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ADDENDUM

Request for Expression of Interest

Land Development at Former Fabrication Yard, Borden-Carleton, PEI

Solicitation Number – PEIG-5672

ADDENDUM #1	Date: March 15, 2021	Page 1 of 1

The following amendment to the Expression of Interest documents is effective immediately. The addendum shall form part of the proponent's submission.

Item	Description
A-1	The Renewable Energy Feasibility Study report is attached to provide background information on the site as it relates to renewable energy. The work presented in this report represents the best efforts and judgement of the authors based on the information available at the time this report was prepared. The report is **INFORMATION ONLY** and Finance PEI is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report.

- End of Addendum -

Report

RENEWABLE ENERGY FEASIBILITY STUDY: FORMER STRAIT CROSSING FABRICATION YARD

BORDEN-CARLETON

PRINCE EDWARD ISLAND

Presented to

financepei

MARCH 25, 2018

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1 Disclaimer

This report was prepared by Richardson Associates (1993) Limited ("Richardson") and Compass Renewable Energy Consulting Inc. ("Compass") exclusively for the benefit and use of Finance PEI. The work presented in this report represents our best efforts and judgments based on the information available at the time this report was prepared. Richardson and Compass are not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. Richardson and Compass makes no representations or warranties, expressed or implied. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

2 Executive Summary

The Province of Prince Edward Island (PEI) is a Canadian leader with respect to the penetration of wind energy as a percentage of its total annual electricity demand. Approximately 25 percent of the province's electrical needs are met by wind, the highest of any jurisdiction in North America.1 Further, PEI's Provincial Energy Strategy looks to expand the role of renewable energy in its energy mix, including the development of additional wind power and the exploration of utility scale solar power.

The former strait fabrication yard located in Borden is currently underutilized and presents good potential for wind and/or solar redevelopment due to its south facing orientation and proximity to Maritime Electric's current generating station, electrical distribution grid as well as the recently upgraded transmission interconnection with New Brunswick.

Consistent with the Province of PEI's continued commitment to renewable energy, Finance PEI engaged Richardson and Compass to conduct a feasibility study to determine the viability for the installation of wind and/or solar system at the former fabrication yard located in Borden, PEI.

This feasibility assessment considers technological, site and financial considerations. From a technical perspective, there are few limitations. Wind, solar and energy storage could all be employed. The proximity to the electrical grid and the interconnection with New Brunswick improve the suitability and reduce electrical connection costs. Each of the technologies have different characteristics providing for different cost and benefits. Combining the use of wind, solar and storage are all possible, however there are trade offs. For example, combining solar and wind on the site, would mean less room for solar panels and potentially impact the per unit cost, while using only wind could result in lower remediation costs.

The site currently has the remnants of the former fabrication yard including concrete columns and concrete pads. From a site constraints perspective, the development of solar or storage is generally not constrained, however, the *Planning Act* limitations on the siting of wind turbines would result in only a small area of the current site that would allow for wind turbines and therefore it would have to be a single turbine site. Further, this analysis does not account for the potential impacts of a municipal by-law like the one adopted in Eastern Kings County, which restricts the development of wind turbines close to the shoreline and within proximity to non-participating neighbours. Should such a by-law be passed in Borden Carleton, this would restrict the feasibility of a wind development on this site.
Battery storage, either lithium ion or flow battery, solutions could also be used, but would provide different benefits than compressed air energy storage and would not serve as a replacement for back up thermal generation that is currently maintained by Maritime Electric.

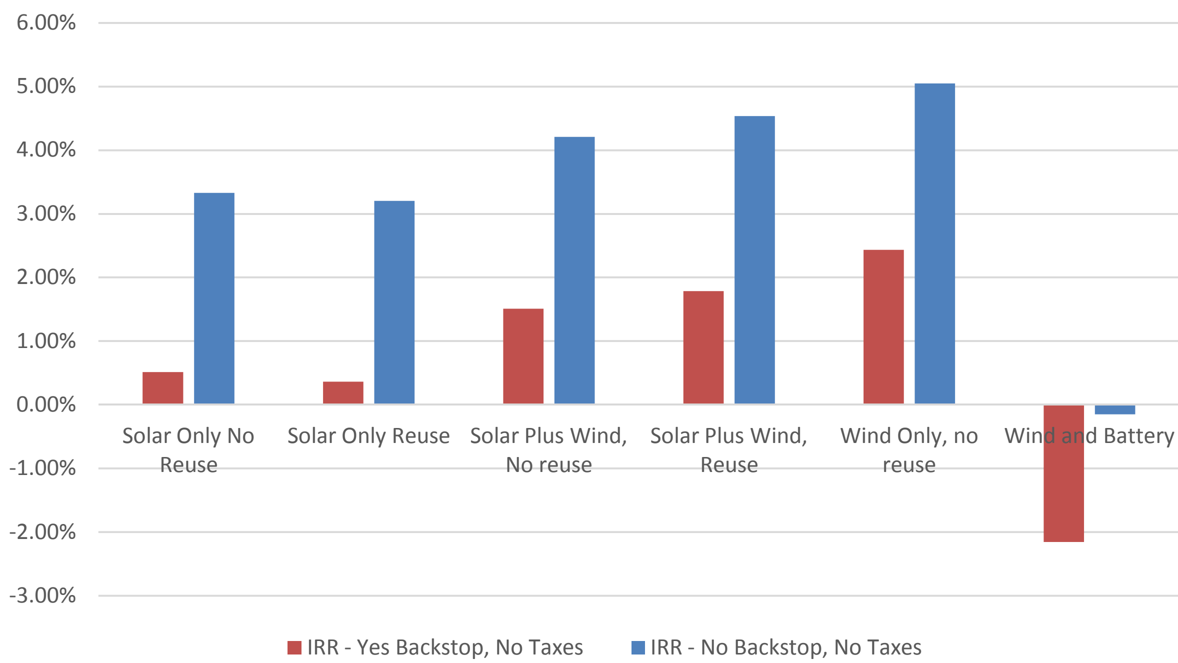
The costs of these technologies are evolving and generally decreasing over time. All benefit from technological improvements as well as economies of scale as global demand for renewable energy and storage has increased. Solar costs have had the most dramatic declines, while wind power has benefit

[1] PEI Provincial Energy Strategy 2016/2017, accessed on line, August 15, 2017, http://www.peiec.ca/uploads/6/6/6/4/66648535/pei_energy_strategy_march2017_web.pdf

from improved energy production while costs and moderate cost declines. Battery storage costs are also declining where compressed air storage costs are very site and size specific.

Six options to install solar, solar and wind or battery storage solutions were costed, and investment returns calculated using a discounted cashflow model. The value of the energy produced, and capacity provided was accounted for as well as operating, financing and load following, or backstop costs charged by New Brunswick power. The internal rates of return (IRR) were compared for these scenarios assuming that the entity that owned them did not pay corporate income tax. A summary of the investment opportunities is presented in Figure 1 below. For each technology option show below, two scenarios are shown. 1) Where backstop charges of $15 USD/MWh are charged to the project and 2) With no backstop charges. As shown, all deployment scenarios have IRRs ranging from -2 to 5%.

Figure 1 – Summary of Deployment Scenario Internal Rate of Returns



The low IRRs are due to a combination of factors including *Planning Act* restrictions on siting of wind turbines, backstop charges paid to New Brunswick Power and costs of site remediation. In absence of these constraints, the IRR for a two-turbine site would be just under 10%, again assuming no debt.

While not the focus of this study, the decision to invest in a renewable and or storage solution may account for non-economic factors that are not discussed above, such as diversity of supply and the green-house-gas benefits of avoiding use of the diesel-powered combustion turbines currently used on PEI.

3 Technology Considerations

This section of the report describes the solar, wind development and storage opportunities at the former fabrication yard.

Deliverables:

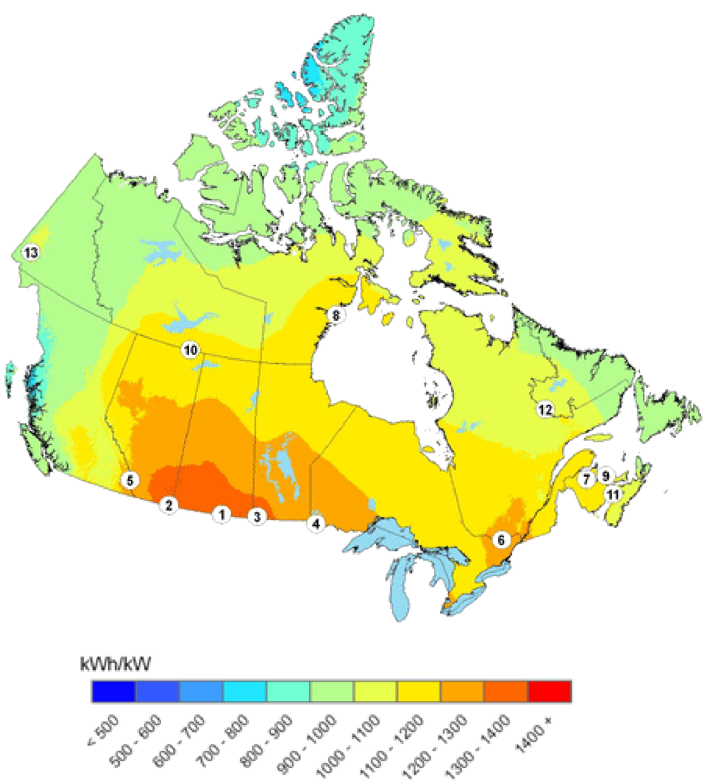
- **D 1 -** Description and discussions regarding renewable energy opportunities.
- **D 2** - Description and discussions regarding the opportunities for utility scale energy storage technologies and facilities.

3.1 Solar Photovoltaic Technology

3.1.1 Solar Resource

PEI has limited solar penetration relative to many parts in Canada. Natural Resources Canada reports that PEI has 400 kW of solar PV installed at the end of 2016.[2] However, PEI's solar resource is on par with most of Ontario, where the majority of Canada's solar development has occurred but lower than Canada's best solar destinations located in the southern part of the prairie provinces, as shown in Figure 2 below.

