area .... **26481.0** ft²

Energy Budget by Energy Source - Baseline Margaree

1. Annual Coil Loads

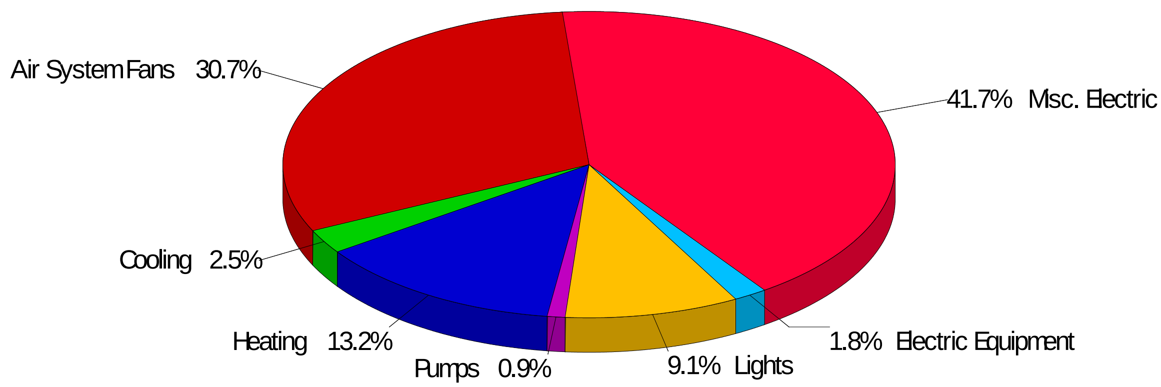
Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	431,818	16.307
Heating Coil Loads	1,303,650	49.230
Grand Total	**1,735,468**	**65.536**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	2,405,373	90.834	8,590,619	324.407
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**2,405,373**	**90.834**	**8,590,619**	**324.407**
Non-HVAC Components				
Electric	2,821,324	106.541	10,076,156	380.505
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**2,821,324**	**106.541**	**10,076,156**	**380.505**
Grand Total	**5,226,697**	**197.375**	**18,666,775**	**704.912**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26481.0** ft²
   Conditioned Floor Area .... **26481.0** ft²

