Feasibility Analysis for a SolarShare Co-operative in the City of Toronto

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Short Project Description

This report describes a feasibility analysis and the development of a business model for a solar electric co-operative within the City of Toronto and the Greater Toronto Area.

Summary

Of the various forms of solar energy, the Toronto Renewable Energy Co-operative (TREC) chose to examine only the feasibility of developing a co-operatively-owned rooftop array of solar photovoltaic (PV) panels, called "SolarShare". TREC identified a portfolio of potential projects and partners representing nearly four megawatts.

Unfortunately, after extensive analysis, TREC found that rooftop PV projects are not profitable in Ontario without a reduction in up-front costs of $3,500-$5,000/kW, an equivalent subsidy, or a substantial increase in tariff payments under Ontario's Standard Offer Contract program.

Acknowledgements

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[1] 401 Richmond St. W, Suite 401, Toronto, Ontario M5V 3A8, Canada, 416 977 5093, MikeBrigham@sympatico.ca, www.trec.on.ca. Brigham is on the board of directors of the Toronto Renewable Energy Co-operative.

[2] 208 S. Green St., Tehachapi, CA USA 93561, 661 325 9590, pgipe@igc.org, www.wind-works.org. Gipe is an adviser to the Toronto Renewable Energy Co-operative.

Evergreen; Ken Traynor, West Toronto Initiative for Solar Energy; David O'Brien, Joyce McLean, and Jack Simpson, Toronto Hydro; and Danny Chui, Mark Goss, and Dianne Young, Exhibition Place.

Summary of Findings

The installed cost of large rooftop solar PV installations in Ontario ranges from $7,500 to $8,500/kW.[3]

The yield of crystalline solar PV in Toronto in theory and in practice is from 1,100 to 1,200 kWh/kW/year.

SolarShare quickly amassed a portfolio of potential projects totalling nearly 4 MW.

Simple economic analysis of feasibility compares well to a more detailed financial model.

Rooftop projects are not profitable in Ontario without a reduction in up-front costs of $3,500-$5,000/kW or an equivalent subsidy.

On average performance degradation of crystalline solar cells is typically less than 1% per year.

Annual running or reoccurring costs range from 0.8% to 1.5% per year of total installed costs.

There is likely a substantial residual value in a solar PV plant in the 21st year.

Background

In December 2004 the Ontario Sustainable Energy Association (OSEA) presented a workshop for stakeholders by ADEME's Bernard Chabot[4] to determine the tariffs necessary for the profitable development of renewable energy in the province. The workshop determined that a price of $0.83/kWh paid under contract for 20 years was necessary for electricity generated by solar PV for a minimal level of profitability under Ontario conditions.[5]

Ontario's groundbreaking Standard Offer Contract (SOC) program implemented in November of 2006, pays $0.42/kWh for electricity generated by solar PV under 20 year contracts[6]. While the highest tariff for solar PV in North America, this is a

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[3] Canadian (CAD) dollars.
[4] Bernard Chabot, ADEME (Agence de l'Environnement et de la Maitrise de l'Energie), 500, Route des Lucioles, Sophia Antipolis, F-06565, France, + 33 4 93 95 79 14, bernard.chabot@ademe.fr.
[5] Powering Ontario Communities: Proposed Policy for Projects up to 10 MW, http://www.wind-works.org/FeedLaws/Canada/PoweringOntarioCommunities.pdf, visited May 14, 2007, page 36.
[6] There is no inflation clause in the SOP for PV such as there is for wind.

fraction of the tariffs paid in Europe and exactly one-half that recommended in OSEA's report to the Ministry of Energy on the SOC program in the spring of 2005.

With the advent of the SOC program, the Ontario Power Authority (OPA) has signed contracts for 89 MW of solar PV, 99.7% of which are for large, ground-mounted, central-station PV arrays. The remaining 0.3% of contracts are for rooftop arrays installed on homes and businesses by what the solar industry calls "early adopters".

Interest in Ontario's SOC program and especially solar PV is extremely high. Many of the small systems installed in the city of Toronto were in response to neighbourhood groups, such as RISE (Riverdale Initiative for Solar Energy), that launched group buying programs. Hundreds turned out for neighbourhood meetings to learn about solar PV and solar hot water systems. However, many interested homeowners were turned away because their homes were not well situated for solar. Others found the up-front cost prohibitive. Thus, there was a growing pool of those in the city who wanted to invest in solar energy but who couldn't find a vehicle through which to do so.

When the SolarShare project was launched in February 2007, TREC envisioned an investment co-operative patterned after TREC's successful WindShare model that installed one 750 kW wind turbine at the City of Toronto's Exhibition Place.

Unfortunately, conditions in the Ontario solar PV market had not appreciably changed since OSEA's pricing workshop in 2004. Nevertheless, TREC was also aware that two companies had signed multiple 10 MW contracts to build solar PV plants at the $0.42/kWh tariff and wondered, "Do these developers know something about solar PV that TREC and OSEA do not?"

In short, "Is there a way to develop a profitable solar PV project in Ontario at $0.42/kWh," and if so, "can it be done using the co-operative model?"

Co-operatives

Because of WindShare's reputation, word spread quickly that TREC was exploring a SolarShare co-operative. Developers and community groups soon began approaching SolarShare for grant funding. They had quickly determined that solar PV was not profitable in Ontario without substantial grant funding and hoped that SolarShare had a pool of money to give away.

Co-operatives are businesses.[7] While they may have social objectives, they are first and foremost businesses that are created to earn a profit for their members—their investors. They are not charities. Co-operatives can be and often are pioneers in new fields, such as WindShare was with wind energy in Ontario. However, co-

[7] The selling of shares by co-operatives in the province is licensed by the Financial Services Commission of Ontario.

operatives cannot develop projects of any meaningful size by appealing to “green fringe” investors, those who are willing to invest without expectation of a return.

The requests to SolarShare for grants was further proof, if any were needed, that the Ontario solar PV market was immature and projects were not likely to be profitable until conditions changed: either solar PV prices drop dramatically, Ontario’s SOC tariff for solar PV is increased substantially, other “top-up” tariffs are offered by utility companies, or other organizations step forward with large grants.

Objectives

TREC’s SolarShare project set out to pursue several objectives.

- Explore the possibilities for the development of solar energy in Toronto
- Examine Solar Co-operatives in Germany and their Applicability to Canada
- Create Economic & Financial Modelling Tools for Solar PV & Solar Thermal
- Determine Key Parameters Affecting Profitability
- Determine the Profitability of Solar PV & Solar Thermal in Ontario
- Determine Conditions Necessary for Profitability in the Future
- Determine Preliminary Financial and Organizational Structure
- Identify Preliminary Sites and Potential Partners
- Develop a Replicable SolarShare Business Plan

SolarShare sought specifically to develop rooftop projects within the urban core of Toronto. The urban core is where the demand for new capacity is greatest and both the benefit of rooftop solar PV and its public profile would be highest.

Further, SolarShare seeks to provide the opportunity for individuals to invest in community solar development.

Outside Sources of Information

There is very little grid-connected solar PV in Canada. In total, there is less than 20 MW of solar PV in the entire country and most of that is off-the-grid. The two largest solar PV systems in Canada are a 100 kW system on the Horse Palace in Toronto and a comparable size system in Charlottetown on Prince Edward Island. Both were installed within the last two years.