Figure 2 – Canadian Solar Resource Map & Provincial Hotspots (Annual kWh/kW)



1 Regway SK, 1384
2 Wild Horse AB, 1373
3 Waskada MB, 1370
4 Rainy River ON, 1265
5 Elkford BC, 1236
6 Quyon QC, 1208
7 Chatham NB, 1168
8 Chesterfield Inlet NU, 1158
9 Miminegash PE, 1136
10 Fort Smith NT, 1126
11 Amherst NS, 1125
12 Wabush NF, 1074
13 Burwash Landing YT, 1056

Source: Natural Resources Canada

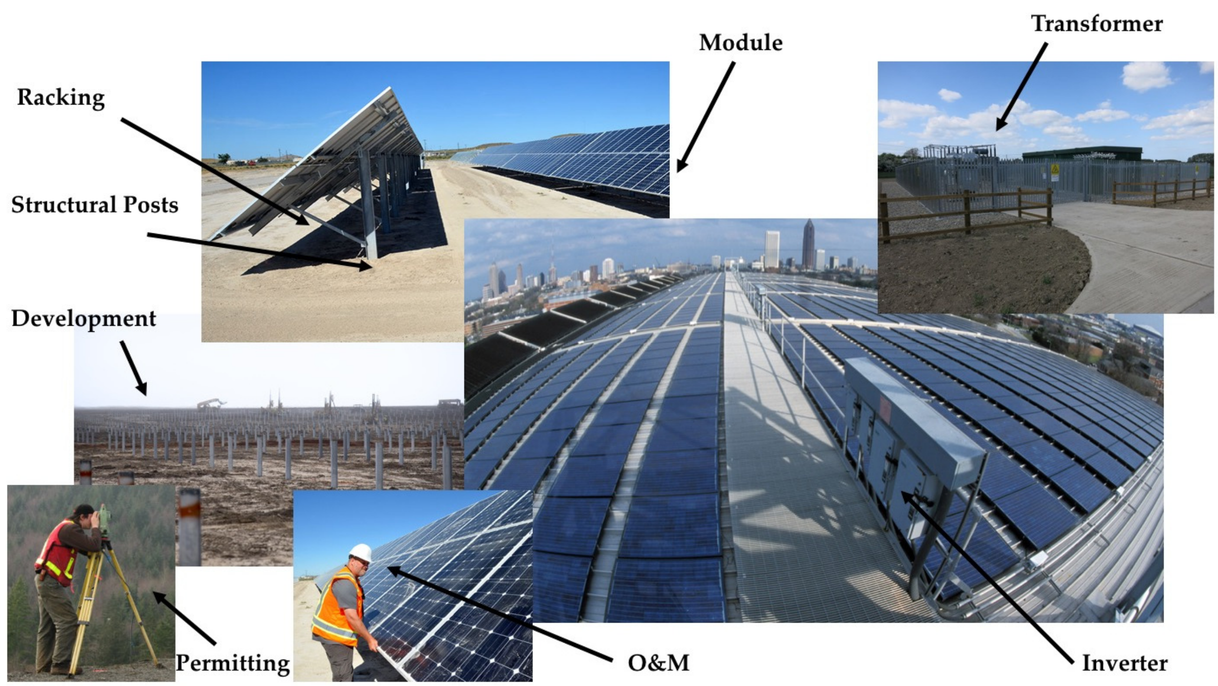
[2] Natural Resources Canada, *National Survey Report of PV Power Applications in Canada 2016*, accessed on line, December 22, 2017, file:///D:/National_Survey_Report_of_PV_Power_Applications_in_Canada_-_2016%20(1).pdf

3.1.2 Technology Overview

Solar photovoltaic (PV) technologies directly convert sunlight into electricity through the photoelectric effect. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the *PV effect*. PV technologies are defined as a solid-state technology that directly converts incident solar radiation into electrical energy.

A PV system is comprised of the PV modules connected together to form arrays, an inverter box for power conversion (i.e., from DC to AC), and other balance of plant such as various mounting systems and in some instances trackers, which move the modules throughout the day to maximize solar generation.

Figure 3 – Images of Solar Supply Chain



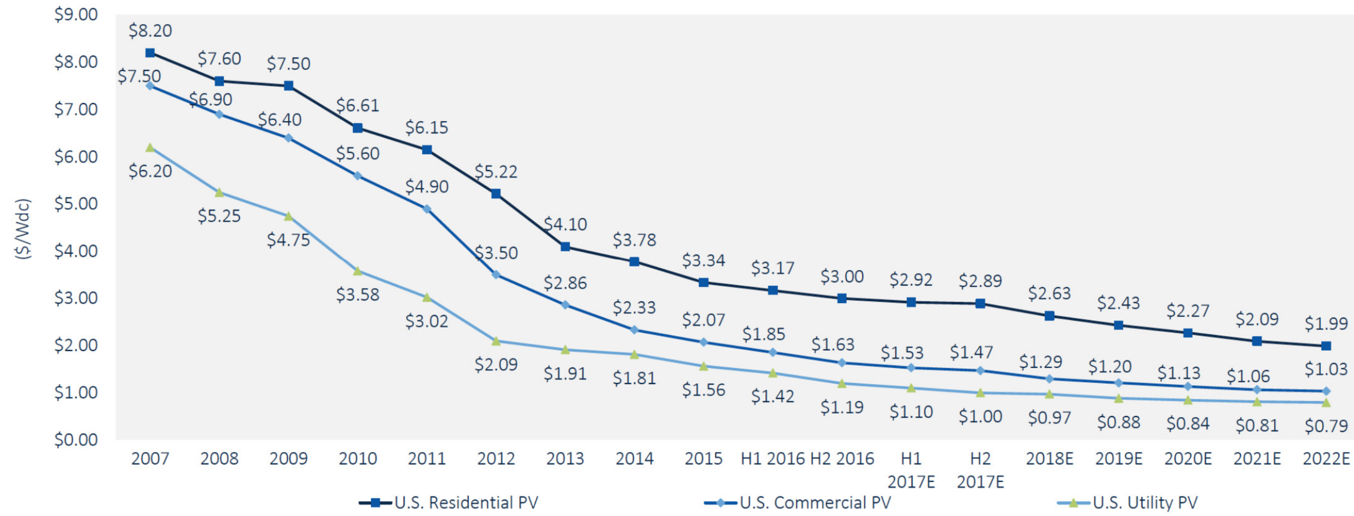
One of the key features of solar PV is that it is scalable and the same technology configuration can be used for micro scale applications, like residential homes, commercial scale, building rooftops, and utility scale, large ground mounted solar farms. This scalability also allows solar PV to be located at the same location as electrical loads avoiding transmission and distribution losses associated with centralized electricity generation.

Solar tracking technology moves a module or array of modules along either one or two axes in order to follow the sun and improve electrical production. As the cost of solar trackers falls and the systems prove to be increasingly reliable, they are taking a greater share of the utility scale solar market.

3.1.3 Solar Cost Evolution

While both solar and wind costs have been and are declining, the historical cost trajectory for solar has been dramatic. GTM Research predicts global average solar project prices to fall a further 27% by 2022, or 4.4% a year. Moreover, they expect the average system price in the U.S. to fall by 31% in that same period (see Figure 4).

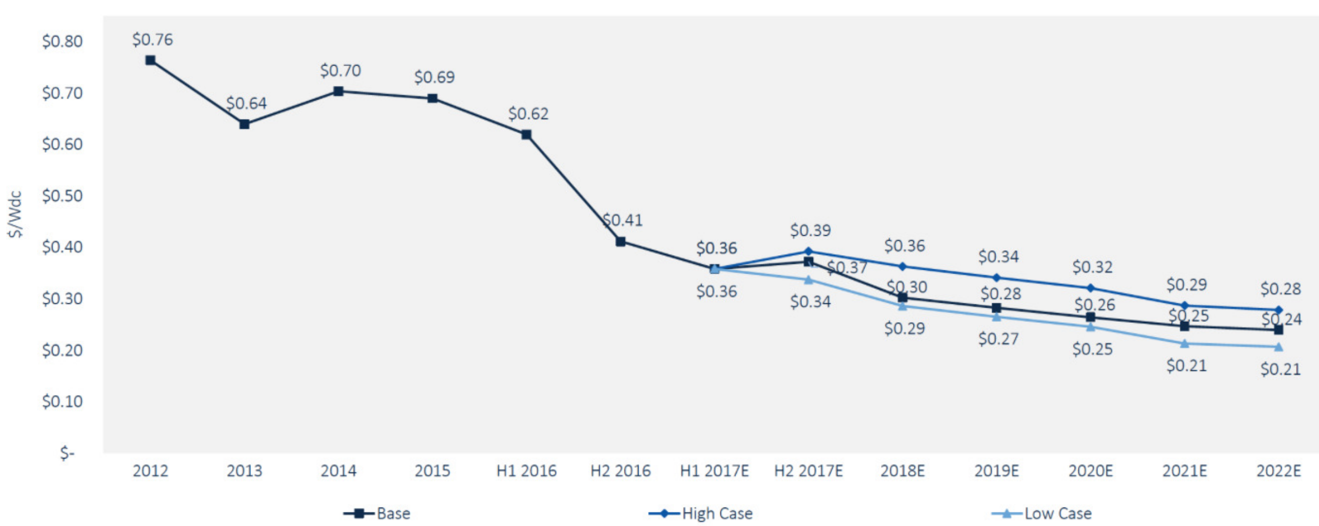
Figure 4 - Historical and Forecast Solar PV Pricing in the U.S., 2007 – 2022 (USD $/Wdc)



Source: GTM Research

Solar system cost reductions have many drivers. In recent years, the primary driver has been the cost per watt of modules. Solar modules have not only become cheaper per watt, but they have increased their efficiency so that modules are also have a higher power rating, reducing the number of modules and associated balance of plant costs. Between 2016 and 2017, a global oversupply of modules caused prices to drop by over 40% (see Figure 5).

Figure 5 - Historical and Forecast PV Module Pricing in the U.S. 2012-2022



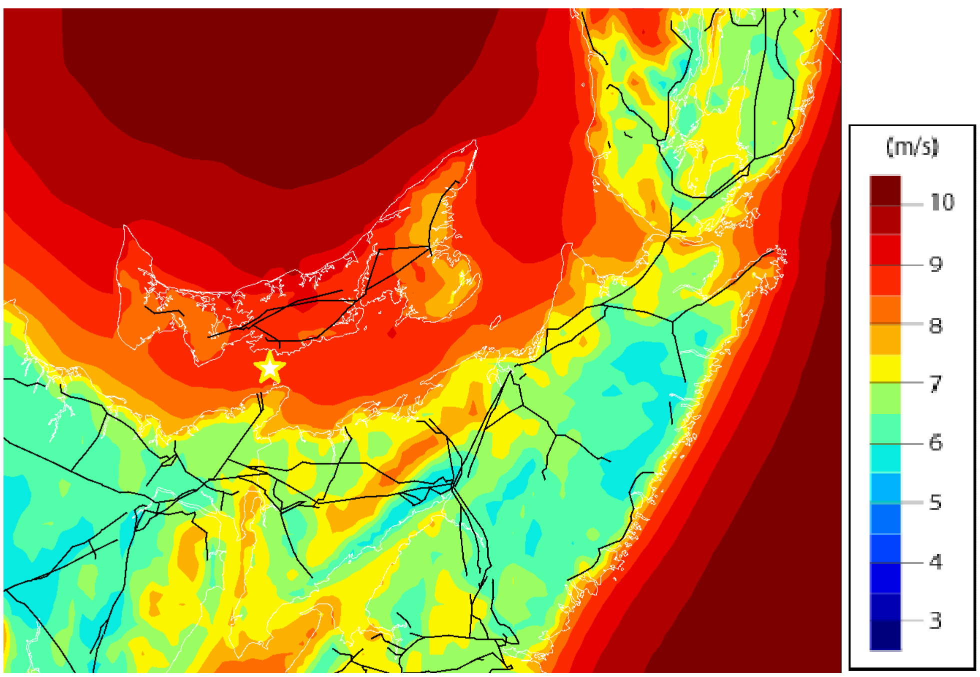
Inverter prices (again, expressed in dollars per watt) have also decreased. Improved installation methods and racking technology has helped, as has economies of scale that allow for cheaper and more integrated sales, marketing, and installation processes.