Annual Component Costs - Proposed Margaree



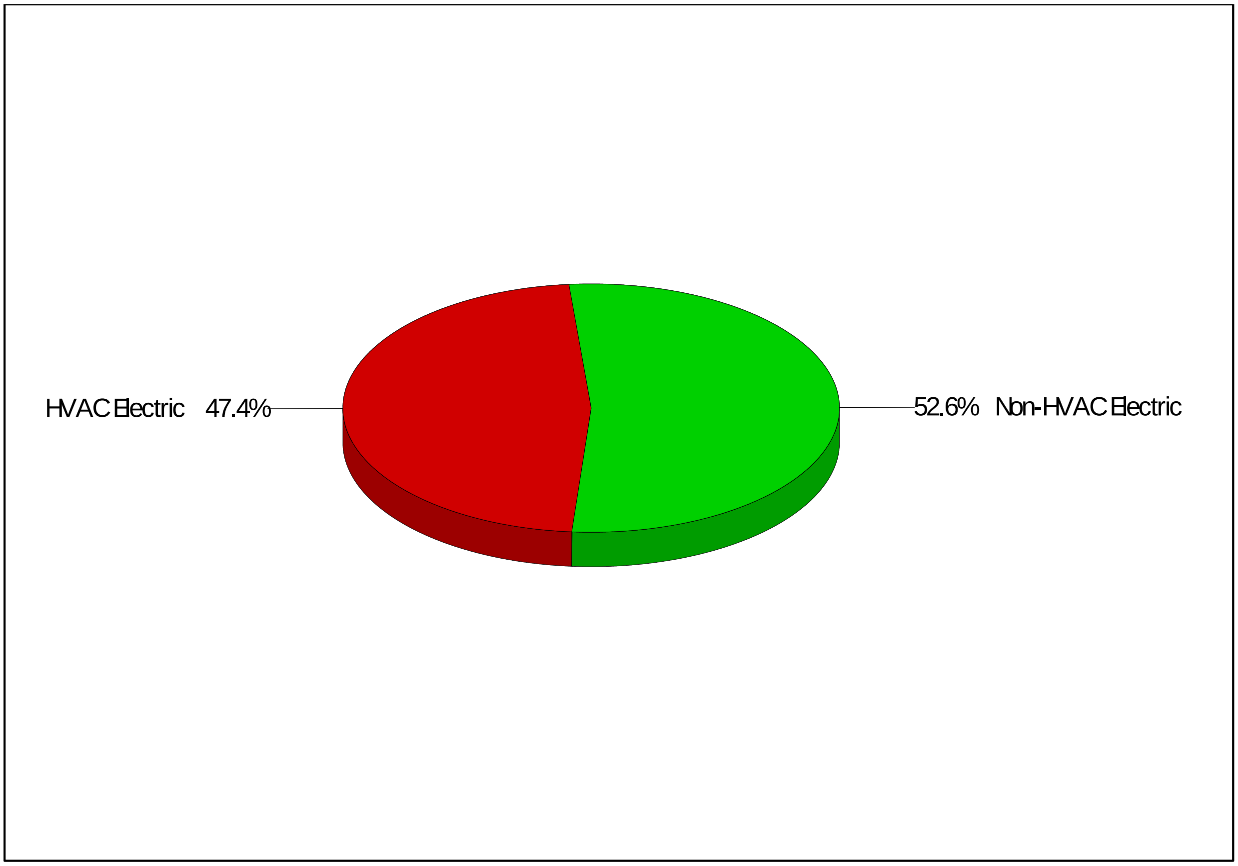
1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	36,875	1.393	30.7
Cooling	3,051	0.115	2.5
Heating	15,809	0.597	13.2
Pumps	1,135	0.043	0.9
Heat Rejection Fans	0	0.000	0.0
HVAC Sub-Total	**56,870**	**2.148**	**47.4**
Lights	10,985	0.415	9.1
Electric Equipment	2,124	0.080	1.8
Misc. Electric	50,092	1.892	41.7
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**63,201**	**2.387**	**52.6**
