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Solar Power Generation Feasibility Study

For
The Community Opportunity and Innovation Network Inc.

Mike Peddle and David Wasserman

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The Current State of Ontario Hydro

With the election of the Conservative Government headed by now Premier Mike Harris, changes to Ontario Hydro were imminent. The end of the 90 year monopoly which the Crown Corporation of the province of Ontario held was about to come to an end. The introduction of competition to the market-place for electricity is currently being forecasted for the year 2000. The Premier commissioned the MacDonald Report. This paper has become a defining tool for the state of the provincial organization and most importantly included a state of recommendations to facilitate the advent of competition in the industry. A comprehensive summary of the recommendations of the MacDonald Report can be found in appendix A. Ontario Hydro represents a massive piece of the provincial governments debt load. The utility falls deeper into debt every day. The belief exists that the best way to confront the fast approaching competition is for the organization to become privatized. The idea here being that 'competition in the generation and distribution of of electric energy is seen as generating greater efficiencies, lower consumer prices, better service and more choice just as it has for telephone service.'[1] Ontario has held the monopoly on power generation, transmission and distribution, both retail and commercial. All around Canada, massive debt and slowly increasing competition for power companies such as Ontario Hydro, has cause and exodus of governments from the energy industry. The move towards private shareholders has occurred in British Columbia, Alberta, and Nova Scotia. The reason being that government is attempting to alleviate itself of the financial burden of these organizations.

The MacDonald Report

Commissioned by the Government of Ontario, the task force set out to re-

[1] William A. Farlinger. A Power Monopoly Embraces Competition - Speech

evaluate the efficiency and effectiveness of the monopoly situation, and to make recommendations on the implementation of competition in the industry. The entire summary of those findings can be found in appendix A. The most important findings are based on the provision of access to the electricity market in Ontario. The committee found that it was necessary to begin by establishing competition in the wholesale market for electricity. This would lay the framework for implementing competition in the retail market place for the supply of energy. A system operator would be established to oversee the transmission, delivery and coordination of electricity and also ensure safety in all aspects of the process. The underlying idea of the recommendations is paving the way for competition in the electricity industry in Ontario. As well the report describes the need to divide the corporation as it currently exists into smaller operating units with specific tasks. This belief is presently being pursued by Ontario as it broken into three distinct units. This is further discussed in the next section. The overhauling of the existing legislation must be undertaken for the onset of competition in the market.

The Changing Face of Ontario Hydro

The reasons for change are numerous and are continually outlined throughout this report in various forms. The withdrawal of government for the purpose of financial motives is key. Others include the fact that there exists a major surplus of generating capacity throughout the industry, and the belief that there are superior economic alternatives to the centralized generation system currently employed. In response to the MacDonald Report (see appendix 1) and to prepare for competition Ontario Hydro has made a dramatic physical change. The organization was split into three distinct companies. The first is a generation unit. The function here is focused on hydro,nuclear and and fossil generating

stations. A distinct system for generation has been created to focus primarily on this task. The second entity is for transmission. This company will operate the '29,000 kilometres' of high-voltage lines for the purpose of directing electricity. The third and final unit is the retail company. This organization is designed to to serve 'Hydro's one million direct customers'[2] .

Ontario Hydro's Restructuring Plan

This restructuring plan can be found in its entirety in appendix 2. The restructuring plan created between Ontario Hydro and the Government of Ontario is based on the recommendations found in the MacDonald Report (appendix 1). The plan was adopted to help the organization move into the competitive marketplace in an effective manner. The advisory committee who compiled the MacDonald Report and the Ontario Government are both strong supporters of opening up the electricity market for competition. The need for eliminating Ontario Hydro's monopoly is based on the concept that the organization historically has not operated in an efficient and effective manner, and the advent of an open market would bring about dramatically needed change. The need to restructure is based on several factors. The first is the fact that other areas have already begun to reposition themselves for the coming changes to the system and Ontario Hydro risks falling behind. Secondly, the business performance from all perspectives in the past 10 years has been abysmal. From poor safety standards to an exponentially growing debt load. Finally, they believe there exist many new business opportunities for the organization in the coming times. The objectives of the restructuring plan are seven-fold. They include supporting investments and jobs, as well as more choice for consumers. Restructuring will also usher in an era of

[2] Ontario Hydro Gets Ready For Competition. Financial Post Daily :v9 n144 (October 11,1996) p7

new standards for safety, and a more business-like approach to investment. The basis of this plan is to create a competitive market place for electricity production, transmission and consumption, as well as divide Ontario Hydro into new electricity companies 'based on sound economic and financial footing'. The underlying tone of the arguments presented above which are found in the White Paper tend to suggest competition is the tool for the government to unload it's stake in Ontario Hydro.