3.2 Wind Technology

3.2.1 Wind Resource

As described above, PEI has a long history in the development and deployment of wind energy. PEI has some of the best wind resources available in Canada. The Borden site, shown in Figure 6 below, has average wind speeds of 8.5 m/s at an 80-metre hub height, based on Government of Canada's Wind Energy Atlas. Today's turbines would exceed 100 metre hub height, and have higher wind speeds and associated energy production.

Figure 6 – PEI and Borden Annual Mean Wind Speed (metres/second)[3]



3.2.2 Technology Overview

Wind turbines transform the linear motion of the air into the rotation of the turbine blades, which drives a generator to produce electricity. The most common wind turbines use three blades around a horizontal axis and employ a gear box that converts the rotor motion of 18-50 rpm into the approximately 1,500 – 1,800 rpm which the generator requires. The nacelle, which houses the generator, rotates so that the turbine will face into the wind.

[3] Canadian Wind Energy Atlas, http://www.windatlas.ca/nav-en.php?field=EU&height=80&season=ANU&lignes=1&lat=46.245129&lon=-63.682697&postal=&no=12

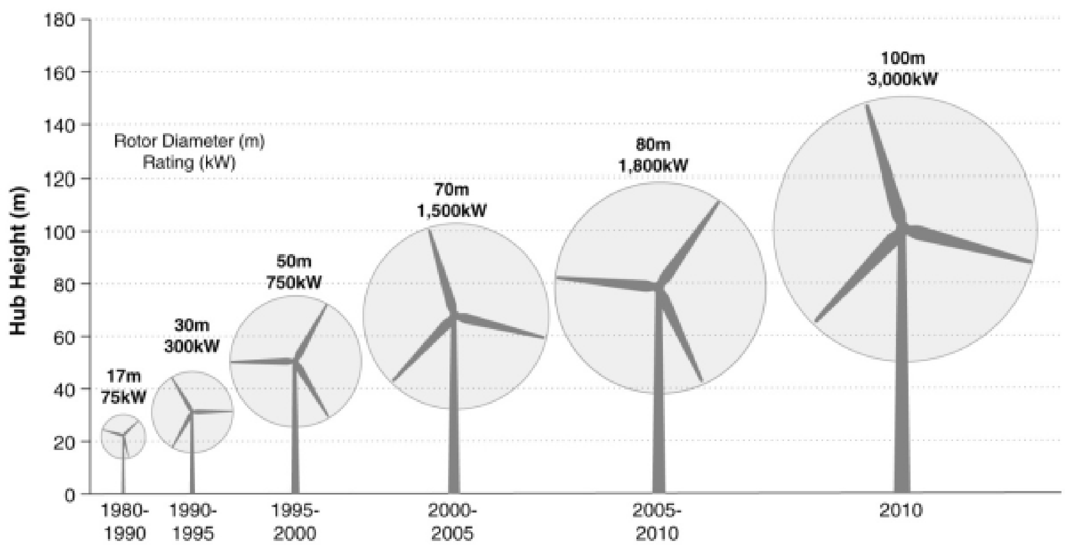
The energy output of a wind turbine is proportional to the swept area of the blades. Doubling the size of the blade increases the swept area by a factor of four. The dependency on wind speed is even stronger—doubling the average wind speed increases the output by a factor of eight.

The energy in the wind turns propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Both vertical and horizontal axis wind turbine designs are used but horizontal turbines are exclusively used in utility scale applications.

3.2.3 Wind Technology Evolution

Advances in wind technology include increasing tower heights and turbine sizes from a few hundred kilowatts to multiple megawatts; high-technology composite blade materials to increase endurance and reduce weight; variable-pitch blades and variable rotational speeds to maximize energy output; and improvements in the gearing and power electronics to raise efficiency. Figure 7 presents an evolution of wind turbine sizes and capacity from 1980 to 2010.

Figure 7 – Evolution of representative turbine architecture

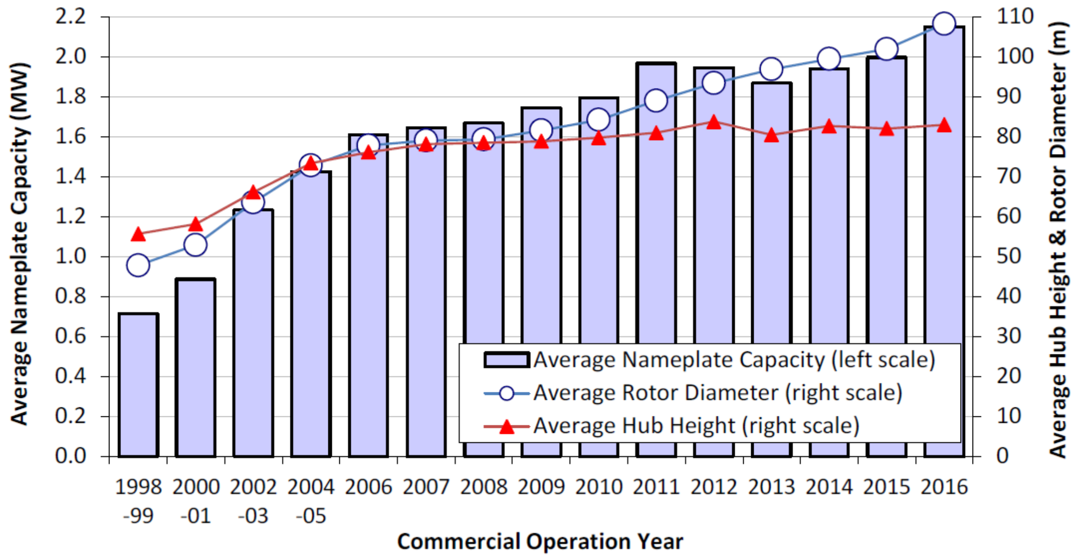


Source: National Renewable Energy Laboratory

By increasing both the swept area of the blades and the hub height, turbines are able to achieve a lower cost per unit of delivered energy. The larger the swept area, the more wind energy that can be converted to electricity. In addition, the wind resource improves at higher hub heights, improving the annual capacity factor.

Figure 8 shows the increase in average annual nameplate capacity, hub height and rotor diameter for U.S. based projects, which all show a steady increase over time.

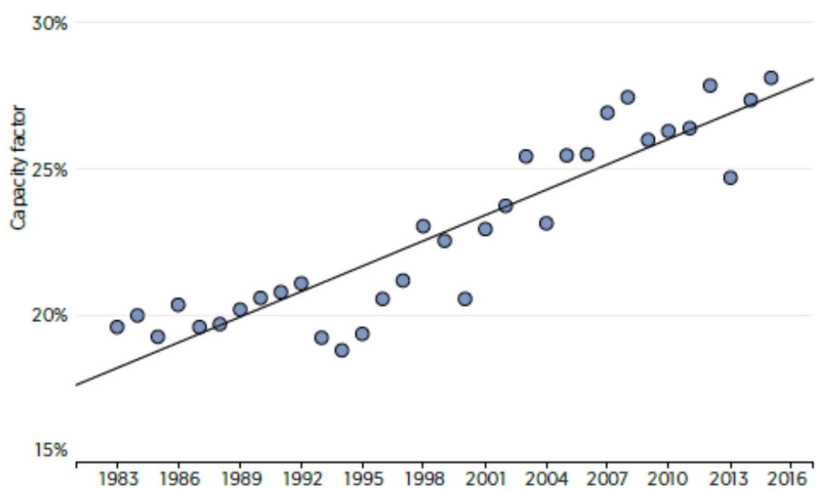
Figure 8 - Onshore Turbine Scaling in U.S.



Source: Lawrence Berkeley National Laborites

These increases in hub height and rotor diameter have resulted in increased capacity factors, see Figure 9. PEI has a strong wind resource relative to most global applications and would be expected to have commensurately better capacity factors, ranging from 35 to 40%.

Figure 9 - Global Weighted Average Capacity Factors for New Onshore Wind Power Capacity Additions, 1983 - 2014

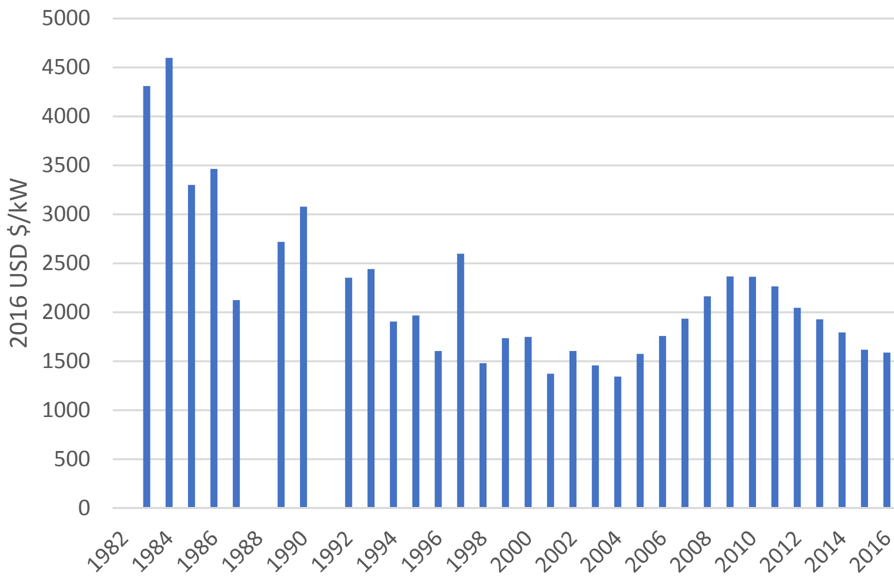


Source: IRENA Renewable Cost Database.

3.2.4 Wind Cost Evolution

The improvements in wind power technology have resulted in lower installed costs over time, as shown in Figure 10. Although based on U.S. data, the trend for costs would be very similar in Canada and PEI.