Grand Total	**120,071**	**4.534**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²

Annual Energy Costs - Proposed Margaree



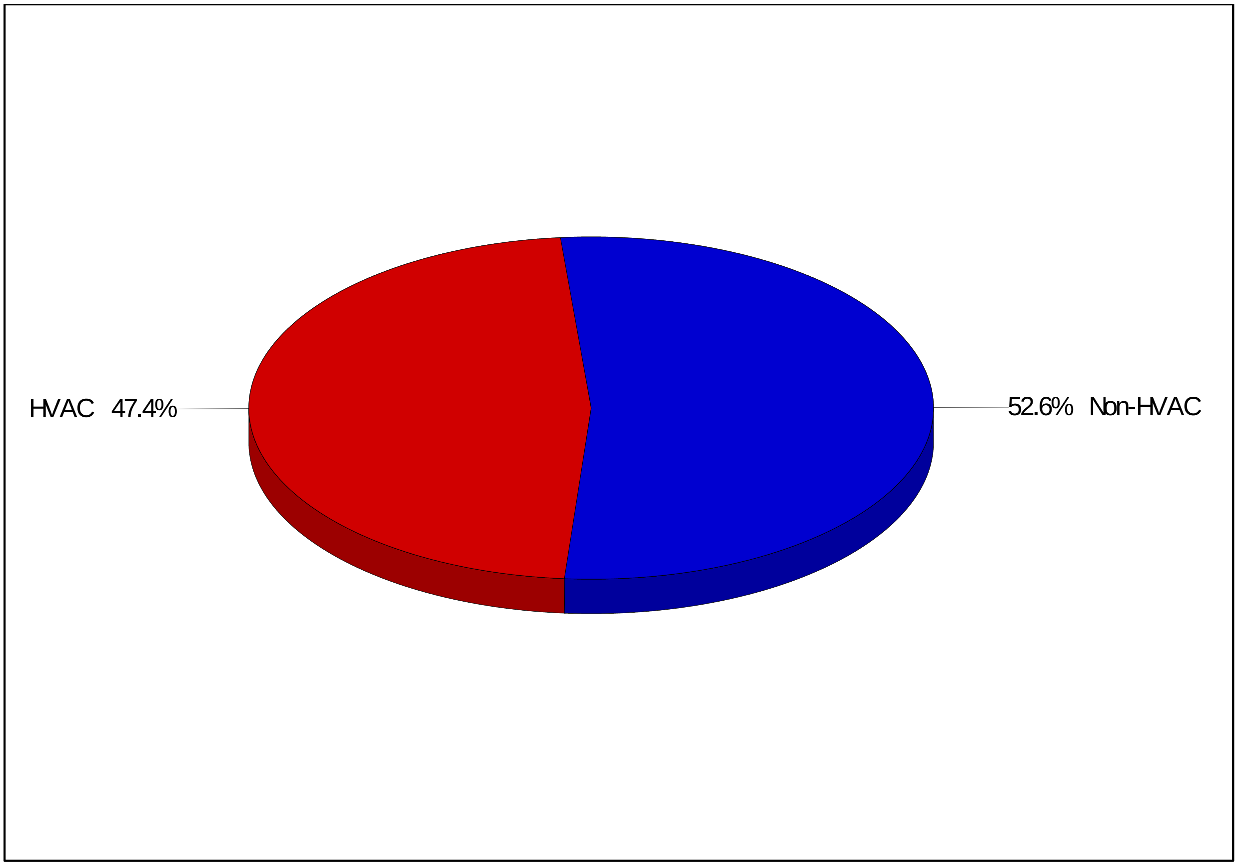
1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	56,870	2.148	47.4
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**56,870**	**2.148**	**47.4**
Non-HVAC Components			
Electric	63,203	2.387	52.6
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**63,203**	**2.387**	**52.6**
Grand Total	**120,073**	**4.534**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²

