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THIN FILM PHOTOVOLTAIC - THROUGH THE FOG

...“the barbarians are at the gate: a set of disruptors – thin-film solar manufacturers – are nipping at the incumbents’ heels.” Josh Suskewicz - Manager Innosight – Forbes.com

...“solar PV overcapacity became evident in margin compressions in Q4’2008, forcing conventional crystalline manufacturers to adjust downward their production forecasts for the short term”...

...“solar energy offers a clear advantage by generating electricity at the end user site as a peak shaver source of electricity bypassing the transmission system”...

...“thin film PV has cost and performance advantages that will enable it to take a very significant market share from most of the mainstream module manufacturers”...

...“rooftops and building integrated PV installations will become an integral part of the thin film growth strategy”...

...“Sustainable Energy Technology Ltd. (“STG”; TSX-VENTURE; \$0.12) currently has the most attractive and lowest cost operating system to make thin film more competitive in rooftop and building integrated Solar applications”¹...

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Disclaimer:

D&D Securities Company does and seeks to do business with Sustainable Energy Technology Ltd. covered in this document. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this study. Investors should consider this document as only a single factor in making their investment decision.

See “Important Disclosures” section at the end of this document for key required disclosures, including potential conflict of interest.

Thin Film PV



Thin Film PV

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Executive Summary

This document is designed to provide the reader with a high level review of the growing and dynamic photovoltaic solar industry. Having enjoyed a number of years of spectacular demand and growth, the solar industry in the second half 2008 sailed into a fog bank, making it difficult to see the immediate future.

Whereas a year ago it would be reasonable to forecast revenue growth in excess of \$50 billion for 2009 – now this figure looks much less certain. We expect the fog to lift by middle of this year setting the PV Solar industry once again on course that could see annual growth of 30%.

Beginning in mid-year 2008 a massive investment in PV production capacity especially lower cost thin film technologies, caused a significant production capacity surplus. A combination of this surplus, the shutdown of the second largest market – Spain – and a global credit crisis created major downward pressure on PV module prices and suppliers of feedstock right down the entire supply chain.

This overcapacity became evident in Q4'2008 margin compressions, forcing conventional crystalline manufacturers to adjust downward their production forecasts for the short term.

Lower panel prices should spur demand and innovations which will continue to reduce system costs, increase efficiency and provide design flexibility. **It is our view that thin film technology although providing less efficient solar systems, will transform the PV solar market with a fundamentally lower cost structure by becoming a “disruptive technology”.**

Even though solar power still requires governmental incentives such as feed-in tariffs or income tax credits it should reach grid parity in a growing portion of the global electric grid within the next 2 to 5 years, ushering highly competitive environment for solar electricity generation and creating new employment opportunities.

Although large ground base “Solar Parks” attract much attention and will continue to harness the electric current produced by the PV systems using the series array configuration, **the evidence is mounting that rooftops and building integrated PV (BIPV) will adopt the more flexible and suitable parallel configuration.**



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Solar energy offers a clear advantage by generating electricity at the end-user site as a peak shaver source of electricity, bypassing the transmission system. In this application, thin film has cost and performance advantages that will enable it to take a very significant market share from most of the mainstream module manufacturers. In our view, rooftops and building integrated PV installations will become an integral part of the thin film growth strategy.

Our study suggests that Calgary based public company Sustainable Energy Technology Ltd. (“STG”) currently has the most attractive and lowest cost operating system to make thin film more competitive in rooftop and building integrated Solar applications. Its patented technologies enable higher yields and expand the solar aperture overcoming thin film’s major disadvantage – the need for more space to produce the same power.

Sustainable Energy is a very small company with limited financial resources and has to be considered highly speculative. The Corporation’s ability to capitalize on the opportunities outlined in this commentary depends on raising sufficient capital.

The report provides a description of the Company’s patented technology advantages with an economic model **based on speculative assumptions** that could present Sustainable Energy Technology Ltd. with earnings capabilities in the order of \$100 million versus their current market capitalization of \$15 million.