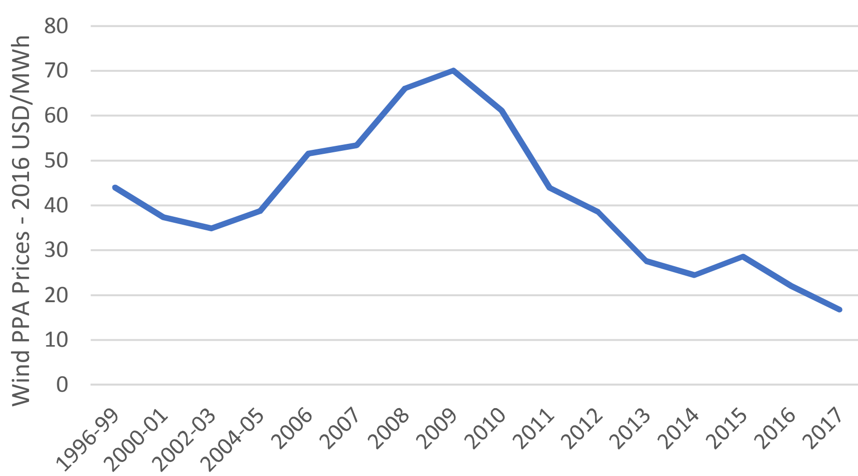
Figure 10 – Installed Wind Power Costs in the U.S.[6]



Source: U.S. Department of Energy

These reductions in capital costs combined with increases in capacity factor are resulting in lower overall costs, which are represented in power purchase agreement (PPA) rates falling over time in the U.S., see Figure 11.

Figure 11 – U.S. PPA Rate (2016 $/MWh)[7]

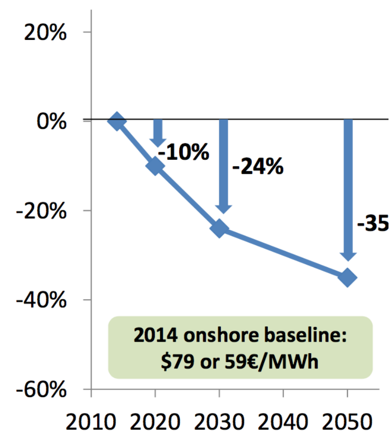


[6] U.S. Department of Energy, *2016 Wind Technology Report*, accessed on line, August 25, 2017, https://energy.gov/eere/wind/downloads/2016-wind-technologies-market-report

[7] Note that the PPA rates used in this graph account for state and federal level incentives and are not reflective of Canadian based PPA rates, but the trend is consistent.

Wind power cost reductions are expected to continue. A 2016 survey by Lawrence Berkeley National Laboratory (LBNL) found that industry and experts expected an average 10% drop in on-shore wind installations costs internationally by 2020, as compared to those in 2014, see Figure 12.

Figure 12 - Predicted Levelized Cost of Energy Reductions in Onshore Wind



Source: LBNL

3.2.5 Co-Location of Wind and Solar

Co-locating wind and solar on the same site can realize savings to both systems. A recent study by AECOM for the Australian Renewable Energy Agency found the potential savings could be as large as 3 – 13% in capital expenditures and 3 – 16% in operating expenditures as they would share common infrastructure investments associated with electrical interconnection as well as civil construction requirements, and operating efficiencies.

The combined solar and wind installation would also have a firmer daily energy production, with solar providing additional energy production during the day. There is also seasonal anti-correlation between wind and solar – solar produces more in the summer and wind in the winter. The Australian study found that a solar farm sized between 25 – 50% of a host wind farm would only increase energy output curtailment by 5%. These characteristics could also reduce the cost and size of a storage system for a given level of output firming or other desired characteristics.

It is possible that co-location could affect the efficiency of each technology separately from considerations around the optimum spacing and placement of solar and wind components. Solar PV reduces its efficiency if it is shaded and therefore collocating with a wind turbine would reduce the size of the solar system that could be used on the former fabrication yard. Further, falling ice from the wind turbines would need to be factored into locating any solar modules in close proximity to wind turbines.

3.3 Storage Opportunities

Renewable energy technology provides the distinct benefit of producing power without any fuel costs and relatively low maintenance costs. However, it challenges grid operators due to its intermittency, where it only produces when the resource is available (i.e. sunny or windy). Energy storage represents a way to address this fundamental challenge in the greater deployment of renewable energy. In addition, it can provide many services that electricity grid operators require with or without renewable energy penetration on the grid.

In PEI, electrical storage has the potential to make better use of existing renewable generation and enable a more cost effective build out of new renewables. It can improve local grid stability issues (i.e. storage that is more power quality oriented) and smooth out spikes and troughs in electricity prices on longer time scales (i.e. storage that is more energy price oriented). Different technologies provide different combinations of power, energy, response time, durability etc.

3.3.1 Energy Storage Value Proposition

In general, storage used to shift renewable generation output in a large-scale deployment can provide the following grid benefits and value streams:

- Voltage support and grid stabilization
- Reduce transmission losses
- Reduce grid congestion
- Increase system reliability
- Defer transmission investment
- Optimize renewable-related transmission
- Provide system capacity and resource adequacy

A combination of these different value streams can be captured depending on the site specific conditions. For example, energy storage at the Borden site could reduce transmission losses in some instances and provide system capacity and resource adequacy, but it would not reduce grid congestion or defer transmission investment. It is also important to note that the renewable generation to be shifted could be generated on-site or could be from installations connected to the transmission system elsewhere.

3.3.2 Energy Storage Technology Options

The Borden Carleton site could be particularly well suited for one of four energy storage technologies:

- Compressed Air Energy Storage (CAES)
- Lithium Ion battery storage (Li-ion)
- Flywheel
- Thermal

3.3.2.1 Compressed Air Energy Storage

Conventional CAES consumes electricity to compress air into a cavern or space under pressure; it is then released to assist in driving a gas-fired turbine. In traditional CAES systems, natural gas is required to develop sufficient heat to drive the turbine, with the compressed air assisting in this. Hydrostor, a storage technology provider, utilizes an adiabatic storage process (A-CAES), where heat is stored separately from the compressed air in a cavern, which can be located under water or underground, and then released along with the air. In this way, by storing the heat created during the compression of the air and reusing during the generation of electricity, it eliminates the need for natural gas to power the turbine.

Figure 13 and Figure 14 provide an overview of different A-CAES configurations that are being offered by Hydrostor. There is a 2 MW underwater A-CAES system installed in Lake Ontario connected to Toronto Hydro's grid in Toronto, Ontario.

Figure 13 - Hydrostor Underwater A-CAES Storage Process

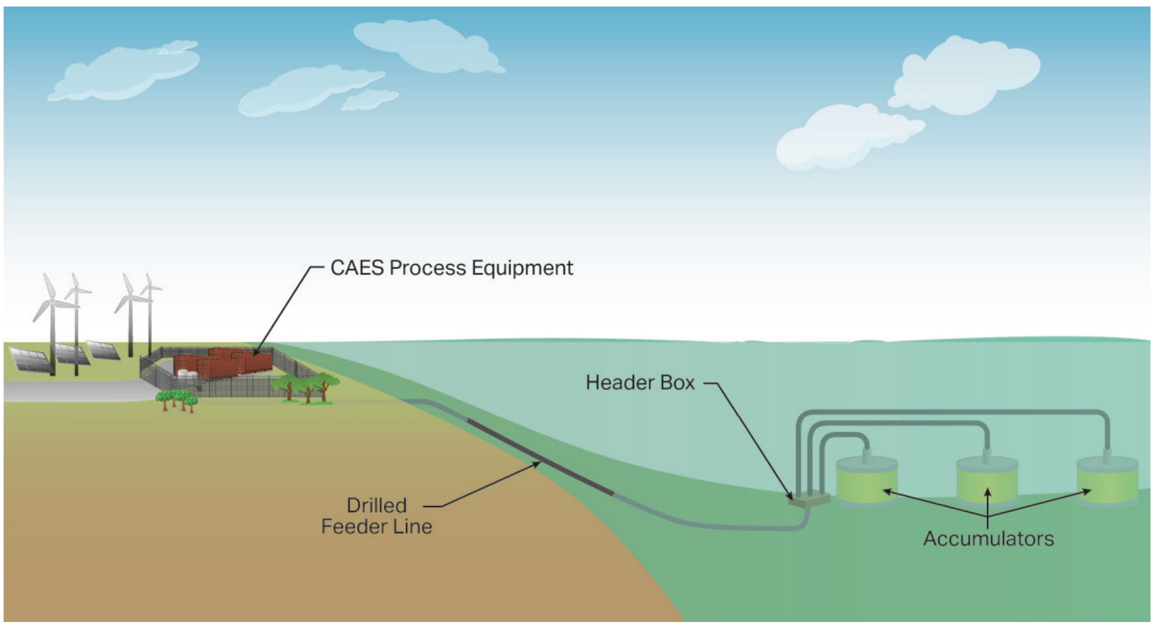
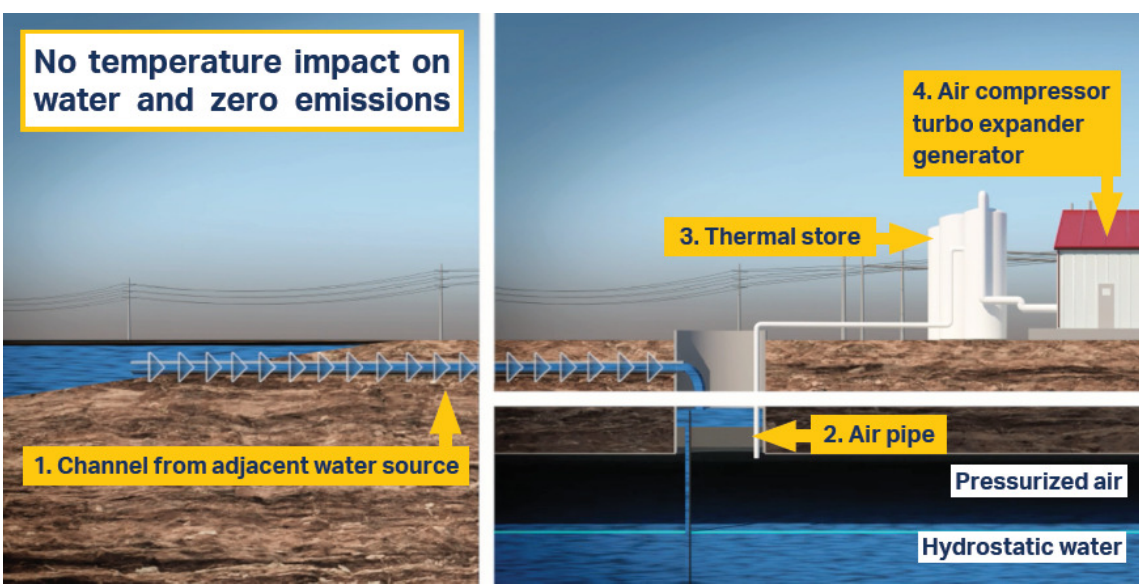


Figure 14 - Hydrostor Terra™ A-CAES Storage Process



3.3.2.2 Flywheel Storage

Flywheel energy storage systems for high energy applications typically trade off some power rating to achieve higher energy ratings, as compared to more power-oriented installations. Kinetic energy within the spinning wheels is converted to electrical energy (or from electrical to kinetic) within a motor/generator.