German Bürgerbeteiligungs

No other country has seen more solar PV development than Germany. Nearly two-thirds of German solar PV capacity has been installed by farmers, homeowners, and by limited partnerships known as Bürgerbeteiligung in German. These limited partnerships, while not true co-operatives, share similar attributes. Most importantly, Bürgerbeteiligungs allow for individuals to invest in commercial solar projects.

Many of the offering documents for Bürgerbeteiligungs can be found on the web. SolarShare examined several of these offerings and visited one 365 kW project operating in Freiburg, Germany.[8] SolarShare also interviewed the manager of another project in Stuttgart.[9]

Toronto Solar Roundtable

Since the introduction of Ontario's SOC program, there has been a flurry of interest in solar, both solar PV and solar DHW (Domestic Hot Water), in Toronto. Several community groups have formed across the city and are pursuing bulk purchases of solar systems. The first was the Riverdale Initiative for Solar Energy (RISE), but a number of others have followed suit.

These groups have organised large public meetings, interviewed vendors, and written detailed bid specifications. At least three groups have selected vendors for solar PV systems up to 3 kW. The installed costs for these systems are now public.

To share the knowledge gained by these independent groups, OSEA and Eneract have organised two meetings, dubbed "The Toronto Solar Roundtable." The meetings have provided a public forum for sharing experience to date as well as a discussion of the continuing barriers to solar energy in the city.

Solar PV or Solar Thermal

Our German colleagues discouraged SolarShare from using the co-operative model for solar hot water, at least initially. Commercial-scale solar hot water systems require a stable market for their heat generation that is not always readily available. There must be a client for the solar hot water with both a willingness and ability to pay for it over an extended period. While such markets exist, they are not as easily identified as the market for electricity sales.

SolarShare investigated using the co-operative model for the development of solar energy in the city because of the interest in solar spawned by Ontario's SOC program that offers a fixed price for solar-generated electricity. The SOC program doesn't currently offer a tariff for the heat produced by solar hot water systems.[10]

The price paid for commercial quantities of solar hot water, then, is negotiated between the solar developer and the potential client. Our German colleagues warned that these negotiations drag on for months if not years as clients wait for a collapse in high fossil-fuel prices.

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[8] Fesa-GmbH, Josef Pesch, PhD, Wippertstrasse 2, Freiburg, Baden-Württemberg, D-79100, Germany, + 49 761 400 1530, pesch@fesa-gmbh.de, www.fesa-gmbh.de.
[9] Ecovision GmbH, Georg Hille, Glümerstr. 35, Freiburg, Baden-Württemburg, D-79102, Germany, +49 761 707 2730, georg.hille@t-online.de, http://www.ecovision-gmbh.solar-monitoring.de/.
[10] OSEA is recommending that the OPA issue a solar hot water tariff in revisions to the SOC program scheduled for the spring of 2008.

Though SolarShare interviewed two vendors of commercial solar thermal systems in the early days of the project, and there are now federal and provincial subsidies that make solar hot water attractive, SolarShare chose to focus our limited time on solar PV. Finding a client and negotiating a contract for solar hot water was more time consuming than this project warranted.

In summary, there is a ready market for solar electricity. The technology is proven, widely available, and economies of scale exist for large systems. For these reasons, it is easier to construct a financial model to determine whether a project is feasible or not with a higher degree of certainty for solar PV than that for solar hot water.

SolarShare will likely revisit the case for a co-operative solar hot water project at a later date.

Organizational Structures

The structure of SolarShare will significantly affect the profitability or financial performance of the venture. This project will make a preliminary determination of the optimum business structure for SolarShare.

Experience to date indicates that the structure of the SolarShare venture will in part determine its financial feasibility. The structure will determine what tax advantages or disadvantages will accrue to individual investors and the venture as a whole. Thus, it will be necessary to obtain a legal opinion on both the structure of the organization and the tax effects this will have under Ontario and Canadian law. Several ownership structures will be evaluated.

Co-operative

The is the default choice because it more easily meets SolarShare’s social and community objectives, as well as being one the least expensive structures to launch. The co-operative would own the assets and earn a return from those assets.

Joint Venture

A joint venture is compatible with most of SolarShare’s co-operative objectives. In a joint venture with Toronto Hydro, for example, SolarShare would provide the debt and Toronto Hydro the equity. This would allow Toronto Hydro to maximize any tax savings through Capital Cost Recovery System (depreciation deduction) of the federal Canadian tax code. By providing the debt portion of the investment, SolarShare’s investors would receive regular payments, assuming the project was profitable and could pay down the debt. In this arrangement, SolarShare would not own the assets. This approach differs from that of the WindShare turbine at the

Exhibition Place where both Toronto Hydro and WindShare each own equal shares of the wind turbine.

Joint Venture with a Tax-exempt Charity

This novel strategy enables a taxable entity, such as Toronto Hydro, to maximize tax savings from the Capital Cost Recovery System (depreciation deduction) and investors in a Solar-Share co-operative to receive regular returns while raising a project subsidy from a charity. The charity, such as Evergreen's Brickworks project or Toronto's Clean Air Partnership would provide the subsidy necessary to make the project profitable (35% to 65%). In return, full ownership or a portion of the ownership in the project would be donated to the charity in the 21st year, that is, after expiration of the Standard Offer Contract.

The potential ownership by a charity in an on-going, cash-generating project would be similar to that of a donor's investment in income-earning endowment designated for the purposes of the charity. The risks may be higher and the returns potentially less than a donor's gift to an endowment, but such a gift may better and more directly fulfil the objectives of the charities devoted to clean air and sustainable energy than would a traditional endowment.

The residual value of solar PV project may be greater than that anticipated here, or the for-profit project may need more than 20 years to pay a sufficient return to justify the investment. Similarly, only a portion of the residual value could be donated to the charity and the for-profit project could retain a portion beyond the 20th year. In such a project both the charity and the for-profit investor share in some degree of the risk as well as in the upside beyond the 20th year.

Preliminary Sites

No project will be possible without a site and no financial analysis will be complete without an estimate of site costs for land rent. The ideal site will have high visibility to maximize the benefits to SolarShare, TAF, and the city, will be readily accessible to simplify installation, service, and public visitation, will incur little or no land use cost, and will have a relatively low risk of vandalism and theft. By the nature of the project, the site must have an unobstructed south-facing view and a low probability of shading intrusion for the 20-year life of the project.

- High Visibility
- Accessibility
- Low or No Land Use Cost
- Low Vandalism Risk
- Unobstructed South Facing View
- Low Probability of Shading Intrusion for 20 Years

There are no shortage of potential rooftop sites within the City of Toronto and the Greater Toronto Area for solar PV installations. Within a few months SolarShare identified nearly 4,000 kW (4 MW) of potential projects within the GTA.

In co-operation with the staff of the Exhibition Place, SolarShare quickly identified several sites on the ExPlace grounds and specifically examined the Better Living Centre and the Direct Energy Centre.[11] In addition, private commercial developers and non-profits brought several projects to SolarShare for co-operative development. At the conclusion of the study, SolarShare was turning away additional projects.

SolarShare Potential Project Portfolio	
	Approximate Size
Site	kW
GTA Art Gallery	200
Solar Barns (WISE)	150
Evergreen Brick Works	200
ExPlace Better Living Centre	500
ExPlace Direct Energy Centre	2,700
Total	3,800
Note: No contracts, leases, or agreements are in place with any of the site owners. This list is merely suggestive of opportunities for SolarShare.	