Annual HVAC & Non-HVAC Cost Totals - Proposed Margaree



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	56,870	2.148	47.4
Non-HVAC	63,201	2.387	52.6
Grand Total	**120,071**	**4.534**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26481.0** ft²
Conditioned Floor Area **26481.0** ft²

Energy Budget by System Component - Proposed Margaree

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	431,152	16.282
Heating Coil Loads	753,347	28.449
Grand Total	**1,184,498**	**44.730**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	729,373	27.543	2,604,904	98.369
Cooling	60,349	2.279	215,531	8.139
Heating	312,704	11.809	1,116,802	42.174
Pumps	22,445	0.848	80,160	3.027
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**1,124,871**	**42.478**	**4,017,396**	**151.709**
Lights	217,287	8.205	776,024	29.305
Electric Equipment	42,019	1.587	150,069	5.667
Misc. Electric	990,798	37.415	3,538,565	133.627
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**1,250,104**	**47.208**	**4,464,658**	**168.599**
Grand Total	**2,374,975**	**89.686**	**8,482,054**	**320.307**

Notes:

1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26481.0** ft²
   Conditioned Floor Area .... **26481.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	431,152	16.282
Heating Coil Loads	753,347	28.449
Grand Total	**1,184,498**	**44.730**

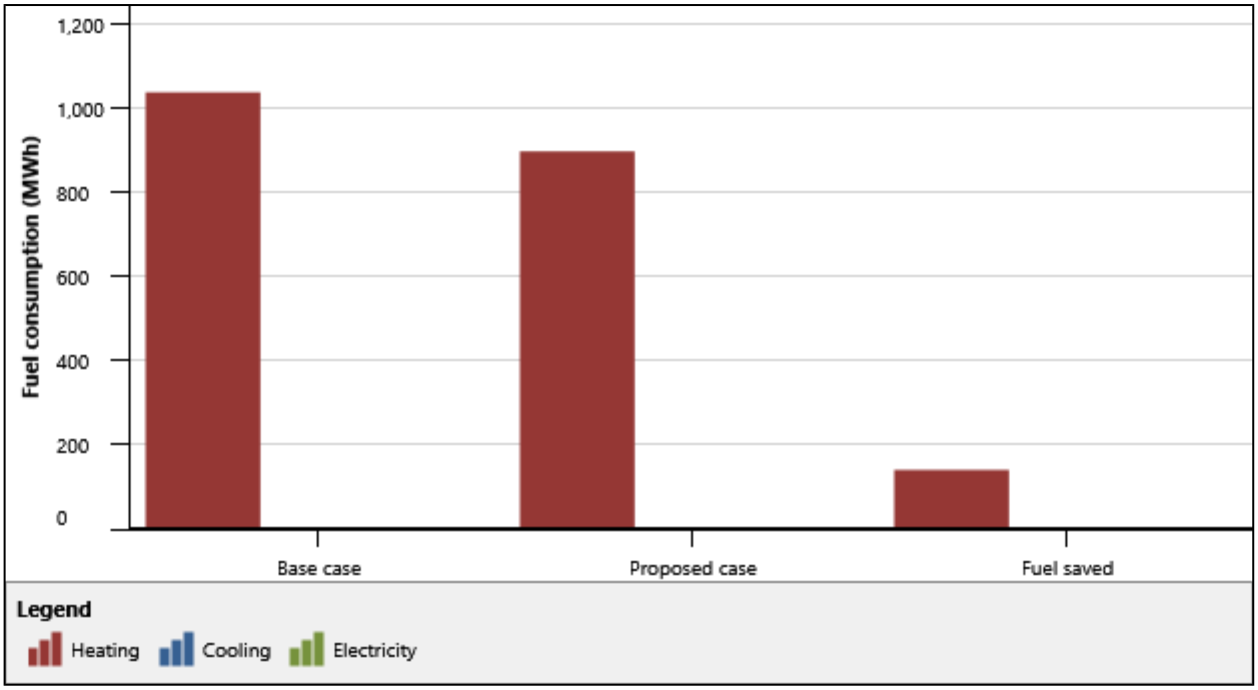
2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	1,124,874	42.479	4,017,408	151.709
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**1,124,874**	**42.479**	**4,017,408**	**151.709**
Non-HVAC Components				
Electric	1,250,131	47.209	4,464,755	168.602
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**1,250,131**	**47.209**	**4,464,755**	**168.602**
Grand Total	**2,375,006**	**89.687**	**8,482,162**	**320.311**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26481.0** ft²
   Conditioned Floor Area .... **26481.0** ft²

Energy savings | Fuel summary

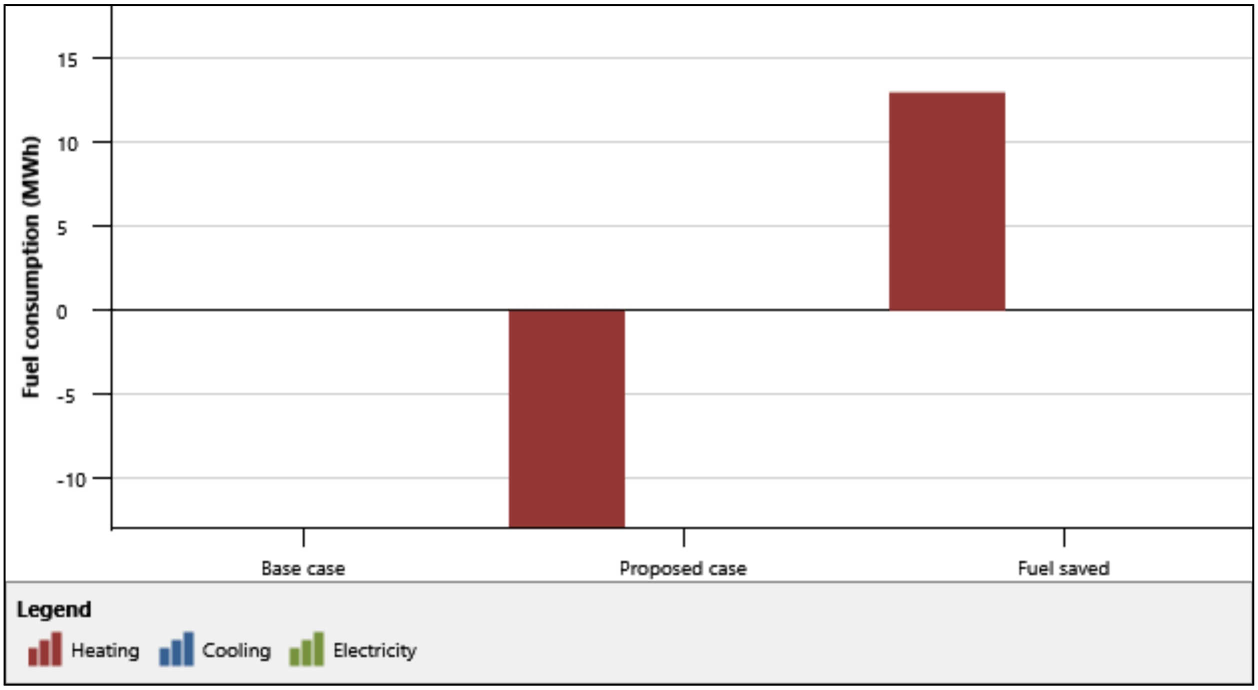
Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	1,036,252	0	0	1,036,252
Proposed case	896,039	0	0	896,039
Fuel saved	140,213	0	0	140,213
Fuel saved - percent	13.5%	0%	0%	13.5%