3.3.2.3 Thermal Air Storage

Thermal storage uses cryogenic technology to store air in liquid form. It is sometimes referred to as Cryogenic Energy Storage (CES) or Liquid Air Energy Storage (LAES). An example is the Highview Power Storage concept, where air is liquefied and stored in insulated tanks at low pressure; it is evaporated and heated and driven through a turbine to discharge the system (see Figure 15). Highview is a company in the UK with three pilot projects to date, the largest a 5 MW installation at a waste treatment plant.

Figure 15 - Highview LAES Thermal Storage Process

Table 1 below shows a comparison of the various energy storage technologies and their corresponding costs and capabilities. Capital costs listed include system replacements as necessary to serve a 20 year life with one duty cycle per day. The system lifetime listed is for the original installation. LCOS is the Levelized Cost of Storage – similar to Levelized Cost of Energy, it is the cost of each MWh discharged by the system over its lifetime.

Table 1 - Comparison of Energy Storage Technology Costs and Capabilities - DRAFT

Technology	Lithium Ion	Compressed Air	Flywheel	Thermal Air
Capital Cost[1] *($/kW)*	$386 - $917	$130 - $180	$551 - $949	$323 - $388
O&M Cost ($/MWh)	$16 - $37	$5 - $7	$34 - $57	$12 - $30
System Lifetime (Years)	5 - 10 years	20 years 30+ years[3]	20+ years 20+ years[4]	20+ years
LCOS (Transmission Use) ($/MWh)	$267 - $561	$116 - $140	$342 - $555	$227 - $280
Roundtrip Efficiency (%)	75 - 79%	60 - 70%[3] 75 - 79%	91% 85%[4]	50 - 55%
Lifetime Cycles	7000	7000	7000	7000
Depth of Discharge	100%[2]	100%[2]	100%[4]	100%[2]

[1]Lazard calculated by $/kW/yr x System Lifetime

[2]Lazard lists energy ratings in "usable energy" with 100% depth of discharge

[3]Hydrostor figures

[4]Temporal Figures

Sources: Lazard, Temporal Power and Highview Power Storage

The table also roughly orders the options by technological maturity: lithium ion is the industry's most bankable and mature technology. Compressed air has a larger installed capacity and history than flywheels. Thermal air installations have so far been pilot projects, and the technology is promising but commercially immature.

Table 1 shows compressed air can deliver the lowest LCOS of the four technologies examined. It should be noted that the cost figures are for traditional CAES, and Hydrostor's technology referenced above, may have different numbers. Lithium-ion systems come in second place for LCOS; given different priorities within the transmission use case for power and grid stability benefits vs. energy and capacity benefits, lithium-ion could be more advantageous. The bankability of lithium-ion compared to compressed air could also be a factor in the optimal storage technology for a given application.

4 Site Constraints

This section looks at the site itself, its geographical location and features, as well as environmental and other regulatory requirements impact the potential design and costs.

Deliverables:

- **D 3 -** Addressing the development issues and/or opportunities for the potential reuse and/or removal of existing site infrastructure, including existing concrete structures, underground utilities, and site remediation.
- **D 4 -** Description and discussions surrounding the geographical, environmental, and legislative limitations surrounding the installation of renewable energy opportunities on the site.
- **D 5 -** Consideration of the restrictive covenants on the property and how they may affect or restrict the proposed development of the property as a renewable energy production facility.

4.1 Site Infrastructure

4.1.1 Description

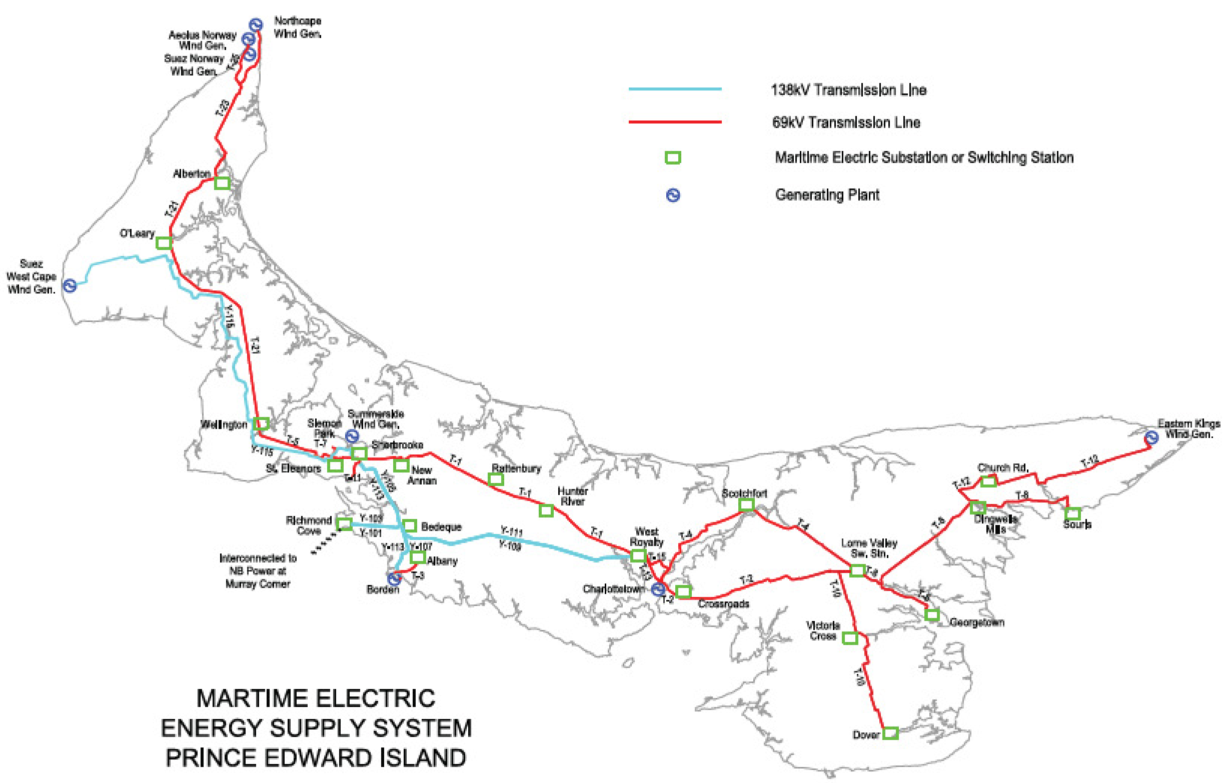
The former fabrication yard is a 150-acre, abandoned industrial yard adjacent to the Northumberland Strait. The area is secured from land access with chain-link fencing, and access is controlled through the Confederation Bridge operations facility. The area of interest is generally flat, except for a 10m berm to the south end of the property. The site is generally south facing, with 270-degree views extending from the Confederation Bridge to the west, through to the adjacent land hosting a dozen or so seasonal, waterfront homes to the east.

The site features a jetty, with a pair of fingers. The jetty has significant freeboard, and deep-water intended for loading pre-fabricated parts onto a floating crane. An unrelated study is currently underway to assess the civil integrity of the jetty.

The site is also in close proximity to the existing Maritime Electric high voltage grid, with the Borden Carleton generating station close by as well as the recently upgraded transmission interconnection with New Brunswick, see Figure 16 and Figure 17.

Figure 16 – Former Fabrication Yard and Borden Generating Station

Figure 17 – Maritime Electric Energy Supply System, PEI



Amongst overgrown grass, remaining on the site are about three-hundred (300) concrete piers (both square and cylindrical, approximately 10m x 1m), and twenty (20) large, flat concrete pads (approximately 15m x 100m), as well as some unused legacy utility services for water, lighting and electricity.

Figure 18: View to the east of the tracked / pillared centre of the property

The site has four distinct areas, see Figure 19, that can be generally referred to as;

1. **Grassy South** – A raised area to the south of the property, sitting about 10m above the rest of the property. The area was used to house office trailers, and has limited infrastructure / foundations, but has had some large construction debris and rubble left on the surface.
2. **Tracked / Pillared Centre** – As seen in Figure 19 the majority of the property has been crossed with Huisman tracks, and support pillars. The pillars on this area cast large shadows and would directly limit any solar PV production with conventional means.
3. **Tracked / padded North** – A series of concrete slabs on-grade typify the north section of the property. The pads are inter-cut with Huisman tracks.
4. **Jetty** – Accompanying the site is a large pier used for loading bridge elements onto a floating crane. Theoretically, the jetty has significant civil stability, but has not been assessed for any renewable energy potential.

Figure 19 – Overview of Former Fabrication Yard Site

Figure 20 through Figure 23 through provide additional photos of the site and the existing infrastructure.

Figure 20 - View to the south through the grassy south of the property

Figure 21 - View to the south through the tracked / pillared centre of the property, with berm visible in background.

Figure 22 - Facing West over the "Tracked / Padded North" area

Figure 23 - Distances between Concrete Features

4.1.1.1 Pros

There are many positive aspects to the site that make it favourable for development for renewable energy and storage. Specifically, the site is located adjacent to both the electrical cable landing site, the Borden-Carleton Combined Cycle Gas Turbine (CCGT), and the associated electrical transmission / sub-transmission grid connection points. Further, there is a possible opportunity to re-use / integrate the existing concrete piers into a solar PV installation.

The site is ideally located on flat ground, with consistent geology, which permitted for the extensive civil works to be constructed for the former fabrication yard. Further, the site is graded, well drained, and secured, which provide significant cost savings in the development of a solar PV installation. Civil-works for projects of this size can typically consume proportionally larger percentages of budgets for sites requiring grading etc. Further, fencing costs installation costs are another cost area. The savings from these two factors should be accounted for in the overall financial analysis.

As a component of the past industrial activities on the Site, there are existing networks for water, electrical, and communications infrastructure on-site. The networks are in various states of degradation, and are unlikely to provide any value for re-use.

Borden-Carleton provides the geographic link to New Brunswick for both vehicular traffic, as well as a recently commissioned sub-marine electric transmission connection. Adjacent to the underwater cables is the Borden Transformer Station, which is a primary electrical transmission link between the PEI grid (Maritime Electric) and the New Brunswick grid (NB Power), and as such, has a high capacity for energy transfer in both directions. This factor is the most positive consideration for the Site, as a grid connection is an expensive addition for a project located away from connection lines, often making many sites unfeasible.

Figure 24 - Borden Transformer Station, owned by Maritime Electric

The existing site infrastructure has a number of potential benefits for a renewable energy facility. The site is currently served by a pad-mount electrical distribution transformer rated for approximately 2MW (13.86/7.2kV to 600/347V - 2,000 kVA). At this time, the transformer is in use, supporting the current occupants of the structures adjacent to the Site, specifically *Siliker Glass* located at 68 Industrial Dr.

Based on the transformer sizing, and the lack of visible aboveground distribution infrastructure, the current electrical distribution ring infrastructure is likely under capacity, and in a state of disrepair. During the site visit, there was no evidence that any of the electrical service was useable for any renewable energy development. It is worth further investigation of the site to understand if there remain any cable ducts or conduits that could be utilized, thus saving on trenching costs.