Does Privatization Mean Lower Cost Electricity ?

The answer to this question is yet unknown. There do however, exist two distinct possibilities. The first is based on the common economic theory that market competition will in fact drive the current price of electricity downwards. The reason for this being that the more firms that there are competing for the consumer's dollar, the more the need to differentiate oneself based on price, hence cheaper hydro. Though this is the classical economic model, there exist factors which contradict this belief. The current reality is that electricity prices in Ontario have been increasing annual for the past several years. This growth has occurred at a rate that has greatly outpaced the CPI (Consumer Price Index) or more simply : inflation. Ontario Hydro is directly responsible for billions and billions of dollars for cleanups, insurance and Aboriginal landclaims as a result of a nuclear endeavours. A fund of two billion dollars was supposed to have been set up for this purpose, however, the money has disappeared. Ontario Hydro believes it can raise the money through yet another public debt offering. The result of which would likely lead to the consumer picking up the bill again. The 30 billion dollars of debt which Ontario Hydro owes would likely either be passed of to the purchaser, who in turn would levy the costs on consumers in the form of increased rates. The

belief that competition will make Ontario Hydro or whatever form it takes, more efficient, is not necessarily the case. In the same speech William A. Farlinger claimed that ' This year residential electricity customers will have enjoyed a 13% decrease in real prices since 1989. Savings for industrial customers have ranged from 11% to as high as 17%'[3] . However, in the White Report (see appendix 2) the graph of electricity rates shows steady increases during this period of time.

The Time is Right for Solar Power

The combination of the ballooning electricity costs and the cost-lowering technology of photovoltaic systems, the value of switching has never been better. 'Until now, solar energy has cost at least 50% more than traditional petroleum-based energy'[4] . In the United States at the time of the publishing of the article Solar Energy, Picks Up Steam, five U.S plants were due to come on-line during the next three years. The result of these new plants was an expected drop in the price of solar energy. 'The per kilowatt-hour cost is expected to reach 12 cents (U.S). This rate, at the time, was in fact competitive with those of the electric companies'[5] . For a long time we have been aware of the negative impacts on the environment from burning fossil fuels, the danger of highly toxic radioactive waste, a bi-product from nuclear fusion, and the massive changes hydroelectric dams impose on the landscape. There exists none of these terrible spin off effects from solar power. It is clean safe and almost one hundred percent environmentally friendly. The fact that Ontario Hydro has had this technology in a product called EN-R-PAK. However, the electrical company

[3] IBID.

[4] Solar Energy Picks Up Steam Daily Commercial New v69 n37 (February 21 1996)

[5] IBID

has not heavily marketed this product for the obvious reason that it reduces the demand for electricity. The fact that this ignorance is prevalent in the industry is frustrating. Instead fossil fuel burning continues to 'emit six billion tons of carbon into the atmosphere every year'[6]. Between 1980 and 1990, 'in Canada, the price of Solar technology has dropped from $30 to 30 cents per kilowatt-hour'[7] . The pay back periods, currently ,for a basic system have been estimated to be about four or five years. Clearly the medium and long term benefits of switching to solar power far outweigh any short term costs. The current uncertainty in the electricity industry with the advent of competition and the opportunity for the Government to dispense of Ontario Hydro, are uncertain times. No one can accurately predict the affect these changes will have on electricity prices. For these reasons, there exists an incredible opportunity for the growth of alternative energy resources such as solar power.

[6] Kate Kempton. Sailing into the Solar Future. Earth Keeper December 1994 pg23.
[7] IBID

FEASIBILITY STUDY OF ALTERNATIVE/MICRO ENERGY GENERATION: THE REVIEW OF NEW TECHNOLOGIES

PART A: FUNDAMENTAL ELEMENTS OF PHOTOVOLTAIC SYSTEMS/ HOW DOES IT WORK?

As prescribed earlier in the report, the micro energy generation technology that will be utilized during the retrofitting processes of various Kawartha Lake resorts, are those that depend on the scientific logics of photovoltaic's, specifically solar process heat systems. The first question that we feel we must answer is; What are the generic principles that apply to all photovoltaic systems? Using primary and secondary research methods, we discovered that Photovoltaic (PV) technologies are increasingly being referred to by numerous environmentalists/scientific theorists as being the ideal environmentally friendly/sustainable energy generation resource.

