Solar Photovoltaic Project

S.G. Nesbitt Memorial Arena

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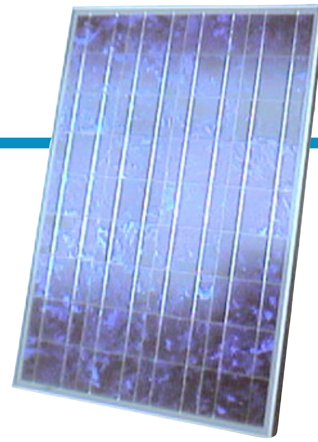

Introduction and Project Description

This is a pre-feasibility study to put a solar array on an arena in Minden ON. The S.G. Nesbitt Memorial Arena is a single ice surface community arena. The building is 2400m^2, with an 1800m^2 roof, half of which faces SSW. The roof is sloped at 21º which is a sufficient slope to receive optimal solar radiation without placing the panels on a bracket mounted system. There are 2 proposals for photovoltaic panels to be placed on the south face of the roof. The first takes advantage of the MicroFIT government incentive for rooftop solar projects under 10kW. The second is a larger 32.4 kW option, covering 212m^2 of roof space. Both are discussed in greater detail below. Throughout our analysis we made what we consider conservative estimates. That being, they are at the higher end of the scale. All assumptions made are outlined in detail below.

Solar Photovoltaic Energy

BACKGROUND

Why Use Solar

Scientists estimate that the earth is approximately 4.5 billion years (Dalrymple, 2001). According to the Big Bang Theory, before the Earth was created, there were trillions of tiny particles floating around inside huge clouds of gas in space. Some of these building blocks created the Earth that we all live and breathe on, and some of them formed the sun that gives our planet that life.

Without the sun, there would be no life. Almost all the energy available to us on earth comes from the sun. Plants use this solar energy to grow; it produces Vitamin D for human beings; and it heats the Earth to a habitable temperature for millions of species. A lot of the sun's energy however, is simply reflected back into space where it can no longer benefit anyone.

Humans have been burning fossil fuels to create electrical energy for hundreds of years. Fossil fuels are basically stored solar energy. Plants and animals that absorbed the sun's energy thousands of years ago then died, and that material is what formed the coal and oil we burn to power our lives today (Coley, 2008). The problem is that this resource is limited; it will eventually run out. Some scientists believe we have already surpassed peak oil, and with our increasing rates of consumption, could run out before the end of the next century (Simmons, 2005).

Scientists have developed a way to harness the sun's energy directly and transform it into a renewable and emissions-free source of electricity, where it can be extremely useful and is particularly attractive in combating global climate change. This technology is called photovoltaic (photo=light and voltaic=electricity) and it involves converting the photons of light from the sun directly into electrons we can use to power our lives.

Solar technology, while a relatively new technology on the global market, is currently the fastest growing energy technology available (REN21, 2009). This growth is due to technological advances, making it more efficient, and from government incentives, such as Ontario's feed-in-tariffs, that encourage local research, development and production.

How Solar PV works
(Largely drawn from (Coley, 2008)

PV cells are made of special materials called semiconductors, such as silicon; these silicon cells are what make up the solar panels. When light strikes a cell, the semiconductor absorbs the energy from the light, knocking its electrons loose and allowing them to flow freely. The multiple electric fields of the solar cell act to force the freed electrons to flow in one direction, as a current. By placing a metal conducting wire at each end of the cell the electrical energy can be drawn off and used externally. The power of the electrical energy is based on its amperage or current. A stronger current equals a higher electrical energy resulting in more power. Multiple panels can be wired in series or in a parallel circuit. A series circuit is advantageous because each panel feeds its current into the next so the resulting current is stronger, however, if one panel is obstructed due to snow or leaves, the whole circuit becomes less efficient. A parallel circuit avoids this issue because each panel is wired into the circuit individually. This means that if one panel is obstructed, it does not affect any of the other panels.