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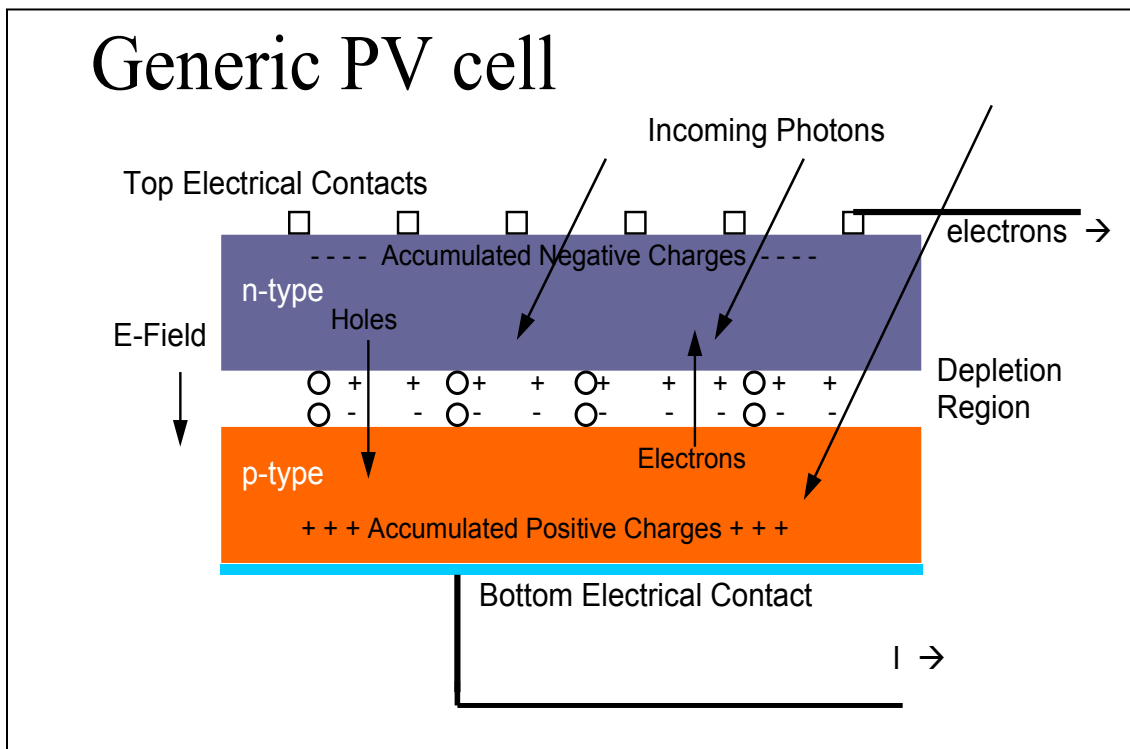
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THIN FILM – THROUGH THE FOG

- Solar power is one of the most promising forms of renewable energy utilizing a free and limitless source of fuel. The energy in sunlight striking the earth for 40 minutes equals the global energy consumption for a year². Solar cells work by absorbing sunlight and converting it to electricity, a process referred to as the photovoltaic (PV) effect.
- Over the last 17 years the market for PV products worldwide has increased at an average annual growth rate of over 30%. This growth has been driven by major governmental incentives introduced in Japan, Germany, Spain, United States, Italy, Greece, Canada (Ontario) and Israel. These incentives – either through feed-in tariffs or tax breaks – have kick-started the solar photovoltaic industry; spurring innovations, giving way to new technologies, capable of providing electricity where it is needed, bypassing the traditional long distance transmission issues.
- Majority of commercial solar cells used today are made of semiconductor silicon (Si) and a top and bottom electrical contact to move the electricity out of the solar cells. The performance of solar cells is measured in terms of its efficiency in converting sunlight into electricity currently ranging from 6% to 18%. Every 1,000 Watts of sunlight striking a 1m² solar module produces 60 to 180 Watts of electricity.