SolarShare has not entered into formal agreements with any of the sites listed. However, all have expressed interest in working with SolarShare to develop potential projects at these sites.

Clearly, this is just a small sample of the solar PV potential on rooftops within the GTA. SolarShare barely scratched the surface. As an indication of the level of interest among Torontonians to develop their solar resources, many of these projects were brought to SolarShare by word of mouth.

Potential Partners

As in WindShare's experience with Toronto Hydro, finding a joint-venture partner can contribute greatly to the project's success. There is very little experience with commercial solar projects in Canada. It can benefit both SolarShare's objectives and those of TAF by finding a project partner who has project development experience and who can aid in replicating the experience with other solar projects in the city.

Another possible criterion for a project partner is that it has sites suitable for a SolarShare project and meets the necessary conditions. For example, solar co-operatives in Germany often use school rooftops (Stuttgart) or other public facilities

[11] TREC and the SolarShare project team would like to thank the staff of ExPlace for their co-operation. ExPlace is a pioneer in renewable energy development in Canada with the 100 kW solar PV plant on the roof of the Horse Palace and with the 750 kW WindShare turbine near the Liberty Grand.

like highway noise barriers (Freiburg), public parking garages (Freiburg), and sports stadiums (Freiburg).

Though SolarShare has no formal agreements with any potential partners, there is no shortage of potential rooftop sites or partners within the city of Toronto. The interest in solar PV is so high that SolarShare has not had to actively seek partners or projects. Those listed below have approached SolarShare.

Exhibition Place

The WindShare turbine is located at the ExPlace and there are few hosts as amenable to co-operatively developing their renewable resource as the ExPlace. Currently the ExPlace operates a 100 kW solar PV array atop the Horse Palace and would like to add additional arrays on the Better Living Centre and the Direct Energy Centre. These two buildings alone have the potential for arrays totalling more than 3 MW of solar PV. If implemented, either of these two projects would represent the largest solar PV installation in Canada and would alone account for more than one-tenth of Canada's total installed solar PV capacity.

There may be other opportunities at the ExPlace as well. Cleveland's Great Lakes Science Center has installed a 30 kW solar PV architectural array in front of their building. The array forms an attractive shade structure that flanks the entryway. The long approaches to the Direct Energy Centre may be suitable for a similar treatment.

While the larger rooftop arrays would generate significantly more energy, a solar PV shade structure in flanking the Direct Energy Centre would be visible to the tens of thousands of visitors to the ExPlace every year. Solar PV becomes real to visitors when they can see working systems. Digital displays can be used to report real-time production from both the shade structure and the much bigger rooftop arrays not visible to passers-by.

Evergreen's Brickworks

Evergreen, the non-profit developer of the city's Brickworks property in the Don Valley, has approached both Toronto Hydro and SolarShare for aid in adding a solar array to their project. Toronto Hydro estimates that the Brickworks buildings could support up to 200 kW of solar PV. Toronto Hydro, SolarShare, and Evergreen have discussed various financing options that would take best advantage of the assets of each party.

WISE

West Toronto Initiative for Solar Energy (WISE) has also approached SolarShare for the co-operative development of the solar potential on the city's former Wychwood transit barns.

GTA Art Gallery

A private solar PV system integrator has also approached SolarShare for financing to install a 200 kW array at a popular GTA art gallery.

Potential Vendors

SolarShare interviewed four solar PV system integrators that service the Ontario market. Each was asked to provide a detailed cost estimate of installing a solar PV system on the Better Living Centre and the Direct Energy Centre at the ExPlace. All vendors were provided with roof drawings and all participated in a site visit in co-operation with the staff of the ExPlace. Three of the four vendors responded with estimates.

The estimated installed costs ranged from $7,500/kW to $8,500/kW.[12] Similarly, yields ranged from a low of 1,100 kWh/kW/year to a high of slightly more than 1,200 kWh/kW/year. Estimated yields degraded from a low of 0.6% per year to a high of 1% per year.

No system the size of those envisioned for the ExPlace have ever been installed in Canada. As a consequence of the Canadian market's immaturity, all but a few vendors may have difficulty delivering rooftop projects of the megawatt scale. Most Canadian vendors are relatively small and may not have sufficient cash flow to carry a $25 million project on their books.

Part of SolarShare's objective is to help build Ontario's solar industry, to help create a more dynamic market than today's cottage industry. It may be prudent, then, for

[12] One estimate was substantially higher than that presented here.

SolarShare to stage the larger projects into phases of 100 kW to 250 kW, allowing vendors to gradually build up their capacity.

There is one manufacturer of solar PV modules in the country and there are several inverter manufacturers, but the solar PV industry in Canada, such as it is, is only nominally Canadian. Cells for the module manufacturer are made in Germany and much of the electronics for the inverters are made in Asia. Nevertheless, the module manufacturer delivers substantial value added through its innovative processing and there is the potential for new Canadian manufacturers using Canadian developed technology. To keep pace with the booming world market, Canadian inverter manufacturers will have to soon invest in new plants. These plants could conceivably be built in Canada and not necessarily in Asia.

To maximize local, regional, and national benefits, SolarShare could give preference to Canadian solar PV manufacturers where possible in addition to SolarShare's preference for Canadian system integrators.

Flexible Economic Model

The enthusiasm, some could charge naïveté, of solar advocates in Ontario since the introduction of Ontario's SOC program has led many to overlook fundamental financial factors in determining the profitability of solar.

Simple economic models can be invaluable in designing incentive programs, such as the SOC program, or in evaluating various project proposals. These economic models differ from more detailed financial models that look at project income and expenses and the effects on investors.

SolarShare examined several simple spreadsheet models for economic analysis: The Profitability Index Method by ADEME's Bernard Chabot, an annuity model used by the Bundesverband Solarwirtschaft (the German Solar Industry Association), and the calculation of a simple annuity and the tariff this would represent.

Note that these spreadsheet calculators remain a work in progress. The workbook contains three spreadsheets: BSi Calculator, Chabot PI Method, and PAYMT Calculation.[13] The calculator determines the price or tariff per kWh necessary to arrive at the financial targets given.

The first page contains cells for entry of the key assumptions. It also contains a summary of the results for each method or table used.

Note that all calculations are before taxes. This is critical to understanding the values produced.

[13] http://www.wind-works.org/Solar/SolarCostCalculatorUsingChabot-BSi-RateMethods.html, visited September 14, 2007.

Variables

As in any economic calculation there are several key variables. Here, they are the specific installed cost ($/kW), the yield (kWh/kW/year), the rate of return on equity desired, the interest on debt, and annual expenses.

Solar Cost Calculator Using Chabot-BSi-Rate Methods			
Adapted by Paul Gipe, pgipe@igc.org			
11-Apr-07			
Enter Data in These Cells.			
Rated Power		1	kW
Installed Cost	I	$10,000	
Specific Installed Cost	Ius	$10,000	$/kW
Annual Expenses	Kom	1.5%	on installed cost
Term	n	20	years
Equity		40%	
Return on Equity	ROE	6.5%	
Debt		60%	
Interest on Debt		6.5%	
Nominal AWCC		6.5%	
Inflation		2.0%	
AWCC real	t	4.4%	Discount rate real
Specific Capacity	Eas	1,200	kWh/kW/yr
Generation		1,200	kWh/yr
Used in Chabot PIM			
Profitability Index Target	PI	0.1	NPV/I
Used in BSi Calculator			
Term of Debt		10	years

This example uses similar assumptions to those used by OSEA in December of 2004: installed cost of $10,000/kW; yield of 1,200 kWh/kW/year; return needed of 6.5%, and annual reoccurring costs or running costs of 1.5% of installed cost.