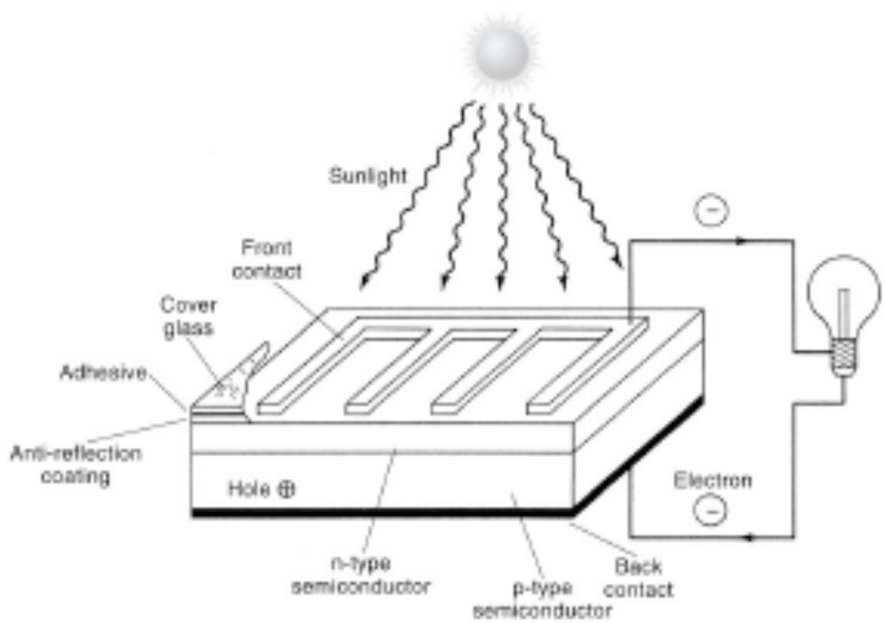

Figure 1: Photovoltaic panel using solar radiation to produce electricity to power a light bulb.

Green Energy Act

In the summer of 2009, the Ontario government passed landmark legislation titled the *Green Energy and Economy Act*, although it is commonly called the Green Energy Act. One of the major facets of the act is its focus on increasing the amount of distributed renewable energy production in Ontario. It hopes to achieve this through an economic tool known as a Feed-in-Tariff, or FIT. A FIT is a fixed price that the government will pay to electricity producers – big or small – to purchase their electricity and feed it into the grid. For renewable energy, these prices are often much higher than the market rate of electricity to offset the higher costs faced by renewable energy projects. This is especially important for Solar PV technology, which is comparatively very expensive.

For Solar PV projects, the FIT varies from $0.442/kWh produced to $0.802/kWh, with the FIT increasing for smaller-sized projects. Projects are also divided between the FIT and MicroFIT programs. MicroFIT programs are projects that are considerably smaller in scale (for Solar PV, it is any project under 10 kW) and thereby require a less detailed application and approvals process (Ontario Power Authority, 2009).

The FIT contract is made between the supplier and the Ontario Power Authority (OPA) and lasts for a specified length of time. For Solar PV projects, the contracts last for 20 years. Information regarding the FIT can be found at the OPA's website: fit.powerauthority.on.ca.

Ontario's Ministry of Energy & Infrastructure has also established a Renewable Energy Facilitation Office, which seeks to streamline the approvals process for developers and is seen as a 'one-stop-shop' of information related to renewable energy projects. Its information can be found at: www.mei.gov.on.ca/en/energy/renewable.

Solar PV Project Options

OPTION 1: 10 KW ROOFTOP PV

Project Description

The first scenario we propose is the smaller of the two proposed projects. It is characterized by sub-10 kW* rooftop solar PV system. Such a project would consist of approximately one row of 55 panels and would rest on approximately 65 m2 of rooftop space. The purpose of limiting the size of the project to 10 kW is the advantages that can be taken from Ontario's Green Energy Act and Feed-in-Tariff that is mentioned above. Such a project would qualify as a MicroFIT project because of its size and would therefore be subject to a less stringent approvals process than a project of larger size. More importantly, the rate paid under a MicroFIT would be considerably higher, at $0.802/ kWh. A typical PV system is estimated to last for 25 years, but this model uses a 20 year project life because that is the length of the MicroFIT contract (Ontario Power Authority, 2009).