The photovoltaic process is a process in which the radiant energy from the sun is converted to direct current (DC) electrical energy. The "nucleus" of a PV system is an array of solid-state devices called photovoltaic or "solar" cells (SC). PV cells convert sunlight directly into electricity using the quantum-mechanical interaction between light and the various materials making up the cell. Each solar cell contains layers of a semiconducting material, referred to as silicon. Small amounts of another material (often referred to as a "doping" substrate), called boron, are used as an additive to each layer of silicon to alter it's electrical characteristics, giving it a tendency to attract electrons. A second "doping" substance is added to another layer of silicon, creating an opposite tendency, the freeing or release of electrons. This opposition of electrical tendencies of the two layers creates an electric potential, in the junction between them. The electrons that are released from this junction area, then move through the silicon once again and into a circuit, to various loads, where they will power lights, energize a water heating system and or other devices.[8] In laymen terms, when radiant energy (sunlight) is emitted from the sun in

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[8] www.Siemenssolar.com

the form of rays and it hits the surface of the "solar" cells, a flow of electricity is triggered.

Because each cell generates a relatively small amount of electricity, groups of cells are connected together to provide useful electrical voltage and power output levels. This connection process of numerous solar cells constitute the creation of a panel. The size of a "solar" cell determines the current output. In addition, the number of "solar" cells connected together in series can determine the output voltage of a panel. A standard "solar" cell has an output voltage of about .46 volts. The top of each SC is negative and the bottom is positive. By connecting the top of one SC to the bottom of another cell, one can boost the voltage of the solar panel by an additional .46 volts. For example, one SC=.46 volts, two SC=.92 volts, three SC=1.38 volts etc.... (36 SC=provide about 16.5 volts of charging voltage). [9] Photovoltaic or "solar" cells, the power producer of a solar panel, are often very delicate and easy to break. In the past, manufacturers designed and produced glass surfaced solar panels. Even though the panels were constructed using tempered glass materials, they were still easily damaged, especially when handled daily by consumers. Today, the majority of the PV manufacturers encase their panels in rigid fibreglass with a clear ultra-violet resistant polymer thick-film plastic over each "solar" cell, allowing each panel to withstand far more abuse[10].

In addition, to the photovoltaic/solar cells, there are numerous other important fundamental components that make up a functioning energy generation system. For instance, all PV systems are equipped with a charge regulator components, which are the essential links between the "solar" cells, battery(s) and the load (appliances, lights and equipment being powered by the system are referred to as electrical loads). Charge Regulators are often referred to as the "highway" in which the electrical current travels along. They also serve a regulating role; they protect the battery from over charge or excessive discharge. Another essential component of a PV system is the use of a battery(s). Since electricity is often needed when the sun does not shine, it must then be stored, usually in batteries. As prescribed earlier, all PV systems can only produce direct current (DC) electricity. Many common appliances and equipment run of alternating currents/loads. Therefore, all PV systems are equipped with an inverter, so if an

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[9] www.Siemenssolar.com

[10] IBID. Siemens Solar President and CEO Gernot J. Oswald, Speech

energy load requires alternating current (AC), an inverter will convert the DC power to AC.[11]

Another component of various PV systems, even though it is not a mandatory item, is a tracking system. By observing the movement of sunflowers, the Swiss inventor Emile Jansen found a simple way of maximizing the yield of panels of PV cells. This invention, which is referred to as a "tracker" is a supplementary system that works in accordance with any PV technology. The basic function of the system component is turn the panels to follow the sun without using either electricity or harmful gases and at a cost that would be absorbed by the increase in energy production. Panel projection in relation to the maximum degree of radiant energy has been scientifically proven to increase energy generation and a viable addition to ones system.[12]

PART B: BASIC DESCRIPTION OF VARIOUS TYPES OF PHOTOVOLTAIC SYSTEMS

As professed earlier, basic PV system principles remain the same. Even though most PV systems are constructed using similar principles or elements, the development of the industry and it's intense concentration on research and development has created the kinds of products/systems that are flexible and dependable. Photovoltaic systems and their use of solar energy are increasingly being seen and relied upon for powering virtually every electrical structure (ei. Small appliances, cars, small towns, telecommunication sites etc.). This section of the report will illustrate how technologies and their manufacturer are increasingly trying to produce systems that will adapt to meet particular energy requirements by varying the type and quantity of the basic elements. Most importantly, it should be known that the technologies highlighted are those; that are most applicable to the study (the feasibility of retro-fitting Kawartha Lake Resorts with solar thermal water heating systems), are being described using generic PV industry "lingo"that may be hard to comprehend at times, that the models names used in the report are those that their producers elected and that the producers will remain anonymous.