Using these assumptions, the models produce the following results.

Results	
	$/kWh
BSi Calculator	0.88
Chabot PIM	0.82
@Paymt Modified	0.92

The tariff produced using the Chabot PIM of $0.82/kWh is about that used in OSEA's 2005 report.

BSi Solar Cost Calculator

The BSi is now the Bundesverband Solarwirtschaft or BSW, the German Solar Industries Association.[14] The table was provided by Gerhard Stryi-Hipp to OSEA for use in determining the solar PV tariffs needed in what has become Ontario's SOC

[14] Bundesverband Solarwirtschaft (BSW) i.Gr., stryi-hipp@bsw-solar.de, www.solarwirtschaft.de.

program. The table uses the approximate English equivalent of the original German.

Chabot-Gipe PIM

In December 2004, ADEME's Bernard Chabot led a pricing workshop in Toronto. The workshop included stakeholders from all the technologies in the Standard Offer Program. The purpose of the workshop was to determine the tariffs needed for profitable projects. Chabot uses a technique that he calls the "Profitability Index Method" to arrive at a recommend tariff. He has written prolifically on the technique.

The spreadsheets used by SolarShare have been adapted from the Chabot model.

The Profitability Index Target should be in the range of 0.2-0.3 to foster industrial growth. A Profitability Index of zero or 0.1 indicates that the project will be profitable, but not greatly so. For rapid growth of a new technology, projects must be more than just profitable. They must be financially attractive to compete for investment capital.

Chabot-Gipe PIM Solar PV.wb3			
Note: Before tax, 100% Adjustment with Inflation.			
From Variables Page			
Average Weighted Cost of Capital Before Tax			
Equity		40%	
Return on Equity	ROE	6.5%	
Debt		60%	
Interest on Debt		6.50%	
Nominal AWCC		6.5%	
Inflation		2.0%	
AWCC real	t	4.4%	
Rated Power (kW)		1	
Installed Cost	I	$10,000	
Specific Installed Cost	Ius	$10,000	$/kW
Annual Expenses	Kom	1.5%	
Term	n	20	years
Discount Rate (AWCC)	t	4.4%	real
Specific Capacity	Eas	1,200	kWh/kW/yr
Capital Recovery Factor (n,t)	Kd	0.0763	
Profitability Index Target	PI	0.1	NPV/I
Cost of Energy	T1	$0.824	$/kWh
Simple Payback		10.1	

Using Chabot's PIM model, program designers can quickly test the tariffs necessary at various installed costs and various values for the Profitability Index.

Solar PV Tariff $CAD/kWh							
Chabot Profitability Index Method Simple Solar PV Tariff Pricing							
PI Index	Installed Cost in $CAD/kW						
$0.824	4,000	5,000	6,000	7,000	8,000	9,000	10,000
0	0.30	0.38	0.46	0.53	0.61	0.68	0.76
0.1	0.33	**0.41**	0.49	0.58	0.66	0.74	0.82
0.2	0.36	0.44	0.53	0.62	0.71	0.80	0.89
0.3	0.38	0.48	0.57	0.67	0.76	0.86	0.95

For example, using the solar PV tariff in the SOC program, it would be necessary for installed costs to fall 60% to 65% to earn the returns desired under the conditions assumed. At installed costs of $7,500/kW, a tariff from $0.60-$0.70/kWh would be necessary. That this conclusion is similar to the current tariffs in Germany is an example of the Chabot model's robustness.

Payment Method

Spreadsheets incorporate a number of functions for calculating annuities. The Payment Calculation table uses the spreadsheet's internal function for calculating the annual payment of an annuity. To try to better reflect reality, annual operating costs have been included. The annuity is calculated on the sum of installed costs and annual costs.

Rate of Return Calculation of Solar PV Using @PAMT Function		
by Paul Gipe		
Installed Cost	$10,000	$/kW Cost of solar system
Fv	$0	At end of period
Nper	20	years
Type	0	End of year
	1	Payment per year
Generation	1,200	kWh/kW/yr
O&M	1.50%	% of installed cost/yr
O&M Cost	$150	$/yr
Inflation	0.02	
Total O&M	$4,458	$ for 20 years, Note this value is higher than from cash flow.
Total PV Investment	$14,458	sum of Installed Cost and Total O&M costs
@Payment	$1,103	@PAYMT(Variables:C16,B5,-B13,B4,0)
COE	$0.92	Cost of Energy

While all three models are useful, the Chabot PIM model appears the most robust, simple to use, and best reflects the realities of the marketplace and solar PV tariffs used worldwide.

Key Parameters

Installed Cost

Installed prices averaged about €5,500/kW ($7,900 CAD/kW) with a range from €4,000/kW to €7,500/kW ($6,200 CAD/kW to $11,500 CAD/kW) for small systems.

The average installed price for large, that is MW-scale, systems averaged €4,800/kW ($6,900 CAD/kW) with a range from €4,000/kW to €6,000/kW ($5,800 CAD/kW to $8,600 CAD/kW).

German installed PV prices are about $2,000 CAD/kW less than the average installed cost of existing solar PV systems in Canada.

German Solar PV Installed Price 2006						
				1.4392		
	€/kW			$CAD/kW		
	Low	Avg	High	Low	Avg	High
Small	4,000	5,400	7,500	$5,800	$7,800	$10,800
Large	4,000	4,800	6,000	$5,800	$6,900	$8,600
Source: German Solar Energy Association.						

Solar integrators are selling 2 kW to 3 kW solar PV systems on rooftops in Toronto for about $9,000/kW to $10,000/kW. SolarShare requested estimates for installing commercial solar PV systems on the roofs of the Better Living Centre and the Direct Energy Centre at ExPlace from four system integrators serving the Ontario market. The estimates received varied from a low of $7,500/kW to a high of $8,500/kW for arrays in the multimegawatt range.

Solar Yields on Tilted Surfaces

The following table gives the typical yields (kWh/kW/year) that can be expected at various locations mostly in North America. The expected average yields in Ontario are about 20% greater than those in Germany.

Solar Radiation & Yields on Tilted Surface				
		mono-Si	poly-Si	Source
	kWh/m²/y	kWh/kW/y	kWh/kW/y	
Canada				
Toronto, ON	1,450	1,217	1,089	RetScreen
Toronto, ON/Sanyo		1,180		RetScreen
Toronto, ON	1,486	1,083		NREL
Wiarton, ON	1,590	1,345		RetScreen
Ottawa, ON	1,490	1,262		RetScreen
Ottawa, ON	1,580	1,166		NREL
Source: RETScreen® Solar Resource and System Load Calculation - Photovoltaic Project, www.retscreen.net.				
Source: NREL, http://rredc.nrel.gov/solar/codes_algs/PVWATTS/.				

For the economic analysis, SolarShare used a yield of 1,200 kWh/kW/year (specific capacity). For the financial analysis, SolarShare used a more detailed projection of 1,140 kWh/kW/year derived from the exact latitude of the ExPlace, 9% miscellaneous array losses, an average inverter efficiency of 94%, and miscellaneous power conditioning losses of 9%.[15]

[15] RetScreen, http://www.retscreen.net/, visited September 3, 2007. RetScreen is free software that uses Microsoft's Excel spreadsheet.