* We have based our model on the Sanyo mono-Si HIP-180B2 panel, which can only reach a 9.9 kW system without exceeding the 10 kW limit. Ensuring you do not exceed this limit is very important and a 9.9 kW system is assumed for the entirety of the model.

Financial Analysis

In our models, we have assumed that the general cost of solar PV is $9000/kW installed. It should be noted that the cost of solar PV can range from $8000-$11,000/kW installed depending on the type of panel, distributor and supplier, but $9000 is the rough average of solar PV (RETScreen, 2009). At this price level, the initial capital cost of the project would be **$89,100**.

However, several additional costs will be borne during the process of the project. These include installation, administrative costs and ongoing maintenance costs:

Installation: For solar PV projects of this size, installation can typically be completed within 2-3 person-days at a cost of $500-$1000 per person day. For this particular model, we have assumed a total cost of $2500 for installation, but it is important to contact your local contractor for case-specific costs (RETScreen, 2009).

Administrative Costs: The MicroFIT program is highly automated and requires very little oversight from the site manager. That is, the local distribution company (LDC) will meter all electricity produced by the project and any income from the production will be automatically deposited into the project owner's bank account. However, the LDC will charge a yet-to-be-determined rate for this service. Other administrative costs include the actual MicroFIT contract with the OPA, which can run as high as several hundred dollars and perhaps more if a lawyer is required (Ontario Power Authority, 2009). For this model, we assume an upfront cost of administration of $1000, and an annual cost of $100.

Maintenance: The level of annual maintenance of a relatively smaller solar PV system is generally considered to be fairly low. A standard cost level is approximately 1% of the initial cost, which in this model is $890 per year (RETScreen, 2009). However, 1% is often used for larger projects, so as an estimate, it is at the higher end of the scale and case-specific costs should be discussed with the contractor.

Revenues: As mentioned above, the project would qualify for a feed-in-tariff under the MicroFIT program. Because of its size, any electricity generated from the project would be sold back to the grid at $0.802 per kWh (Ontario Power Authority, 2009). Based on the estimated size and efficiency of the project system, we estimate that the system would generate approximately $9,243 annually. When combined with our cost model, the project has a payback of 11.2 years and generates a pre-tax rate of return of 6.0%. It is very important to note that these figures represent a project without any external funding or grants, which such a project would likely qualify for. Possible external funding options are listed later in the report.

OPTION 2: 32.4 KW ROOFTOP PV

Project Description

The second option is a significantly larger project and would have a total installed capacity of approximately 32.4 kW, roughly three times as large as Option 1. This sizing is based on the available roof space on the arena, which we estimate can comfortably hold approximately 180 panels, the amount used in this model. The project would use roughly 212 m^2 of rooftop space. Perhaps one of the greatest differences between Options 1 and 2 is that Option 2 exceeds the 10 kW limit and therefore must be classified under the FIT program. Again, the model uses a 20 year project life (Ontario Power Authority, 2009).

Financial Analysis

In our models, we have assumed that the general cost of solar PV is $9000/kW installed. It should be noted that the cost of solar PV can range from $8000-$11,000/kW installed depending on the type of panel, distributor and supplier, but $9000 is the rough average of solar PV (RETScreen, 2009). At this price level, the initial capital cost of the project would be **$291,600.**

However, several additional costs will be borne during the process of the project. These include installation, administrative costs and ongoing maintenance costs:

Installation: The costs of installation for Option 2 are considerably larger than those in Option 1, as the project size is greater. We estimate a project of this size would take 4-5 person days at $500-$1000 per person day (RETScreen, 2009). In our model, we have assumed an installation cost of $4000, but as mentioned above, it is very important to contact your local contractor for case-specific costs.