To facilitate the movement of pre-cast concrete bridge components, the site maintains a set of Huissman tracks covering approximately half of the site. The foundations of the tracks are capable of supporting dynamic loads from 1,200 to 7,500 tonnes, and could be useful for solar foundations. Further civil engineering analysis would be required to confirm current condition, and usefulness.

4.1.1.2 Cons

While the existence of the Huisman tracks represents a potential cost reduction associated with the foundations needed for solar PV, they run at right angles of 145° and 235°, neither of which is well optimised for solar PV generation. The primary con associated with the reuse of Borden site is the number of concrete piers that exist. The vast majority of these piers would have to be removed to maximize the solar PV potential of the site. Even if solar was not developed, many of the piers would have to be removed to facilitate wind development on the site.

During the original civil works, the electrical service cable was buried based on the assumption of a temporary work-site and was not commissioned for a full lifecycle. During a site inspection in May 2017, there was no visible infrastructure (disconnects, boxes, conduits, ducting, etc.) that would indicate any usable services. Therefore, we assume the current state of underground cable is not satisfactory for any kind of safe re-use.

4.2 Site Limitations & Impacts

4.2.1 Environmental and Legislative

Within the Province of Prince Edward Island, the key regulations related to siting of wind turbines greater than 100 kW is 1) the Planning Act, and 2) Renewable Energy Act. Within the Planning Act Subdivision and Development Regulations contained within Section 54.1, the following sub-sections relate directly to turbines of greater than 100kW. Generally, setbacks are required to be kept from property edges, and habitable structures. As there are a number of habitable structures abutting the site at the north end of the site, these form a key site constraint.

Figure 25 - Overview showing nearby Habitable Structures

Within PEI, turbines must be located with a setback of four (4) times turbine height from any existing habitable building.

Setbacks may be less three (3) times the height of the wind turbine tower from any existing habitable building, if a number of criteria are met, including; the permit holder owning the abutting lot; and that turbine tower is not located closer than the total height of the wind turbine tower from any habitable building on the same lot; and that no matter what, the wind turbine tower is not located closer than three (3) times the total height of the wind turbine tower from any habitable building on another lot.

Turbines may not be located closer than the height of the wind turbine tower from any part of a lot line. Or the nearest boundary of a public road, private road or right-of- way.

Importantly, there is an exception based on consent of the owner of an abutting lot within the setback. A permit holder may locate a wind turbine tower closer than the distance equal to the total height of the wind turbine tower from any part of a lot line of a lot that is not owned by the permit holder if the permit holder first obtains the written consent of the owner of that lot.

Finally, a long-term restriction exists once a turbine has been built since no person shall locate a habitable building closer to an existing wind turbine tower than the distance equal to the total tower height of the wind turbine tower.

Given these restrictions on siting, the wind eligible area for this site is relatively small and would only make sense for a single turbine, see light purple area in Figure 26 below.

Figure 26 – Wind Eligible Area

Within the *Renewable Energy Act, Renewable Energy Designated Areas Regulations,* wind turbines greater than 100 kW have to be located in one of five zones of inclusion, or if outside these zones, the wind project requires authorization from the Minister. The former fabrication yard falls within Zone 5 Borden Carleton, within these regulations and therefore would be eligible for a wind turbine greater than 100 kW.

4.2.2 Restrictive Covenants

There are a number of restrictive covenants that have been entered into regarding the use of the lands. The critical covenant seeks to restrict the use of the jetty / lands as alternatives to the use of the bridge, thus hindering traffic growth. None of the proposed plans would seek to circumvent the use of the Confederation Bridge.

For any potential energy development and/or any demolition on-site, it will be required to utilize the Confederation Bridge as a main supply channel.

4.2.3 Winds

As described above, the site benefits from a strong wind regime which is positive for wind development but would restrict the ability of the site to use any form of solar PV tracking technology, therefore any solar solution would be a fixed tilt option.

4.2.4 Summary of Site Constraints

Given the site's proximity to electrical infrastructure and favorable grading, it is a good candidate for solar development with the exception of the existing concrete piers which would have to be removed. The existing in-ground concrete could further reduce foundation cost for solar PV racking. From a wind perspective, there is the ability to install a single turbine given Planning Act restrictions, and there would be some requirement to remove existing concrete piers at a minimum.

A combination of both wind and solar could be pursued in order to reduce overall connection and operating costs. By combining solar and wind there is less available area for solar due to the requirement that the turbine be located at least four times its height from the north boundary of the property. This location causes significant shadows on a majority of the available area, and makes solar in this area not feasible. Furthermore, electricity storage could be pursued in conjunction with either or both renewable technology choices, however the type of storage application may impact the size of the solar PV system.

4.3 Deployment Options

Given the site considerations described above and the ability to reuse some of the existing infrastructure there are five potential renewable energy deployment options, each of which can be combined with energy storage.

1) Solar only, no reuse of existing infrastructure
2) Solar only, reuse of existing infrastructure
3) Solar plus wind, no reuse of existing infrastructure

4) Solar plus wind, reuse of existing infrastructure
5) Wind only, no reuse of existing infrastructure

Images of the four scenarios that incorporate solar are presented below followed by a preliminary summary table of the total capacity and forecast energy production from each.

Figure 27 – Option 1: Solar only, no reuse of existing infrastructure

Figure 28 – Option 2: Solar Only, reuse of existing infrastructure

The difference between Option 1 and Option 2 is that the solar panels are oriented due south, at 180° degree azimuth in Option 1 where in Option 2 they are aligned with the existing concrete infrastructure and therefore the azimuth is closer to 145° degrees, which results in a lower production on a per unit basis, but would allow for some reuse of the concrete infrastructure.

Figure 29 – Option 3: Solar plus wind, no reuse of existing infrastructure

Figure 30 Option 4: Solar plus wind, reuse of existing infrastructure

Deploying wind and solar together will mean less of the property will be covered in solar panels to avoid the shading from the wind turbine as the sun moves from east to west throughout the day. The result for Options 3 and 4 is a smaller solar farm collocated with a single turbine. In Option 3, like Option 1, the solar panels are oriented due south and do not take advantage of any existing site infrastructure, where in Option 4, like Option 2, they are oriented at 145° in order to leverage the existing concrete in place.

Table 2 presents a summary of each of the five deployment options, showing the solar and wind component sizes as well as the total annual energy produced from each scenario.

Table 2 – Summary of Deployment Options

Deployment Option	Azimuth	Solar Size (MWdc)	Solar Capacity Factor	Wind Size (MW)	Wind Capacity Factor	Total Annual Energy (MWh)
1) Solar only - no re-use of infrastructure	180°	13.5	13.6%	0	0	16,122
2) Solar only - re-use of infrastructure	145°	13.6	12.7%	0	0	15,130
3) Solar & wind - no re-use of infrastructure -	180°	7.9	13.5%	3.2	40%	20,580
4) Solar and wind - re-use of infrastructure	145°	7.7	13.1%	3.2	40%	20,010
5) Wind only	N/A	0	0	3.2	40%	11,200

As shown above, between the solar systems alone, option 1 has a higher capacity factor than option 2, 13.6% vs. 12.7% because the solar modules are oriented due south and do not take advantage of the existing underground concrete infrastructure. Both solar options, 1 and 2, produce more energy than the wind alone, option 5, however, the wind capacity factor is approximately 3 x higher than that for either solar option. These production characteristics will be accounted for in the financial analysis which follows.

5 Financial Analysis

This section describes the project economics for each of the five deployment scenarios presented above. The economics account for a variety of project specific considerations including capital costs, site remediation, interconnection as well as operating costs. Each of these are scenario specific, as are energy production modelling.

Deliverables:

- **D 6** - Preparation of the estimated development costs for the project including but not limited to civil and structural considerations, equipment supply and installation, utility integration, protection, and commissioning.
- **D 7** - Preparation of the expected annual maintenance and operational costs.
- **D 8** - Description and discussions regarding the necessary electrical utility integration.
- **D 9** - Preparation of energy production and revenue modeling for the expected gross electrical capacity available from the renewable energy sources, and the expected annual energy production and revenue from the site.
- **D 10** - Preparation of the expected return on investment.

5.1 Capital Costs

Capital costs accounted for in the financial model include equipment and installation, site remediation and interconnection.

5.1.1 Equipment & Installation Costs

The capital costs required for each scenario are based on the technology selection, solar vs. wind vs. battery, as well as the potential re-use of existing site infrastructure. As described above, the re-use of underground concrete infrastructure is anticipated to reduce foundation costs for solar equipment, but would also sacrifice energy production.

From a solar perspective, each of the four deployment scenarios that would use some solar would be considered utility scale and benefit from economies of scale. However, from a wind perspective the site can only use a single turbine, and therefore would not benefit from the same economies of scale for certain fixed costs such as project management, cranes and interconnection.

5.1.2 Site Remediation Costs

As described above, the site is already flat and graded and therefore suitable for solar or wind development with little incremental civil infrastructure costs, except for the concrete structure removal. To proceed with any of the renewable energy or storage redevelopment options, we assume that all the above ground concrete structures, except for those that would be re-used, are cut down to grade and removed from the site.

5.1.3 Interconnection Costs

As shown in Figure 26 – Wind Eligible Area the former fabrication yard is in close proximity to Borden CCGT site, as well as the Borden transformer station and the recently upgraded underwater cables to New Brunswick. Therefore, the interconnection would either be at the 69 or 138 kV. The costs to connect and ensure property safety measures are captured together.

5.2 Operating Costs

There are two types of operating costs included in the financial analysis, 1) Equipment Operations & Maintenance (O&M) and 2) Backstopping Costs. Equipment O&M is associated with planned and unplanned maintenance activities on site, including solar inverter replacements for solar projects. Backstopping costs are those charged by New Brunswick power to integrate additional renewable energy production into their grid.

5.3 Revenues

The revenues that would accrue to any renewable energy project are associated with the energy and capacity value created.

5.3.1 Energy Value

Under the *Renewable Energy Act*, the Minimum Purchase Price Regulation has set a price for renewable energy generated in PEI for a period of up to 20 years.

5.3.2 Capacity Value

PEI is a winter peaking province and therefore only resources that can provide generating during times of peak demand would be credited with some form of capacity value. In PEI, wind or storage would be attributed with some capacity value. The value of capacity is based on discussions with Maritime Electric Company.

5.4 Project Returns

To calculate overall project returns a discounted cashflow model was developed that accounted for all of the capital and operating cost assumptions described above as well as other assumptions that impact model outputs such as useful life, debt equity ratio and tax rate. A summary of key assumptions used in the model, as well as the internal rate of return (IRR), across the deployment options is presented in

Table 3 below. Of note, we assume a non-taxable entity would own the project. Further, there is some uncertainty as to if backstop charges would be applied to solar as well as wind projects by NB Power and therefore each scenario's IRR is presented with and without backstop charges.