Annual Reoccurring Expenses

In both economic and financial models, provisions must be made for operations and maintenance expenses. While solar PV is significantly less expensive to operate and maintain than wind turbines, solar PV does incur annual or reoccurring expenses for running the plant. Notably, electronic inverters are not trouble free, and are by far the shortest lived system component with lifetimes generally in the 8 to 12 year range.[16]

Solar advocates in North America often overlook the cost of not only of operating and maintaining solar PV, but also reasonable charges for insurance, and extraordinary repairs.

Though there are reports on operating costs of some existing projects in North America as well as reports estimating annual reoccurring costs for proposed projects, there is no extensive literature on the costs of operating and maintaining solar PV plants in Canada and the USA.

There is a wealth of experience operating and maintaining solar PV in Europe, especially in Germany.[17] Moreover, some of this experience is in the public domain through offering documents and reports to investors that are published on the web.

Germany's Bundesverband Solarwirtschaft (the German Solar Industries Association) assumes that 1.5% of total installed cost will be paid annually in expenses for leased space, maintenance, and repairs. This is considerably higher than that suggested in North America and often comes as a shock to those unfamiliar with long-term operating costs of solar PV in Europe.

The estimated annual running costs of three German Bürgerbeteiligungs, or share partnerships, were examined. Each of these projects has been built and is in operation. All are in southern Germany.

- Fesa's B31 Bürgerbeteiligung[18]
- Regiosonne Breisgau Solar Bürgerbeteiligung[19]
- Stuttgart School Roof Top Bürgerbeteiligung[20]

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[16] Inverters are needed to convert the DC from the solar panels to the AC delivered to the network.
[17] In 2007, there was 2,500 MW of solar PV in operation in Germany.
[18] http://www.wind-works.org/Solar/FesaFreiburgSolarB31BuergerbeteiligungCashFlow.html, visited September 3, 2007.
[19] https://www.badenova.de/web/de/www-badenova-de_internet/angebote-internet/regiosonne2/breisgau_solar/regiosonne_Breisgau_Solar.html, visited September 3, 2007.
[20] http://www.wind-works.org/Solar/StuttgartSchoolRoofTopBuergerbeteiligung.html, visited September 3, 2007.

For example, consider Fesa's B31 project, a 365 kW solar PV array on a noise barrier in Freiburg, Germany.[21] The expenses listed below approximate 1% of total installed cost. Most of the cost is in managing, monitoring, and insuring the project.

The expenses for Regiosonne (Badenova, the local utility) Breisgau's Solar Bürgerbeteiligung differ slightly from those of Fesa's B31 project but costs for management, maintenance, and insurance dominate. Total costs are about 1.2% of installed costs per year.

Again, costs for management, maintenance, and insurance dominate the estimated annual operating costs for Stuttgart School's Roof Top Bürgerbeteiligung.

The average running costs for these three projects, totalling more than $8 million in investment, is about 1.2% of installed costs per year. For SolarShare's conservative analysis, annual reoccurring costs were assumed to be 1.5%.

Annual Reoccurring (Running) Costs			
Fesa B31 Reoccurring Expenses			
		Year 2	
Installed Cost		1,916,000	
Reoccurring Expenses			% of Installed Cost
	Deductible start-up costs		
	Management	6,691	0.3%
	Tax advice	1,500	0.1%
	Land lease	500	0.0%
	System monitoring	2,979	0.2%
	Maintenance and repair	1,020	0.1%
	Provision for removal	1,065	0.1%
	Insurance	5,477	0.3%
	Subtotal of expenses	19,232	1.0%
Regionsonne Breisgau Buergerbeteiligung			
		Year 1	
Installed Cost		2,600,000	
Reoccurring Expenses			% of Installed Cost
	Deductible start-up costs		0.0%
	Management	12,915	0.5%
	Tax advice		0.0%
	Land lease		0.0%
	System monitoring		0.0%
	Maintenance and repair	9,228	0.4%
	Provision for removal	1,820	0.1%
	Insurance	7,175	0.3%
	Subtotal of expenses	31,138	1.2%
Stuttgart School Roof Top Buergerbeteiligung			
		Year 1	
Installed Cost		1,310,000	
Reoccurring Expenses			% of Installed Cost
	Deductible start-up costs	0	0.0%
	Management	6,163	0.5%
	Tax advice	1,530	0.1%
	Land lease	0	0.0%
	Roof reconstruction	0	0.0%
	System monitoring		0.0%
	Maintenance and repair	5,507	0.4%
	Provision for removal	720	0.1%
	Insurance	3,231	0.2%
	Partner commission	1,250	0.1%
	Subtotal of expenses	18,401	1.4%
Total Installed Cost		5,826,000	
Total Expenses		68,771	1.2%

[21] See http://www.fesa-gmbh.de/de/realisiert/solar.php?id=61, visited September 3, 2007. This one project near Freiburg is larger than any single project in Canada.

Term

Though solar PV systems can last for many decades, the term, or period, considered in this example is equal to the number of years (20) that solar PV is paid under Ontario's SOC program.[22] Note that the financial model described in the next section can cover a longer period.

Return on Equity

SolarShare is a for-profit business where the assets are co-operatively owned and managed. The targeted return on investment in the co-operative is 7%. SolarShare believes this is a sufficient return to attract the capital to build projects at the megawatt scale. Social investors may be willing to accept less of a return if the risks are low. However, no projects of the scale proposed by SolarShare have ever been built in Canada and, consequently, the risks not well identified.

Interest on Debt

The simplest model for SolarShare is for the co-operative to provide all the financing directly without the need for a bank loan. The economic model is designed to be flexible so that it can be used by to characterise more traditional investments with entries for both equity and debt.

Average Weighted Cost of Capital

The Average Weighted Cost of Capital (AWCC) is the weighted average of the desired rate of return on equity and the interest on any debt used. The AWCC is then used as the real discount rate.

Flexible Financial Model

SolarShare has prepared a detailed and comprehensive financial model for a solar PV co-operative. The spreadsheet model has been adapted from the WindShare model used to develop WindShare's single turbine at the ExPlace. The model has been adapted for solar PV generation.

As opposed to the economic model, the financial model includes pro-forma income statements, balance sheets and cash flow statements for both before and after tax conditions. The full financial model is necessary when approaching investors and lending institutions as well as any regulatory agencies overseeing financial

[22] The Financial Model is more flexible than the Economic Model and allows for an extended period to earn a return on the solar investment.

transactions. Because tax policy can have a profound impact on profitability relative to individual investors, the financial model must include tax considerations.

The input variables used are shown on the following table.