Administrative Costs: Like the MicroFIT program, the FIT program is equally automated and fairly straightforward. However, because the projects are larger under the FIT, the approvals process is more complex and may require more time and money. Indeed, the contract and application with the OPA is more detailed under the FIT than the MicroFIT (Ontario Power Authority, 2009). That being said, much of the administrative costs are essentially identical to Option 1, so we have assumed an administrative cost of $1500 and an annual cost of $100.

Maintenance Costs: Again, we assume that under Option 2, annual maintenance costs are equal to approximately 1% of the initial cost of the system, which in this model is $2,900/yr (RETScreen, 2009). But, we again note that this is at the high end of the scale and costs should be discussed with the contractor.

Revenues: As mentioned above, the project would qualify under the FIT program and because of its size, electricity generated from the project could be sold back to the grid at a price of $0.713/kWh. Based on the size and estimated efficiency of the system, the project should generate $26,892 a year. With costs taken into account, this results in a simple payback of 12.4 years and a return of 4.8%. Again, we must emphasize that these figures do not account for any possible grants or external funding.

	Size (kW)	Cost ($)	FIT Rate ($/kWh)	Payback (years)	Return (%)
Option 1	9.9	92600	0.802	11.2	6
Option 2	32.4	297100	0.713	12.4	4.7

Figure 2: Cost Comparison and summary of 2 proposed options.

Pragmatic Considerations

The major aspects of this project have been discussed above, but a few pragmatic issues should be taken into consideration, including potential barriers and opportunities.

Social Acceptability

One of the largest barriers faced by renewable energy projects is their social acceptability. Social acceptance of a project is very important, as projects that might be economically feasible might be hampered by a variety of factors that will make them unacceptable to the general public. Wind power, another renewable energy technology, is most commonly associated with social acceptance issues, primarily over aesthetics, noise, health impacts and wildlife concerns. As a result, several wind power projects are not developed.

Solar PV technology is also subject to social opposition. To some, having solar panels placed on an easily viewed rooftop may not be aesthetically pleasing. This concern, however, is more common on residential properties than commercial or recreational properties, such as the arena. Any aesthetic concerns can be offset with educational or community landmark benefits, which are mentioned in the following section. Solar PV also faces criticism from agricultural proponents when projects are proposed on agricultural land. This concern, of course, does not apply to rooftop PV technologies.

In addition to the technology itself, it is very important that the process of proposing the project and developing the project be done in the most open, transparent and inclusive manner possible. Quite commonly, renewable energy projects are developed in a manner that seeks to ignore this type of a process and as a result, are vehemently opposed by the community. Community ownership of a project – including municipal ownership – is positively associated with social acceptability, but does not guarantee it (Toke, Breukers, & Wolsink, 2008). We strongly encourage making the greatest effort possible to make it an inclusive development process.

Educational Benefits & Community Showpiece Applicability

One of the major benefits of this project, apart from the economic and environmental benefits, is the educational benefit it could bring. Once installed, the system could act in partnership with schools in the nearby area to educate young people on solar energy. Indeed, the Toronto Renewable Energy Co-operative – the group that runs the wind turbine at Exhibition Place in Toronto – has partnered with the Toronto District School Board to run Renewable Energy Education programs with nearly 12,000 students in Toronto (Toronto Renewable Energy Co-operative, 2009). Obviously, the Minden arena project would not match the scale of the Toronto project, but the general idea and benefits would be similar.

Students would not be the only ones to benefit educationally from the project. Individuals, community groups and commercial businesses could also benefit from the project as a formal demonstration. That is, they could see the system right before their eyes and potentially explore the possibility of applying the technology to their own properties. Furthermore, the arena, which is frequented by the community, would serve as an ideal location to showcase the benefits of solar PV technology.

Next Steps

The intent of this report is to act as a pre-feasibility study of the solar PV project on the rooftop of the arena. In-depth, highly detailed and case-specific studies are beyond our capacities and the scope of this report. However, if you elect to move forward with a solar PV project, we can point you in the right direction.

The next steps involve contacting a solar energy developer and contractor nearby. That is, a professional. Searching for external funding and grants for the project would also be beneficial, especially since such a project would qualify as a community project.