Energy savings | Fuel summary

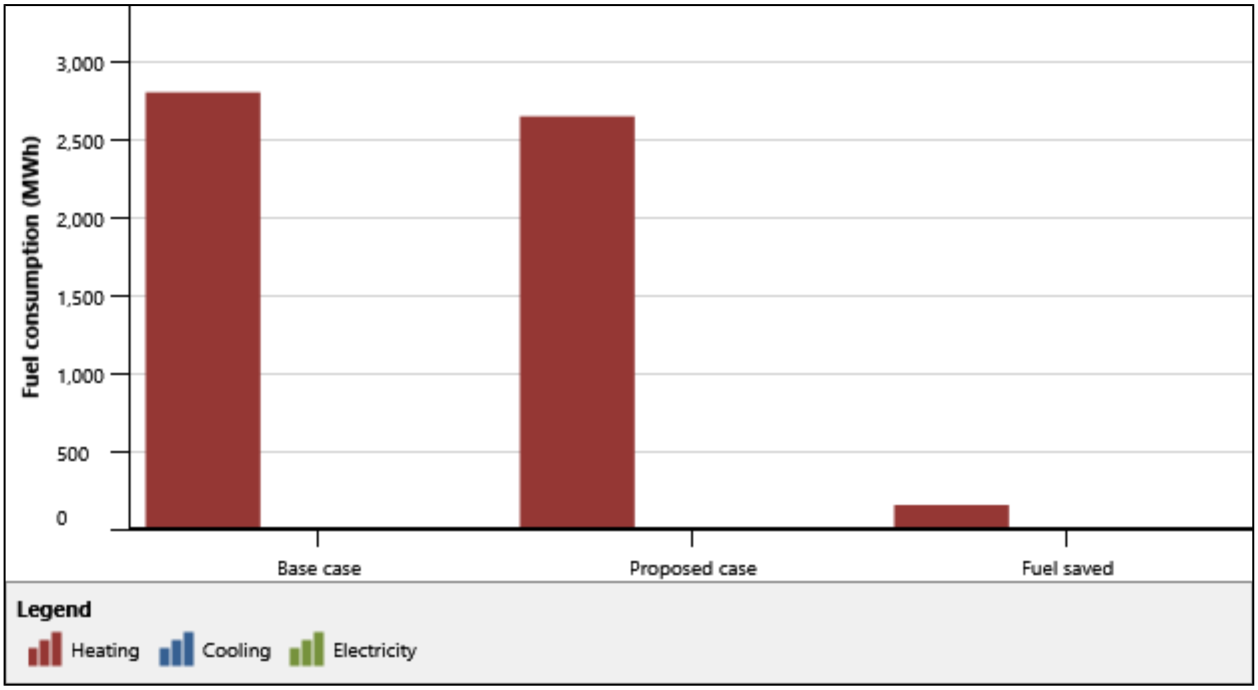
Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	0	0	0	0
Proposed case	-12,971	0	0	-12,971
Fuel saved	12,971	0	0	12,971
Fuel saved - percent	0%	0%	0%	0%