Variables in Financial Model

Assumptions		
Expense inflation	2.50%	
Investment interest rate	2.25%	
LTD interest rate	7.50%	
Standby interest rate	2.00%	
Portion debt	0%	
Term of debt (years)	15	
Contingency rate - Operating expenses	10%	
Contingency rate - Capital cost	0%	
SOP rate per kWh	0.42	
Rate paid per kWh after 20th year	0.42	
RET (LDC "top-Up") rate per kWh	0.00	
EcoEnergy income (after SOP clawback)	0.005	
Co-op discount rate (targeted rate of return)	7.0%	
Annual recurring costs (oper, maint, admin, etc.)	1.5%	
System startup year	2009	
Project term (20, 25, or 30 years)	20	
Sale of residual value at end of term (insert manually)	0	
Income tax rate (co-op, 2008)	17%	
Array size (kWp)	1,000	
Misc. PV array losses	9%	24%
Average inverter efficiency	94%	total
Misc. power conditioning losses	9%	losses
PV production, MWh/year (before degradation)	1,140	
Output degradation by 10th year	8%	
Output degradation by 25th year	17%	
Output degradation annually past 20th year	0.30%	
Racking type (fixed or movable) and angle of inclination	Fixed, 20'	
Rooftop or Ground Mount	Rooftop	
Cost per watt installed	7.50	
Total system price w/o development soft costs	7,500,000	
SolarShare funding	100%	7,500,000
Other funding - sale of residual value at project start	0%	0
Other funding - grants	0%	0
Key to shaded areas:		
Turquoise = key variables		
Pale yellow = minor variables		
Grey = notes only. See cell comments.		

Panel Degradation

Solar panels degrade slightly as they age. The degree of degradation is a function of technology, the amount of sunlight to which they are exposed, quality of manufacturing, and environmental factors. Thin film solar cells have a higher degradation relative to that of crystalline cells. SolarShare considered only conventional crystalline solar cells in its analysis.

The performance degradation of conventional crystalline cells is small but can add up over the decades the panels will be in use. The majority of degradation occurs in the first few years. Some panel manufacturers warrant performance during the first 10 years for less than 10% degradation. SolarShare assumed 8% degradation during the first decade with 70% of this occurring in the first year.

All panel manufacturers will warrant performance at the end of the warranty period, generally guaranteeing at least 80% of rated output. SolarShare has assumed performance just slightly better than that to be cautious.

Residual Value

Crystalline Solar PV has a long operating life, much longer than that for wind turbines. Some crystalline solar PV systems have been in continuous use for more than 30 years and have many more years of life left yet.

The solar PV tariffs in Ontario's SOC program are paid for 20 years. However, those in Spain's program are paid for the first 25 years. Beyond 25 years, the Spanish program reduces the tariffs to 80% of their original value and continues to pay this reduced tariff for the life of the facility.[23] The Spanish program indirectly acknowledges the expected long life of a solar PV system and places a value on it.

In Ontario it is anticipated that at the end of the 20-year contract, the solar PV system will switch to a tariff reflecting either the wholesale price of power or the equivalent net-metering rate. Though there will likely be a market for the solar electricity, it is difficult today to determine the price that it will be paid and the revenues that the solar plant will earn in the 21st year and beyond.

Regardless of the cash flow that will be earned, the solar panels themselves and some of their associated hardware will have value. If wholesale power prices are

[23] The Spanish tariffs are also adjusted for inflation, unlike Ontario's solar PV tariffs.

low, the solar system may have greater value elsewhere.[24] The system could be dismantled and sold as a unit or in pieces.[25]

Thus, there is a high probability that the solar PV system will have a residual value in year 21. What the exact value will be is difficult to determine and it would highly speculative to place a concrete value on something 20 years into the future. Nevertheless, it's likely the system will have some value.

The residual value of a system could be determined by one of three methods; Salvage Value, Replacement Value, or Net Present Value (NPV) of the Net Profit From The Future Energy Sales. Of these, the Net Profit From Future Energy Sales was the one method that proved to be too difficult to evaluate under the scope of this project due to the numerous variables involved. Thus, only the salvage values and replacement costs were examined. See the worksheet entitled "Residual Value".

Salvage value and replacement cost figures were each evaluated over three project time periods; 20, 25, and 30 years. In each case, inflation at a rate of 2.5% per year was first calculated for the number of years in the project term and applied to each cost component before factors were applied that would devalue the system.

Next, cost components were devalued to allow for the number of years of use. Because labour would be required to uninstall a system under this option, a devaluation factor for labour of 150% was used; 100% to negate the value of the original installation labour and a further 50% allowance to cover labour of disassembly and removal. It should be noted here that an ongoing expense allocation for decommissioning the system was not included in this model as is often done in European pro forma financials because this labour allocation has already been included.

Next, a second devaluation factor was applied to allow for a reduction in value due to expected future cost reductions for new products. For instance, if in the 20th year, the cost of new panels has reduced by 75% over the cost of panels at the project start, there should be a further evaluation by this amount. In this worksheet, projected salvage values ranged from a high of 24% of the original system cost at 20 years down to 11% of new system cost after 30 years.

Estimations of future replacement cost were calculated in much the same fashion as for determining the salvage value, but with two exceptions. Panels were devalued only to allow for the anticipated amount of performance degradation due to the number of years and use. Inverters were devalued because it was assumed

[24] While it is always difficult to project power prices 20 years into the future, it is particularly difficult in Ontario where successive governments have chosen to subsidize electricity consumption by payments from the taxpayers. Every man, women, and child in Ontario bears a public debt of about $3,000 each due to this policy.

[25] In the late 1980s Arco's 6.5 MW solar PV plant on Carrizo Plains, California, the largest in the world until 2005, was dismantled and sold in pieces to buyers world-wide.

that the end of the project, there would be a mix of older and somewhat newer inverters, all of which should be fully functioning. Interestingly, after 30 years it would appear that the influences of inflation and component devaluation roughly equal each other such that the system cost remains unchanged.

As a result of this exercise, it would appear that residual values for the system would range from a low of 21% to a high of 100% depending on the project term and whether the user chooses salvage value or replacement cost as their preferred method of residual value determination.

On the assumptions page, a cell is provided wherein the user may insert the anticipated residual value if the system is disposed of at the end of the initial project term. The authors chose to work with a residual value of zero, for three reasons:

- So as to pursue a very conservative approach,
- With the widely varying range of results, it is difficult to ascertain what would actually be a realistic figure, and
- A method of capitalizing on the (possibly substantial) residual value could not be found. This particular issue represents a potentially large opportunity to improve the financial performance of the project, but the difficulty lies in utilizing it.

Charitable Flip

Rather than place a quantitative value on the PV system in the future, SolarShare has chosen instead to acknowledge the value qualitatively by noting that the value exists. SolarShare then suggests that all or some portion of the residual value, whatever it might be, can be transferred or flipped to another party. The receiving party then determines what it is worth to them using their own assumptions. For example, a charity could be solicited to provide a grant or subsidy to pay down the up-front cost of a project. In return the charity would receive all or a portion of the residual value in the 21st year. Similarly, the City of Toronto could provide a subsidy, insurance, and a lease-free rooftop on a building at the ExPlace. In the 21st year SolarShare would transfer all or a portion of ownership to the city. The charity or the municipality would then receive all or a portion of the profits generated by the solar PV plant for the next ten to fifteen years.

Falling Module Prices

The costs of solar PV systems have been steadily declining since their introduction. While there have been many press releases and news articles prophesising dramatic drops in the cost of solar PV, there are now two reasons to believe that this may occur. First, a world-wide shortage of PV-grade silicon appears to be coming to an end as more than two dozen companies around the world will bring to market an unprecedented level of new production capacity. The second factor is dramatic growth in new PV module assembly which will increasingly put downward pressure on PV panel prices in coming years. News accounts in the trade press suggest that these factors together may lead to the price of PV panels falling by as much as 40% before 2010.

In order to examine the effects such price changes would have on the overall system costs, a worksheet in the financial model was prepared entitled “Cost Decreases”. In this worksheet, two scenarios were considered, and the results are surprising. Even decreases in panel costs as great as 40% in three years or 60% in six years will, after inflation is taken into account, only reduce total system cost over today's installed system costs by 17% and 25% respectively.