Solar Developers in the Minden/Peterborough Area:

Who: **Generation Solar**
What: Design, supply, install and service solar PV systems
Where: Peterborough, ON
Website: www.generationsolar.com
Contact: (705) 741-1700 or info@generationsolar.com

Who: **REAL Energy Alternatives**
What: Design, supply, install and service solar PV systems
Where: Peterborough, ON
Website: www.realalternatives.ca
Contact: (705) 743-8061 or realenergy@sympatico.ca

Who: **Eco Alternative Energy**
What: Design, supply, install and service solar PV systems
Where: Peterborough, ON
Website: www.ecoaltenergy.com
Contact: (705) 742-9997

Funding Sources

Green Municipal Fund (GMF)

The GMF is a fund operated by the Federation of Canadian Municipalities that seeks to provide funding for environmentally and energy related projects in Canadian municipalities. Often, these projects have costs between $100,000 and $500,000 and significant levels of funding through grants are available.

More information can be found at: www.sustainablecommunities.fcm.ca/GMF/

Community Power Fund (CPF)

The CPF was established several years ago as a $3-million fund to aid community groups (including municipalities) develop energy projects through grants for small pre-feasibility studies, larger feasibility studies and capital financing of projects. The CPF is nearly empty, but a much larger fund is being established under the Green Energy Act and the CPF is likely to administer it.

More information can be found at: www.cpfund.ca

Lending Institutions

Lending institutions, such as banks and credit unions, are often sources of financing for energy projects. Municipal projects, especially those with an OPA contract, are considerably appealing to lenders because of their secure credit rating. However, bank loans can significantly reduce the viability of the project if the interest rate charged on the loan is higher than the rate of return. If possible, low or zero-interest loans would be preferable.

Alternative Idea: Conservation Measures

While researching information online for this report, we came across a group called Local Authority Services. They offer an energy auditing service for municipal buildings all over Ontario. Interestingly, we encountered two audits they completed of municipal arenas in Ontario.

The audit appears to consist of a highly detailed site visit where the total energy consumption is evaluated at the arena and every contributing factor to the consumption is assessed. Pictured below is a chart taken from one of the reports and it displays the variety of factors that could be changed at the arena to decrease energy consumption. As you can see, many of the factors are very cost-effective.

Proposed Retrofit

Opportunity	Annual Energy Savings Elec. (kWh)	Annual Energy Savings Thermal (ekWh)	Annual GHG Savings (tonnes CO_2)	Savings per year ($)	Cost of Project ($)	Simple Payback (years)
Rotary Timer - Upstairs Heating	0	800	0.1	40	400	10
Head Pressure Control	9,800	0	2.2	700	4,000	5.7
Variable Speed Drive - Cooling Tower	9,600	0	2.1	700	5,800	8.3
Freezers in Boiler Room - Relocated	2,600	0	0.6	200	300	1.5
Parallel Instantaneous DHW	0	5,400	1.0	200	2,500	12.5
Cooling Tower Full Efficiency Pack	14,700	0	3.2	1,100	9,000	8.2
Desuperheater for Flood Water	0	70,000	12.9	3,000	20,000	6.7
Atmospheric Boiler to Condensing	0	69,000	12.7	3,000	16,000	5.3
Infrared Camera	31,000	0	6.8	2,300	10,300	4.5
TOTALS	**67,700**	**145,200**	**41.6**	**11,240**	**68,300**	**6.1**

Figure 3: Proposed Retrofit of Glencoe Arena, Middlesex, On.

Energy conservation measures are often considered to be considerably more cost-effective than other initiatives, such as energy production projects. The work done by Local Authority Services is well beyond the scope of this report and our expertise, but the potential for cost and energy savings is quite high. If you are interested in pursuing these measures, we highly recommend contacting Local Authority Services:

Local Authority Services
Toronto, ON
Phone: (416) 971-9856
Email: amo@amo.on.ca
Website: www.amo.on.ca

Copies of the arena reports can be found at:
www.amo.on.ca/Content/las/EnergyServices/Audit/AuditBinder/default.htm

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