Photovoltaic systems can be simple as just a solar panel and a load, which is usually used

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[11] IBID.

[12] IBID.

for the direct powering of a water pump motor, or they may be as complex as those used to power a modern home. While a water pump may only need to function when the sun is shining intensely, a modern home system will often be demanded to operate day and night. In addition, it may have to supply both AC and DC loads, have reserve power and may include a back-up generator. A myth that most individual believe is that solar power is an independent process (either you must be connected to the power grid or not), that must be utilized in an independent fashion, which is a false concern. Even though it has not been legislatively agreed upon or legal in Canada to utilize, there are technologies on the global market that can mutually operate with any government utility infrastructure. There are other several factors that will determine the specific components that one will need, as well as, how they will configure in your system. For instance, the amount of power needed an important consideration when choosing a PV system. Some other equally important factors that one should consider are; the systems location, the distance of the panels to the load, the types of loads and it's frequency of use. The rest of following section is a brief description of a range of technologies that are most applicable to the study and attainable to us, the consumer.

Solar Thermal Process Heat Systems

For about two decades, solar process heat systems have significantly evolved due to rising environmental concerns (the useless over consumption of a finite stock of fossil fuels), in turn making it an increasingly favourable alternative energy generation choice of the people(s). Photovoltaic or solar process heat systems have become viable energy contributors to millions of industrial, government and commercial facilities around the world: and contributing significantly to their thermal energy loads, an aggregate constitution equivalent to the thermal capacity of over one nuclear plant.[13]

Why are solar thermal process heaters so popular? Because they represent a cost-effective and environmentally friendly alternative to traditional fossil fuel technologies. These eco-energy generation systems exploit a readily available, free and constant source of energy - the sun and emit no scent or adverse toxins/pollutants. What are the advantages of Solar process heat

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[13] Http://strategis.ic.gc...20CONTAINS%20'heat')))

systems. No matter what sector one is a part of, industry Canada boasts that (industry, government or commercial) solar process heat systems offer a number of attractive advantages;

"1. They are long-lasting, reliable sources of clean thermal energy that can replace 20-80 percent of thermal requirements provided by fossil fuels (eg. Fuel oil, natural gas, electricity).

2. Solar systems are often more cost effective on a life-cycle basis than conventional process heat systems. Since solar systems are designed to last 20-30 years, and pay for themselves in 3-10 years, they provide owners with as many as twenty years of practically free energy N saving a facility thousands of dollars. Additionally, solar system capital costs can be reduced significantly by provincial and federal tax credits for solar equipment, including a 10% federal tax credit and accelerated depreciation.

3. By investing in solar process heat systems to provide a portion of their thermal energy requirements, users have the opportunity to respond to increasingly stringent clean air mandates (locally or nationally) without having to invest in expensive, nonproductive air emissions control equipment and staff to operate and maintain it.

4. For private companies and government agencies that have long range planning horizons with respect to their thermal energy requirements, solar provides insurance against:

*Fuel price volatility

* Concerns about fuel supply disruptions"[14]

Now too get back at the topic at hand, which was the introduction of an ideal solar heat process system for the numerous resorts that exist within the Kawartha Lakes proximity. The following technology was presented in a case format of the Strategis website - http://www.crest.org/r...s/seia_slrthrm/31.html (1996);

Coolfont Manor House Report

West Virginia's Coolfont Manor House, nestled in the Appalachian Mountains near Berkeley Springs, is a 1,350 acre lake side resort with a 9,000 square foot swim and fitness centre. Originally opened in 1965, it boasts a 1,530 square foot solar collector installed by SKS Inc. In 1989. Although Coolfont has used solar collectors to heat water for it's laundry and kitchen since 1977, the new system installed by SKS Inc. Has resulted in an advancement of integrating heating, cooling and water purification. The new design directs and redirects energy to various loads and nearly eliminates waste. In 1990, the U.S. Department of Energy gave

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[14] IBID.

Coolfont and SKS Inc. The "Energy Innovation" award for their efforts.