While such cost decreases are significant, they alone are not sufficient to improve the profitability of solar PV systems under current financial conditions in Ontario to reach SolarShare’s targeted 7% return.

Flow-Through Investments

To encourage investment in high-risk natural resources ventures, the federal and provincial governments have permitted businesses to pass or “flow” tax benefits through to their individual investors. Mining companies use investments in “Flow-Through” shares to pass tax savings from exploring and developing new mineral deposits on to their individual shareholders, typically those in high tax brackets.

Flow-through shares are used in situations where companies have large tax deductions that cannot be used in the early years of a project. Such shares allow these large tax deductions to flow through to investors who then use them to reduce their taxable income. The value of the benefit is a function of the investors’ tax rate. The higher the tax rate, the greater the benefit. To high-income investors, the sheltering of income from taxes effectively lowers the net cost of one's investment. Conversely, high-income investors are willing to accept a lower rate of return than otherwise because of the tax benefits.

Investments in solar energy qualify for accelerated depreciation or the Capital Cost Allowance under section 43.2 of schedule II of Canadian Income Tax Regulations for Clean Energy Generation.[26] Although there is a steady income from power generation in a solar PV project, the income is insufficient to fully use the capital cost allowance in the early years.

In the case of a solar PV project, there are therefore two elements making Flow-Through shares attractive to SolarShare. First, the project would appeal to a broader range of investors, and, second, a project could be viable at yields somewhat lower that the 7% return targeted by SolarShare.

Unfortunately, it appears that Flow-Through shares have never before been offered by a co-operative, and some work would have to be done to convince the Canada Revenue Agency that such should be permitted.

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[26] See http://www.parl.gc.ca/information/library/PRBpubs/prb0606-e.htm#appendixb.

Additional Public Support Needed

Results from both the economic and financial analysis indicate that a SolarShare solar PV project--of any scale--is currently not profitable in Ontario under the SOC program without additional financial assistance.

Such assistance could be in the form of federal, provincial, or city grants and subsidies as well as or complementary to additional payments per kWh on top of the province's SOC program's solar PV tariff. Specific examples include:

- Significantly boosting EcoEnergy payment (federal),
- Federal or Provincial Tax Credit/Deduction (subsidy),
- Boosting OPA's solar PV Tariff,
- Adding a Solar PV Top Up Tariff,
- Up-front Provincial Subsidy,
- Capital Grants (subsidies), or
- Low Interest Loans.

SOLUTION SCENARIOS FOR A 7% RATE OF RETURN

(ASSUMING NO RESIDUAL VALUE)				
	SOP rate per kWh	**RET (LDC) top-up rate per kWh**	**Cost per watt installed**	**Other Funding, Grants, etc,**
Default values	**$0.42**	**$0.00**	**$7.50**	**0%**
Single variable solutions				
SOP Rate change (alone)	**$0.86**			
RET (LDC) top-up rate per kWh (alone)		**$0.44**		
Cost per watt installed (alone)			**$3.70**	
Other Funding, Grants, etc (alone)				**61%**
Solution value combinations	$0.42	$0.00	$8.00	65%
			$7.50	61%
			$7.00	57%
		$0.10	$8.00	52%
			$7.50	47%
			$7.00	42%
		$0.15	$8.00	40%
			$7.50	35%
			$7.00	26%
		$0.20	$8.00	38%
			$7.50	33%
			$7.00	27%
		$0.25	$8.00	32%
			$7.50	26%
			$7.00	19%

In the current political climate in Ottawa, it is extremely unlikely that the federal government will increase EcoEnergy payments or provide any federal tax credit specifically for solar energy. Solar energy proponents must look to the local and provincial level.

Ontario’s solar PV tariffs rank among the lowest in the world. This may have been justified in the initial stages of the SOC program as “price discovery”. By now everyone should know what solar really costs in Ontario.

Price Summary for Solar PV Tariffs Worldwide					
Ranked by Tariff and Years Offered					
			Tariff	1.43923	1.36761
Jurisdiction	Application	Years	€/kWh	CAD/kWh	USD/kWh
Italy	Rooftop		0.550	0.792	0.752
South Korea	>3 kW	15	0.566	0.815	0.775
France	Building Integrated	20	0.550	0.792	0.752
Germany	Rooftop	20	0.492	0.708	0.673
Czech Republic		15	0.463	0.667	0.633
Spain	<100 kW	25	0.440	0.634	0.602
Austria	<5 kW	12	0.460	0.662	0.629
Ontario		20	0.292	0.420	0.399
Washington State*	Mfg. in state	8	0.453	0.652	0.620
California*	Commercial	5	0.366	0.667	0.500
South Australia*	Residential	5	0.265	0.382	0.363
*Form of net-metering					

Ontario ranks near the bottom of jurisdictions world-wide that pay for solar-generated electricity. Ontario's solar PV tariff, while the highest in North America, is a fraction, often only one-half, that in Europe and Asia.

OSEA has proposed that the OPA take immediate action to correct the solar PV tariff of $0.42/kWh. OSEA has discussed its proposal with OPA's staff as well as its board of directors and the staff of the Ministry of Energy.

OSEA has specifically suggested that OPA introduce solar PV tariffs differentiated by size or application. For tariffs differentiated by size, OSEA has proposed a sliding scale from $0.80/kWh for small systems to the current $0.42/kWh for systems greater than 2.5 MW.

Ontario Revised Solar Tariffs by Size	
Size	Tariff
kW	$CAD/kWh
<10	$0.80
>10<100	$0.75
>100<1,000	$0.70
>1,000<2,500	$0.65
>2,500<10,000	$0.42

As an alternative, OSEA suggests that tariffs could be differentiated by application. The SolarShare project specifically targeted rooftop installations within the city of Toronto where new generation is most needed. Thus, there could be a tariff for ground-mounted systems of the current $0.42/kWh and a sliding scale for solar PV mounted on rooftops to encourage more rooftop installations.

Ontario Revised Solar Tariffs by Size and Application	
	Tariff
	$CAD/kWh
Ground-Mounted	$0.42
<10 kW Rooftop	$0.80
>10<100 kW Rooftop	$0.70
>100 kW Rooftop	$0.65

OPA has taken no action on OSEA's proposal and is unlikely to do so without either a Ministerial directive to do so or by legislation specifically describing such tariffs.

SolarShare also approached Toronto Hydro and PowerStream[27] for the development of a "top-up tariff" by the Local Distribution Companies (LDCs). SolarShare suggested that LDCs pay a tariff on top of or in addition to the SOC program's solar PV tariff.

Like OSEA's proposed new solar PV tariffs, the LDCs top-up tariff would be differentiated by size. Instead of OPA paying the full tariff necessary, the LDC would pay the difference, that is, the LDC would pay $0.15/kWh to $0.38/kWh depending up the size of the system.

Both LDCs have expressed an interest in considering a top-up payment in their next rate filing with the Ontario Energy Board. It's unlikely that any tariff that could result from this action will not be put into effect before early 2009.

The province of Ontario has proposed an up-front subsidy of $500 for solar hot water systems to match that offered by the federal government in its EcoEnergy program. It is conceivable that the province could also offer an up-front subsidy for solar PV. However, this is often more politically difficult to do than to provide an increased tariff as funds for an up-front subsidy must be budgeted. Even though funds may not be dispensed if few projects are not built and few applications received, funds for the subsidy must be set aside as an outstanding obligation of the government. In contrast, consumers only pay for the costs of a tariff if there is actual generation, much like the costs for purchasing power from outside the province.