Energy savings | Fuel summary

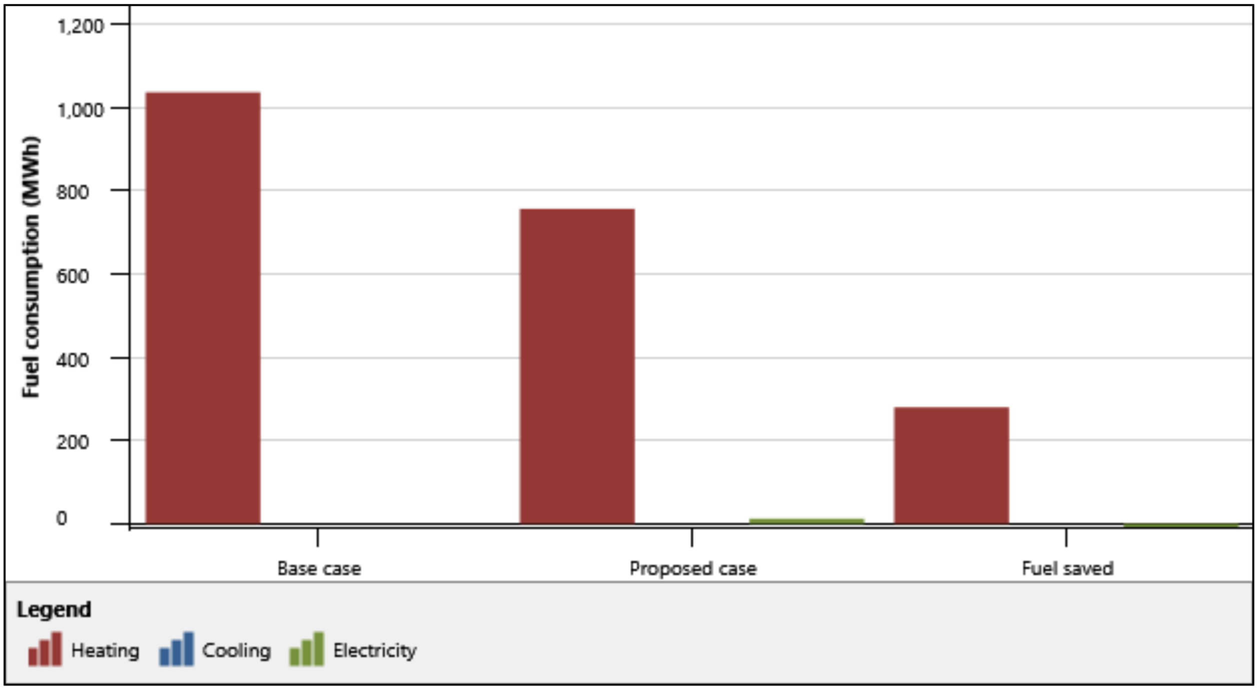
Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	2,806,551	0	0	2,806,551
Proposed case	2,652,271	0	0	2,652,271
Fuel saved	154,280	0	0	154,280
Fuel saved - percent	5.5%	0%	0%	5.5%

Energy savings | Fuel summary

Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	1,036,252	0	0	1,036,252
Proposed case	756,465	0	12,386	768,851
Fuel saved	279,787	0	-12,386	267,402
Fuel saved - percent	27%	0%	0%	25.8%

APPENDIX C

LCCA Calculations

13046.64

Margaree - Baseline

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Estimated Energy Cost ($)		$265,353	$277,704	$291,386	$306,062	$322,430	$337,209	$336,146	$344,337	$352,430	$360,487	$368,522	$376,525
Estimated Maintenance Cost ($)		$ 30,292	$30,898	$31,516	$32,146	$32,789	$33,445	$34,114	$34,796	$35,492	$36,202	$36,926	$37,665
0	$0					$0					$0		
0	$0										$0		
0	$0												
0	$0												
0	$0												
0	$0												
0	$0												
0	$0												
W	$0												
Net Annual cash flow ($)	$0	$295,645	$308,602	$322,903	$338,209	$355,219	$370,654	$370,260	$379,134	$387,923	$396,689	$405,448	$414,189
Present value of cash ($)	$0	$289,225	$295,343	$302,318	$309,772	$318,286	$324,903	$317,509	$318,057	$318,363	$318,487	$318,450	$318,250
NPV - 25yrs	**$7,259,512**												