The main source for the thermal energy for the centre is the 1,350 square foot unglazed solar mat/panel which covers the roof on the south side of the building. Diluted ethyl glycol and silicon runs through the black tubes within the mat and collects solar heat; the glycol fluid continues through the loop to deliver the heat that is needed. During the summer, the heat in the loop is deliver directly to the hot water heaters of their swimming pool water. In the winter, the heat can be delivered indirectly to power heat pumps, which further recover latent energy from the atmosphere, thus providing a way to collect heat on rainy or overcast days. In addition, the Coolfont system is able to collect thermal energy on cloudy days and at night by operating the glycol loop below surrounding temperatures. The loop picks up heat from the environment as well as from direct sunlight.

STATISTICS

1. Applications: Indoor pool water heating, pool room winter dehumidification, spa and hot tub water heating, building air conditioning with waste heat recovery to pool/hot tub heating loads, shower water heating.
2. Market: Hotel/Resort Industry
3. Location: Berkeley Springs, West Virginia
4. Solar Collector Type: Unglazed SolaRoll TubeMat collectors
5. Solar Collector Area: 1,530 sq.ft
6. Solar Collector Mounting: Mounted flush to roof
7. Solar Collector Manufacturer: Bio Energy Systems, Ellenville, NY
8. Installation/Start Up Date: 1989
9. **Total Energy Needed Annually for the Application: 895.6 Million BTU's**
10. **Total Energy Requirement Supplied by Solar: 605.8 Million BTU's**
11. **Percentage of Annual Load Met by Solar: 68%**
12. Backup Subsystem Fuel: Propane and electricity
13. **Total Annual Energy Requirement Met by Backup System: 5-10 Million BTU's**
14. **Percentage of Annual Load Met by Backup System: 10%**
15. **Solar System Capital Cost (Including Installation): $49, 385**
16. **Normalized Solar Systems Cost: $32.25 sq.ft**
17. Person to Contact for Additional Information:

    Albert Nunez
    SKS Inc.
    8 Sherman Ave.
    Tacoma Park, MD 20912
    (301)270-8959
    (301)270-0313 (fax)

***** **Our future objective is to find an Ontario based manufacturer that produces a similar product*****

Other Technologies that may be Beneficial to the Kawartha Resort Industry

Solar Shingles: In the past the conventional use of roofing shingles were to protect your house against rain, sleet and snow. United Solar Systems Corporation of Troy Michigan, have developed a smarter shingle that can also generate significant energy for a given household. There unique shingle invention, consist of solar cells to turn sunlight into useful electricity. In addition, these new shingles look pretty much like the conventional ones made out of asphalt. Developed with the aid of the U.S. Department of Energy, the "nouveaux" solar shingles are sold in 10-ft.-long, 5 lb. sheets. Installation is about straight forward as standard shingles, except for the electrical connections. Expert electrical installers use a template to drill small holes about every 10 feet and then slip an electrical connection through the hole into your before nailing down each shingle. When the installer finishes, an electrician will connect the wiring in the attic to an inverter that will serve the function of transforming the cells direct current into alternating current if needed.[15]

Solar Blinds

The conventional use of blinds have always been an effective and convenient way to control the amount of sunlight coming into a room. Wouldn't it be beneficial for blinds to instead block unwanted light and capture and store energy from radiant energy and utilize it in the night. The Solar Blind does this. Each horizontal slat of a stylish blind is coated and encased with a thin, flexible photovoltaic residue on it's rear edge that converts sunlight into useful electricity and stores it in rechargeable batteries for later use. A night, the flat electroluminescent strips on the frontal area of a blind glow softly with light, providing a room with a background of ambience. According to the inventors of the Solar Blind, the energy that collects from a 3-by-6 foot blind with 14 slats will roughly produce an output that is equivalent to two 200-watt incandescent bulbs. For creating different types of ambience, the light source can be tuned to different colours, ranging from pure red to white. When the blind system is exposed to full radiant potential, the Solar Blind could generate about 49 watts of electricity. New York Cities Ecco Design, the inventors of the Solar Blind, estimates that the production cost of a 3-by-6 foot blind systems

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[15] Today's Home Owner, September 01, 1996.

production cost is roughly $400 to $500. This system would be ideal for resorts that boast an architecture that consists of numerous windows. The ambience would be highly appreciated by consumer that are on a romantic outing. [16]

[16] Popular Science, Blinded by the Light. March, 1997.