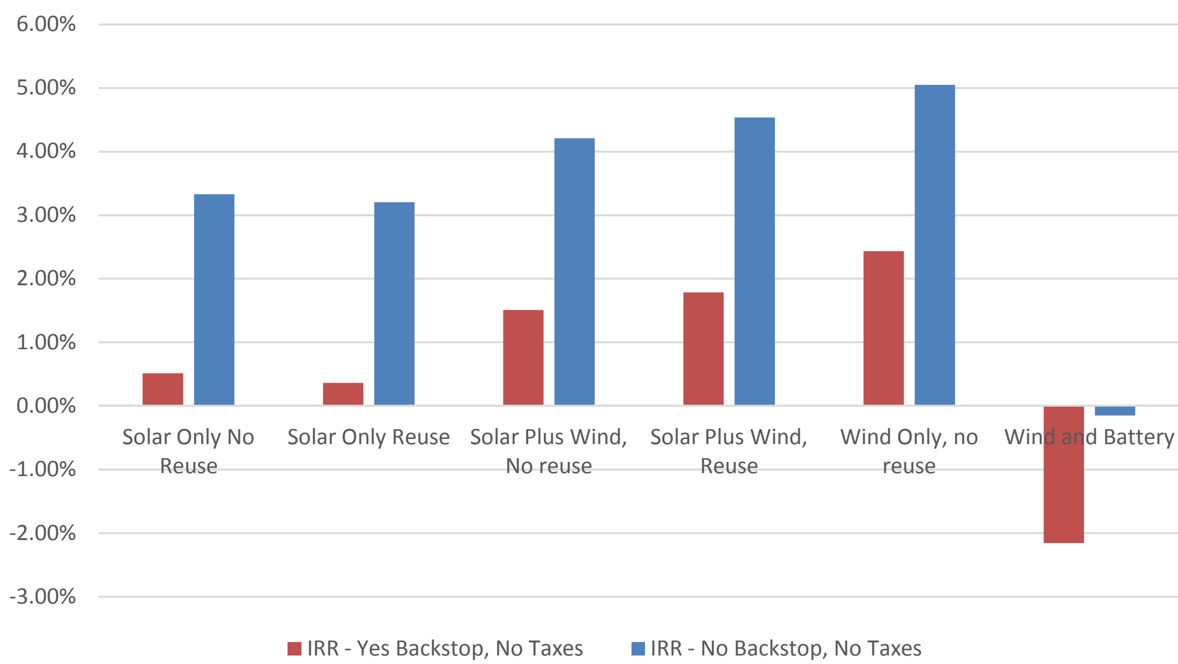
Table 3 - Overview of Deployment Scenario Assumptions & Returns

Deployment Scenario		Solar Only No Reuse	Solar Only Reuse	Solar Plus Wind, No reuse	Solar Plus Wind, Reuse	Wind Only, no reuse	Wind and Battery (Li-On)
System Sizing	**Units**						
Capacity							
Solar	MWdc	13.5	13.6	7.9	7.7		
Wind	MWac			3.2	3.2	3.2	3.2
Battery	MWhac						20.0
Annual Energy Output	MWhac	16,122	15,129	20,579	20,010	11,213	11,213
Capital Costs							
Equipment & Installation							
Solar	$ 000	$17,400	$16,200	$11,200	$9,800	$0	$0
Wind	$ 000	$0	$0	$10,100	$10,100	$10,100	$10,100
Battery	$ 000	$0	$0	$0	$0	$0	$8,500
Site Remediation	$ 000	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
Interconnection	$ 000	$250	$250	$250	$250	$250	$250
Total Capital	$ 000	$19,150	$17,950	$23,050	$21,650	$11,850	$20,350
Operating Costs							
Equipment O&M							
Solar	$/kWdc	$12	$12	$12	$12		
Wind	$/kWac			$50	$50	$50	$50
Battery	$/kWac					$42	$42
Backstop	$/MWh	$19	$19	$19	$19	$19	$0
Revenue							
Energy	$/MWh	$82	$82	$82	$82	$82	$82
Capacity[8]	$/kW-year	$0	$0	$11	$11	$11	$40
Capital Structure							
Debt %	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cost of Debt	%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Other							
Useful Life	Years	25	25	25	25	25	25
Inflation	%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Tax Rate	%	0%	0%	0%	0%	0%	0%
Outputs							
IRR - No Backstop	%	3.33%	3.21%	4.21%	4.53%	5.05%	-0.15%
IRR - Yes Backstop	%	0.51%	0.35%	1.27%	1.53%	2.00%	-2.49%

[8] Winds firm capacity is assumed to be 28%.

As shown above and in Figure 31 below, the deployment scenario IRRs range from -2 to 5%, depending primarily if a backstop charge is applied to the project. The low IRRs are in part due to the site constraints which inhibit the siting of a second wind turbine on the site, as well as the backstop charge for new renewable energy deployment on PEI, which represents almost 25% of the first-year revenue. In addition, the incremental charge associated with removing the concrete piers also reduces the IRRs.

Figure 31 – Summary of Deployment Scenario IRRs



The lowest project returns are for the wind and battery hybrid option. This is due in part to the relatively low value attributed to capacity in PEI, as well as the fact that storage only earned capacity value limited value streams that the storage system is earning. In this model, storage only earned the capacity value as oppose to regulation service or voltage support that the storage system could also provide. In absence of the site remediation, *Planning* Act restrictions and back stop charge, a two turbine site could earn almost a 10 % IRR.

Finally, the decision to invest in a renewable and or storage solution may account for non-economic factors that are not discussed above, such as diversity of supply and the green-house-gas benefits of avoiding use of the diesel-powered combustion turbines currently used on PEI.

Appendix A – Helioscope Models

1) Solar only - no re-use of infrastructure
2) Solar only - re-use of infrastructure
3) Solar & wind - no re-use of infrastructure
4) Solar and wind - re-use of infrastructure

1) Solar only - no re-use of infrastructure Former Strait Crossing Fabrication Yard, Industrial Rd, Borden-Carleton, Prince Edward Island

Report

Project Name	Former Strait Crossing Fabrication Yard
Project Description	Former Strait Crossing Fabrication Yard Borden-Carleton Prince Edward Island
Project Address	Industrial Rd, Borden-Carleton, Prince Edward Island
Prepared By	Jonathan Cheszes jon@compassenergyconsulting.ca

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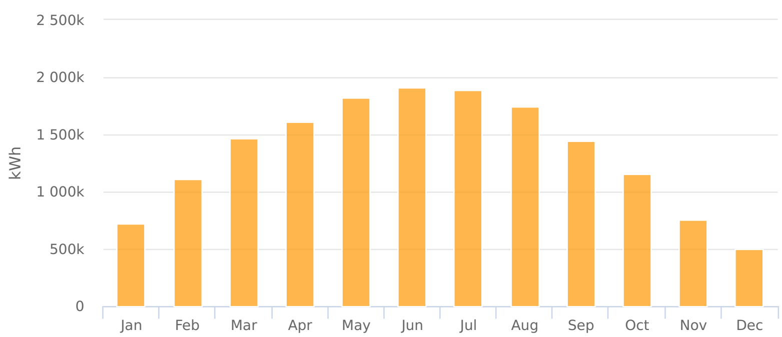
System Metrics

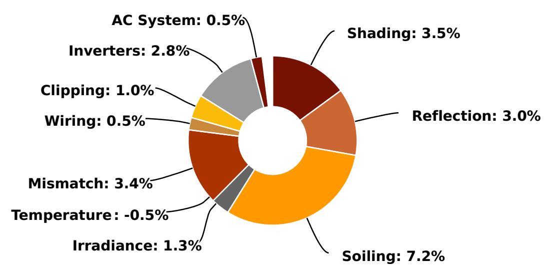
Design	1) Solar only - no re-use of infrastructure
Module DC Nameplate	13.5 MW
Inverter AC Nameplate	10.00 MW Load Ratio: 1.35
Annual Production	16.12 GWh
Performance Ratio	79.3%
kWh/kWp	1,190.8
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	7d42142704-df700c96ac-561928677d-ddba661596

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,254.8	
	POA Irradiance	1,502.5	19.7%
	Shaded Irradiance	1,450.5	-3.5%
	Irradiance after Reflection	1,407.3	-3.0%
	Irradiance after Soiling	1,306.0	-7.2%
	Total Collector Irradiance	**1,306.0**	**0.0%**
Energy (kWh)	Nameplate	17,669,366.4	
	Output at Irradiance Levels	17,444,556.1	-1.3%
	Output at Cell Temperature Derate	17,524,688.2	0.5%
	Output After Mismatch	16,931,574.5	-3.4%
	Optimal DC Output	16,838,814.5	-0.5%
	Constrained DC Output	16,664,212.6	-1.0%
	Inverter Output	16,202,200.0	-2.8%
	Energy to Grid	**16,121,200.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		8.9 °C
	Avg. Operating Cell Temp		15.5 °C
Simulation Metrics			
		Operating Hours	4596
		Solved Hours	4596

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Condition Set

Description	Condition Set 2
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
33.25	28	14.3	1.7	1	1	1	1	1	1	2.8	23.5

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
CS6X - 320P-FG (Canadian Solar Inc.)	CS6X-320P-FG_MIX_CSI_EXT_V6.52_2016Q4.PAN, PAN

Component Characterizations

Device	Characterization
Sunny Central SC 1000MV-11-ES (SMA)	Default Characterization

Components

Component	Name	Count
Inverters	Sunny Central SC 1000MV-11-ES (SMA)	10 (10.00 MW)
Strings	10 AWG (Copper)	2,280 (539,331.3 m)
Module	Canadian Solar Inc., CS6X - 320P-FG (320W)	42,306 (13.5 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	30°	180°	6.7 m	2x1	21,153	42,306	13.5 MW

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Detailed Layout

3) solar only - re-use of infrastructure Former Strait Crossing Fabrication Yard, Industrial Rd, Borden-Carleton, Prince Edward Island

Report

Project Name	Former Strait Crossing Fabrication Yard
Project Description	Former Strait Crossing Fabrication Yard Borden-Carleton Prince Edward Island
Project Address	Industrial Rd, Borden-Carleton, Prince Edward Island
Prepared By	Jonathan Cheszes jon@compassenergyconsulting.ca

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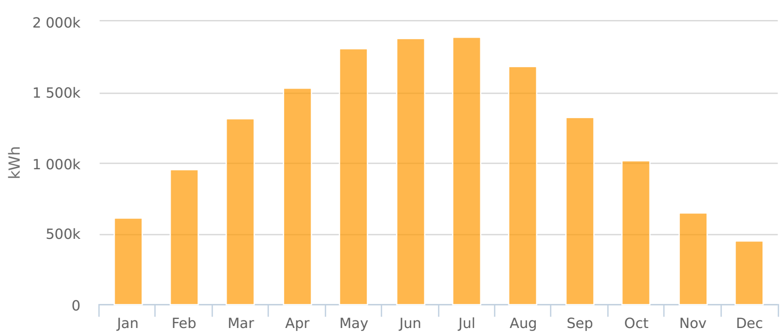
System Metrics