Year #	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)	$376,625	$376,265	$375,445	$374,168	$372,435	$370,250	$367,613	$364,528	$360,995	$357,019	$352,600	$347,742	$342,446
Estimated Maintenance Cost ($)	$38,418	$39,186	$39,970	$40,769	$41,585	$42,417	$43,265	$44,130	$45,013	$45,913	$46,831	$47,768	$48,723
0			$0					$0					$0
0								$0					$0
0													$0
0													$0
0													$0
0			$0										$0
0			$0										$0
0													$0
W													$0
Net Annual cash flow ($)	$415,043	$415,451	$415,415	$414,937	$414,020	$412,666	$410,878	$408,658	$406,008	$402,932	$399,432	$395,510	$391,170
Present value of cash ($)	$311,980	$305,505	$298,844	$292,017	$285,044	$277,941	$270,727	$263,416	$256,024	$248,566	$241,056	$233,505	$225,927

NOTE:
This preliminary opinion of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trend changes, non competitive bidding situations, unforseen labour and material adjustments, and the like are beyond the control of CBCL Limited. We cannot warrant or guarantee that actual costs will not vary from the opinion provided.

5769.49

Margaree - Net Zero Ready

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)		$117,344	$122,806	$128,856	$135,347	$142,584	$149,120	$148,650	$152,272	$155,851	$159,414	$162,967	$166,506	$166,551	$166,391	$166,029	$165,464	$164,698	$163,731	$162,565	$161,201	$159,639	$157,880	$155,926	$153,778	$151,436
Estimated Maintenance Cost ($)		$ 53,596	$54,668	$55,761	$56,877	$58,014	$59,174	$60,358	$61,565	$62,796	$64,052	$65,333	$66,640	$67,973	$69,332	$70,719	$72,133	$73,576	$75,047	$76,548	$78,079	$79,641	$81,234	$82,858	$84,516	$86,206
Energy Efficiency upgrades	$3,200,000					$0					$0					$0					$0					$0
0	$0										$0										$0					$0
0	$0																									$0
0	$0																									$0
0	$0																									$0
0	$0															$0										$0
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0	$0																									$0
W	$0																									$0
Net Annual cash flow ($)	$3,200,000	$170,940	$177,474	$184,618	$192,223	$200,599	$208,294	$209,008	$213,837	$218,648	$223,466	$228,301	$233,146	$234,524	$235,724	$236,748	$237,597	$238,274	$238,779	$239,114	$239,280	$239,280	$239,114	$238,785	$238,293	$237,642
Present value of cash ($)	$3,200,000	$167,228	$169,849	$172,849	$176,061	$179,742	$182,584	$179,231	$179,389	$179,441	$179,413	$179,313	$179,142	$176,287	$173,341	$170,313	$167,212	$164,046	$160,824	$157,552	$154,237	$150,887	$147,508	$144,106	$140,686	$137,254
NPV - 25yrs	**$7,368,492**																									

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Margaree - Site #1

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Estimated Energy Cost ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)		$ 43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$52,221	$53,265	$54,330
PV system	$1,210,000					$0					$0		
String inverters	$0										$147,498		
Electrical upgrade	$50,000												
Energy Efficiency upgrades	$3,200,000												
0	$0												
0	$0												
0	$0												
0	$0												
W	$0												
Net Annual cash flow ($)	$4,460,000	$43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$199,719	$53,265	$54,330
Present value of cash ($)	$4,460,000	$42,747	$42,655	$42,563	$42,471	$42,380	$42,289	$42,198	$42,107	$42,016	$160,347	$41,836	$41,746
NPV - 25yrs	**$5,683,916**												

Year #	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$63,657	$64,930	$66,228	$67,553	$68,904	$70,282
PV system			$0					$0					$0
String inverters								$179,800					-$89,900
Electrical upgrade													$0
Energy Efficiency upgrades													$0
0													$0
0			$0										$0
0			$0										$0
0													$0
W													$0
Net Annual cash flow ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$243,456	$64,930	$66,228	$67,553	$68,904	-$19,618
Present value of cash ($)	$41,656	$41,566	$41,477	$41,387	$41,298	$41,209	$41,121	$156,929	$40,944	$40,856	$40,768	$40,680	-$11,331