Grants or subsidies, for example, from the Federation of Canadian Municipalities might be used to reduce the up-front costs, thereby effectively cutting the cost per installed watt. Charitable organizations, such Toronto's Clean Air Partnership, could also be a source of up-front subsidy payments.

From both the economic and financial models it is clear that if the solar PV tariff is not raised and up-front subsidies must solely be relied on, they must be on the order of $3,500/kW to $5,000/kW to make solar PV profitable in Ontario.

Low-interest loans would provide little benefit to the project absent some other kind of substantial financial support. SolarShare's targeted return of 7% is already much lower than the returns needed for private risk capital.

Frequent talk of the value of low-interest loans for solar PV investments indicates a lack of understanding of current economic conditions. In the current examples, a commercial solar PV project would lose money and would not be able to pay back any kind of loan. Some potential "green fringe" investors in SolarShare may likely

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[27] Formerly Vaughn Hydro.

be willing to accept a lower rate of return than that targeted in this project. Even so, current solar PV costs and returns under SOC program tariffs are so insufficient that investors would lose money.

Accessibility

All reports, articles, tables, and spreadsheets used as part of the SolarShare project have been or will be posted publicly and are available for use by others. These documents can be found at

- www.trec.on.ca, or
- www.wind-works.org/Solar/SolarList.html.

Many of SolarShare's publications and findings have been posted regularly on www.wind-works.org and have been made available to Toronto's Solar Roundtable and any others who wished to use them.

In addition, SolarShare has translated and posted several income and expense tables from registered German offering documents for solar PV Bürgerbeteiligungs.

- Fesa Freiburg Solar B31 Buergerbeteiligung Cash Flow
- Stuttgart School Roof Top Buergerbeteiligung
- Ecovision's Stuttgart School Solar PV Fund

Future Direction

There are several factors facing the development of solar PV in Toronto.

1. Due to rapidly growing environmental awareness and specifically awareness of the damage caused by coal-fired electrical generation, there is a great deal of enthusiasm and desire to see the development of PV projects, particularly in Toronto.
2. This enthusiasm is added to by the fact that there is a growing need for electricity in Toronto's downtown core, which will be difficult to correct by adding more transmission lines. Clean electrical generation, such as solar PV within the city provides an ideal solution.
3. A small portion of the population fall into a group we have previously referred to as "The Green Fringe", who are willing to invest in solar PV projects despite the fact that there are not yet sufficient financial rewards for doing so.
4. At present, and in the absence of other grants, subsidies, or increased renewable energy top-ups, the revenues derived from energy sales under the SOC program are approximately half of what is required to undertake a profitable investment in solar PV.
5. The installed costs of solar PV systems, while decreasing, are not likely to experience dramatic overall decreases despite the fact that certain components, most notably the panels themselves, may experience dramatic price decreases as early as within the next three to six years.

6. The possibility of offering top-up renewable energy tariffs, are presently being explored by some local distribution companies. If offered, such top-up tariffs may be available as early as 2009. These top-up tariffs may dramatically improve the profitability (and therefore viability) of solar PV systems.

With the above in mind, although PV systems cannot be profitably developed today, there may be ways of reaching the goal of building profitable PV systems using a staged approach.

Stage One

Market Conditions

- SOP rate remains at $.42 per kilowatt hour
- No LDC top-up tariffs are available
- Cost per installed watt of solar PV is $7.75 to $8.25
- Grants or subsidies are available for small-scale systems (up to approximately 50 kW)
- Partners can be found who are willing to donate the use of their rooftops at no cost and invest some money in the PV system
- Members of the public who are among the Green fringe who are willing to invest in a solar project with a 0% rate of return

Approach

- Begin with the deployment of two to three systems, approximately 40 to 80 kW in 2008 and 2009
- Using available grants or subsidies and funding from partners to cover at least 45% of the project cost, which should bring the rate of return up to approximately 2%
- Appeal to investors in the Green Fringe with messages such as "Be one of the pioneers in helping to bring solar energy to Toronto". The proposal would be that they may invest in our project without a return, but have their money repaid over time
- Offer the additional option of allowing these investors to direct the payback of their funds into investments in future SolarShare projects
- build experience in developing small systems where any accompanying mistakes should also be small
- Begin to refine estimates of all costs associated with the project and power production forecasts
- Build a reputation as a competent, reputable, community-based, active developer of solar PV projects in Toronto

Stage Two

Market Conditions (the same as Stage One except as follows)

- LDC top-up tariffs are offered of at least $0.15 per kilowatt-hour
- Cost per installed watt of PV is $7.50 to $8.00
- Grants or subsidies are available for systems up to 100 kW
- Members of the public who are among the Green Fringe are willing to invest in a solar project, at a 3% to 4% rate of return

Approach

- Deployment of two to three more systems, approximately 50 to 200 kW in 2009 and 2010
- Using available grants or subsidies and funding from partners to cover at least 35% of the project cost
- Appeal to investors in the Green Fringe with messages such as "Help us build on our success in bringing solar energy to Toronto". The proposal would be that they may invest in our project with a 3% to 4% rate of return
- In an effort to reduce the reliance on grants or subsidies and funding from partners, and to be able to successfully attract mainstream investors, possibly offer flow-through shares which should attract ever larger amounts of investment from high net-worth investors, and do so at a lower rate of return
- Build on the image of being a reputable, community-based, active solar project developer but promote the fact that investors can now earn a small financial return

Stage Three

Market Conditions (the same as Stage Two except as follows)

- Cost per installed watt of PV is $7.25 to $7.75
- Annual reoccurring costs are reduced to 1% per year or less

Approach

- Deployment of ever larger systems (possibly greater than 1 MW) in 2011 and onward

- Use available grants or subsidies and funding from partners to cover at least 30% of the project cost (increasingly, this funding would be coming from partners with the reduced reliance on grants or subsidies)
- Appeal to mainstream investors with messages such as "Earn a decent return on your money and help us continue our solar successes in Toronto". The proposal would be that investments in the SolarShare projects now earn a 7% rate of return, which should attract large amounts of investment capital for continuous development of increasingly larger projects.
- With SolarShare's track record, such investments will be increasingly regarded as conservative
- Build on the SolarShare image but increasingly add the focus of larger scale solar projects with ever more dependable returns, thereby further broadening SolarShare's appeal to investors

Areas Requiring Further Examination

- Explore the possibilities of utilizing Flow-Through Shares and how this would best be done
- Attempt to find a way of capitalizing on the residual value of PV systems
- More clearly determine what the ongoing operating costs are and how they may be reduced without jeopardizing system performance
- Explore with LDCs how they can benefit by offering Solar PV top-up tariffs
- Research the market viability of selling shares in the small, early stage PV projects: Determine the degree of acceptance by "Green Fringe" investors' of no-yield and low-yield share offerings in a co-op PV project, and how best to market such

Conclusion

SolarShare identified nearly four megawatts of potential rooftop solar PV projects within the urban core of Toronto. However, these projects cannot be developed on any substantial scale without either dramatic cost reductions in solar PV systems, higher payments for solar-generated electricity (either from Ontario's SOC program or from top-up tariffs by local distribution companies), or substantial government subsidies, or an equivalent amount of private donations.

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