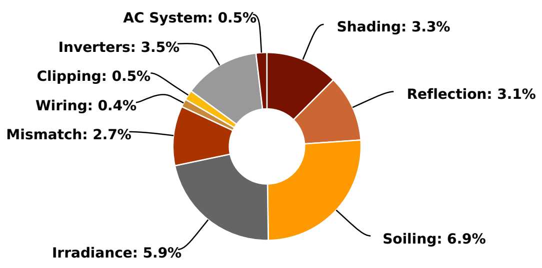
Design	3) solar only - re-use of infrastructure
Module DC Nameplate	13.6 MW
Inverter AC Nameplate	11.0 MW Load Ratio: 1.24
Annual Production	15.13 GWh
Performance Ratio	76.5%
kWh/kWp	1,109.0
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	7d42142704-df700c96ac-561928677d-ddba661596

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,254.8	
	POA Irradiance	1,450.4	15.6%
	Shaded Irradiance	1,402.2	-3.3%
	Irradiance after Reflection	1,359.2	-3.1%
	Irradiance after Soiling	1,265.2	-6.9%
	Total Collector Irradiance	**1,265.2**	**0.0%**
Energy (kWh)	Nameplate	17,267,925.1	
	Output at Irradiance Levels	16,255,347.7	-5.9%
	Output at Cell Temperature Derate	16,335,334.4	0.5%
	Output After Mismatch	15,886,948.0	-2.7%
	Optimal DC Output	15,828,942.5	-0.4%
	Constrained DC Output	15,756,254.9	-0.5%
	Inverter Output	15,205,900.0	-3.5%
	Energy to Grid	**15,129,900.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		8.9 °C
	Avg. Operating Cell Temp		15.3 °C
Simulation Metrics			
		Operating Hours	4596
		Solved Hours	4596

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Condition Set

Description	Condition Set 2
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
33.25	28	14.3	1.7	1	1	1	1	1	1	2.8	23.5

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
HSL72P6-PC-3-320 (Hanwha)	Default Characterization, PAN

Component Characterizations

Device	Characterization
ULTRA-1100-TL-OUTD-4-US-690-x-y-z (ABB (Power-One))	CEC 2014-08-16

Components

Component	Name	Count
Inverters	ULTRA-1100-TL-OUTD-4-US-690-x-y-z (ABB (Power-One))	11 (11.0 MW)
Strings	8 AWG (Copper)	2,420 (526,503.9 m)
Modules	Hanwha, HSL72P6-PC-3-320 (320W)	42,632 (13.6 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	16-18	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	30°	145.884°	6.8 m	4x1	10,658	42,632	13.6 MW

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Detailed Layout

3) solar & wind - no re-use of infrastructure - i.e. Truss system Former Strait Crossing Fabrication Yard, Industrial Rd, Borden-Carleton, Prince Edward Island

Report

Project Name	Former Strait Crossing Fabrication Yard
Project Description	Former Strait Crossing Fabrication Yard Borden-Carleton Prince Edward Island
Project Address	Industrial Rd, Borden-Carleton, Prince Edward Island
Prepared By	Jonathan Cheszes jon@compassenergyconsulting.ca

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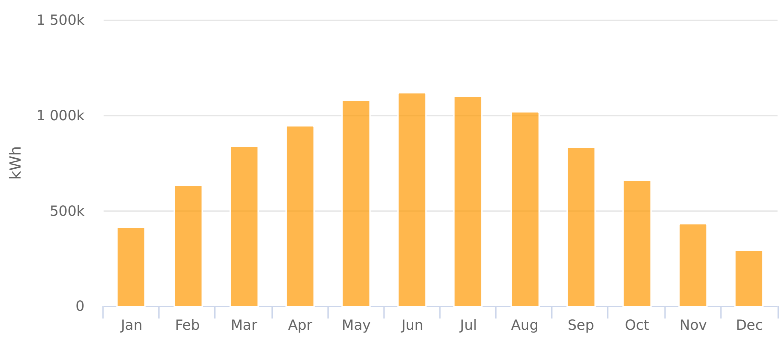
System Metrics

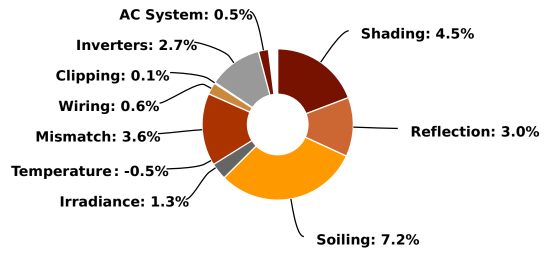
Design	3) solar & wind - no re-use of infrastructure - i.e. Truss system
Module DC Nameplate	7.89 MW
Inverter AC Nameplate	7.00 MW Load Ratio: 1.13
Annual Production	9.367 GWh
Performance Ratio	79.0%
kWh/kWp	1,186.8
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	7d42142704-df700c96ac-561928677d-ddba661596

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,254.8	
	POA Irradiance	1,502.5	19.7%
	Shaded Irradiance	1,434.8	-4.5%
	Irradiance after Reflection	1,392.2	-3.0%
	Irradiance after Soiling	1,292.2	-7.2%
	Total Collector Irradiance	**1,292.2**	**0.0%**
Energy (kWh)	Nameplate	10,191,327.6	
	Output at Irradiance Levels	10,058,904.7	-1.3%
	Output at Cell Temperature Derate	10,105,048.9	0.5%
	Output After Mismatch	9,737,324.1	-3.6%
	Optimal DC Output	9,679,362.0	-0.6%
	Constrained DC Output	9,674,467.9	-0.1%
	Inverter Output	9,413,630.0	-2.7%
	Energy to Grid	**9,366,560.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		8.9 °C
	Avg. Operating Cell Temp		15.4 °C
Simulation Metrics			
		Operating Hours	4596
		Solved Hours	4596

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Condition Set

Description	Condition Set 2
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
33.25	28	14.3	1.7	1	1	1	1	1	1	2.8	23.5

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
CS6X - 320P-FG (Canadian Solar Inc.)	CS6X-320P-FG_MIX_CSI_EXT_V6.52_2016Q4.PAN, PAN

Component Characterizations

Device	Characterization
Sunny Central SC 1000MV-11-IT (SMA)	Default Characterization

Components

Component	Name	Count
Inverters	Sunny Central SC 1000MV-11-IT (SMA)	7 (7.00 MW)
Strings	10 AWG (Copper)	1,330 (343,970.0 m)
Module	Canadian Solar Inc., CS6X - 320P-FG (320W)	24,663 (7.89 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	30°	180°	6.7 m	2x1	12,332	24,663	7.89 MW

Detailed Layout

4) solar and wind - re-use of infrastructure i.e. Truss system Former Strait Crossing Fabrication Yard, Industrial Rd, Borden-Carleton, Prince Edward Island

Report

Project Name	Former Strait Crossing Fabrication Yard
Project Description	Former Strait Crossing Fabrication Yard Borden-Carleton Prince Edward Island
Project Address	Industrial Rd, Borden-Carleton, Prince Edward Island
Prepared By	Jonathan Cheszes jon@compassenergyconsulting.ca

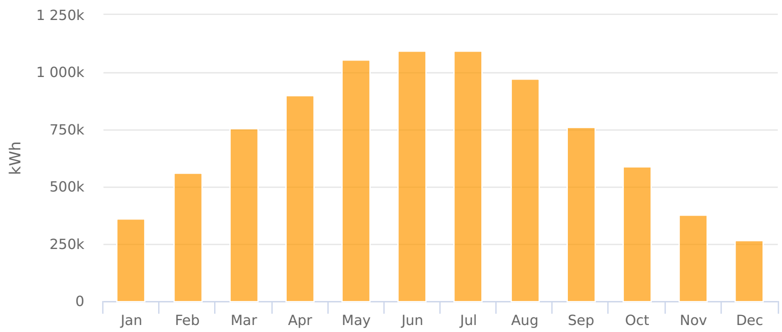
COMPASS
COMPASS ENERGY CONSULTING

System Metrics

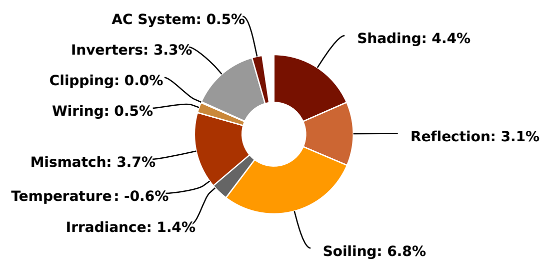
Design	4) solar and wind - re-use of infrastructure i.e. Truss system
Module DC Nameplate	7.69 MW
Inverter AC Nameplate	7.00 MW Load Ratio: 1.10
Annual Production	8.797 GWh
Performance Ratio	78.9%
kWh/kWp	1,144.3
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	7d42142704-df700c96ac-561928677d-ddba661596

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,254.8	
	POA Irradiance	1,450.4	15.6%
	Shaded Irradiance	1,387.2	-4.4%
	Irradiance after Reflection	1,344.7	-3.1%
	Irradiance after Soiling	1,252.6	-6.8%
	Total Collector Irradiance	**1,252.6**	**0.0%**
Energy (kWh)	Nameplate	9,623,456.4	
	Output at Irradiance Levels	9,490,731.5	-1.4%
	Output at Cell Temperature Derate	9,543,290.7	0.6%
	Output After Mismatch	9,191,065.9	-3.7%
	Optimal DC Output	9,145,114.1	-0.5%
	Constrained DC Output	9,141,230.0	0.0%
	Inverter Output	8,841,480.0	-3.3%
	Energy to Grid	**8,797,270.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		8.9 °C
	Avg. Operating Cell Temp		15.2 °C
Simulation Metrics			
	Operating Hours		4596
	Solved Hours		4596

Condition Set

Description	Condition Set 2
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

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Carport	-3.56	-0.075	3°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
33.25	28	14.3	1.7	1	1	1	1	1	1	2.8	23.5

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
CS6X - 320P-FG (Canadian Solar Inc.)	CS6X-320P-FG_MIX_CSI_EXT_V6.52_2016Q4.PAN, PAN

Component Characterizations

Device	Characterization
ULTRA-1100-TL-OUTD-4-US-690-x-y-z (ABB (Power-One))	CEC 2014-08-16

Components

Component	Name	Count
Inverters	ULTRA-1100-TL-OUTD-4-US-690-x-y-z (ABB (Power-One))	7 (7.00 MW)
Strings	10 AWG (Copper)	1,288 (278,144.1 m)
Module	Canadian Solar Inc., CS6X - 320P-FG (320W)	24,025 (7.69 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	17-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	30°	145.884°	7.8 m	2x1	12,013	24,025	7.69 MW

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Detailed Layout