NOTE:
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Margaree - Site #2

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)		$ 43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$52,221	$53,265	$54,330	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$63,657	$64,930	$66,228	$67,553	$68,904	$70,282
PV system	$1,210,000					$0					$0					$0					$0					$0
String inverters	$0										$147,498										$179,800					-$89,900
Electrical upgrade	$10,000																									$0
Energy Efficiency upgrades	$3,200,000																									$0
0	$0																									$0
0	$0															$0										$0
0	$0															$0										$0
0	$0																									$0
W	$0																									$0
Net Annual cash flow ($)	$4,420,000	$43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$199,719	$53,265	$54,330	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$243,456	$64,930	$66,228	$67,553	$68,904	-$19,618
Present value of cash ($)	$4,420,000	$42,747	$42,655	$42,563	$42,471	$42,380	$42,289	$42,198	$42,107	$42,016	$160,347	$41,836	$41,746	$41,656	$41,566	$41,477	$41,387	$41,298	$41,209	$41,121	$156,929	$40,944	$40,856	$40,768	$40,680	-$11,331
NPV - 25yrs	**$5,643,916**																									

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Margaree - Site #3

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Estimated Energy Cost ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)		$ 43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$52,221	$53,265	$54,330
PV system	$1,210,000					$0					$0		
String inverters	$0										$147,498		
Electrical upgrade	$40,000												
Energy Efficiency upgrades	$3,200,000												
0	$0												
0	$0												
0	$0												
0	$0												
W	$0												
Net Annual cash flow ($)	$4,450,000	$43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$199,719	$53,265	$54,330
Present value of cash ($)	$4,450,000	$42,747	$42,655	$42,563	$42,471	$42,380	$42,289	$42,198	$42,107	$42,016	$160,347	$41,836	$41,746
NPV - 25yrs	**$5,673,916**												

Year #	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$63,657	$64,930	$66,228	$67,553	$68,904	$70,282
PV system			$0					$0					$0
String inverters								$179,800					-$89,900
Electrical upgrade													$0
Energy Efficiency upgrades													$0
0													$0
0			$0										$0
0			$0										$0
0													$0
W													$0
Net Annual cash flow ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$243,456	$64,930	$66,228	$67,553	$68,904	-$19,618
Present value of cash ($)	$41,656	$41,566	$41,477	$41,387	$41,298	$41,209	$41,121	$156,929	$40,944	$40,856	$40,768	$40,680	-$11,331

NOTE:
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Margaree - Site #4

Year #	0	1	2	3	4	5	6	7	8	9	10	11	12
Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Estimated Energy Cost ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)		$ 43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$52,221	$53,265	$54,330
PV system	$1,210,000					$0					$0		
String inverters	$0										$147,498		
Electrical upgrade	$0												
Energy Efficiency upgrades	$3,200,000												
0	$0												
0	$0												
0	$0												
0	$0												
W	$0												
Net Annual cash flow ($)	$4,410,000	$43,696	$44,570	$45,461	$46,370	$47,298	$48,244	$49,209	$50,193	$51,197	$199,719	$53,265	$54,330
Present value of cash ($)	$4,410,000	$42,747	$42,655	$42,563	$42,471	$42,380	$42,289	$42,198	$42,107	$42,016	$160,347	$41,836	$41,746
NPV - 25yrs	**$5,633,916**												

Year #	13	14	15	16	17	18	19	20	21	22	23	24	25
Year	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Estimated Energy Cost ($)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estimated Maintenance Cost ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$63,657	$64,930	$66,228	$67,553	$68,904	$70,282
PV system			$0					$0					$0
String inverters								$179,800					-$89,900
Electrical upgrade													$0
Energy Efficiency upgrades													$0
0													$0
0			$0										$0
0			$0										$0
0													$0
W													$0
Net Annual cash flow ($)	$55,417	$56,525	$57,656	$58,809	$59,985	$61,185	$62,408	$243,456	$64,930	$66,228	$67,553	$68,904	-$19,618
Present value of cash ($)	$41,656	$41,566	$41,477	$41,387	$41,298	$41,209	$41,121	$156,929	$40,944	$40,856	$40,768	$40,680	-$11,331

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