Figure 1: Typical Solar Cell



Source: Dr. Peter Mark Jonsson



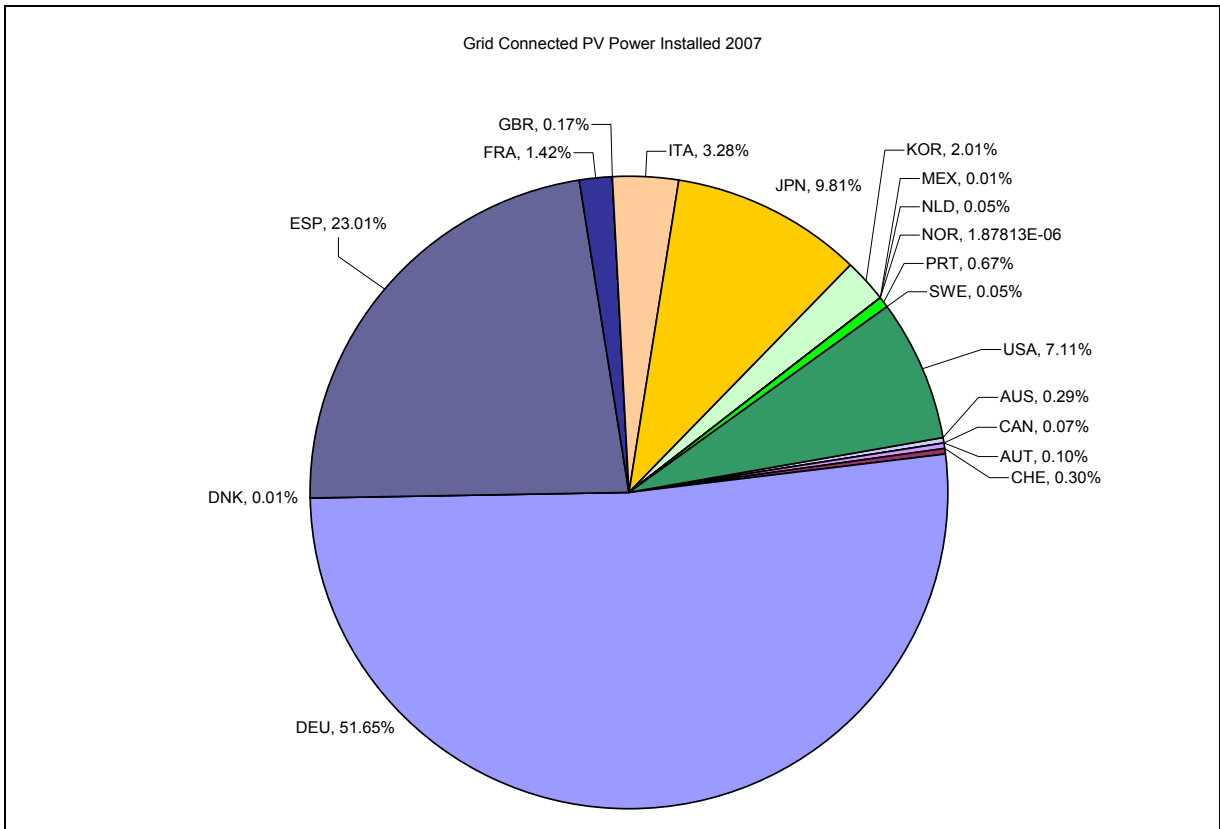
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PV MARKET REALIGNMENT – COST CREDIT CRISIS

- In the past, the bulk of the PV market has been using expensive and labour intensive silicon wafer material. Silicon – essentially sand – is the second most abundant element on the earth's surface, but processing it to a suitable pure crystalline form required for PV applications is very energy and capital intensive.
- In 2004, Germany introduced preferential financial incentives program promoting PV Solar, causing a silicon supply shortages and a surge in its costs between 2006 and 2008. Now, this short term silicon shortage is reaching a supply and demand balance as more manufacturing capacity has come online.
- After 30 years of research and development it has been determined that solar cells made from “thin film semiconductors” are less expensive to produce in larger volumes and require less raw material than the more traditional silicon based PV cells. Achieving larger volumes at lower prices with reduced raw material usage will allow for the commercialization of the thin film photovoltaic cells.
- Thin film became recognized as a solution to the silicon shortage that precipitated out of Germany’s implementation of feed-in tariffs. Although, thin film produces only about half the power per square meter as presently available Crystalline Photovoltaic (c-PV), it costs less than a third the cost of c-PV to produce. Also, its cost per Watt is expected to drop even further as manufactured costs come down and module efficiencies improve.
- Thin film manufacturers have developed systems for the large scale fully automated manufacturing of PV panels with lower material input costs. This allows for a much more competitive pricing structure.
- First Solar, Inc. (Nasdaq: “FSLR”) – a world leader in advanced thin film semiconductor technology – reported manufacturing cost of solar modules in Q4’2008 at US\$0.98 per Watt finally breaking the US\$1 per Watt price barrier.
- In 1995 globally installed photovoltaic capacity was approximately 200 Megawatts (MW) of which 23% was installed in Japan. By 2007 global PV capacity reached approximately 8,000 MW of which Germany accounted for 50%.
- Installed Solar capacity is expected to grow by cumulative average growth rate (CAGR) of over 45% for the next five years. Some forecasts estimate that installed PV capacity will reach 24,000 MW by 2012 of which thin film will represent 40% to 75% as compared to 6% of installed capacity in 2007.³



Figure 2: Grid Connected PV Power Installed in 2007



Source: IEA



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- The amount of total installed Solar from 2008 to 2012 may equal the total amount of nuclear electrical production scheduled to come on line in the same timeframe (see Figure 3).

Table 1: Nuclear Power Plants under Construction

Number of Reactors	Estimated Start up Year	Country	Total MW(e)
1	2009	Iran	915
6	2009	India	2,642
5	2010	S. Korea	5,940
1	2010	Argentina	692
1	2011	Pakistan	300
1	2012	France	1,600
2	2015	Ukraine	1,900
17		Total:	13,989

Source: Nuclear Energy Institute

- Although, the feed-in tariffs are not a long term solution to the viability of PV, they have kick-started a fledgling industry. Total sales of PV installations have grown from less than \$0.25 Billion in 1993 to US\$30 Billion in 2007 with estimated global sales of \$100 Billion by 2012.
- At the end of 2008 the global photovoltaic industry consisted of more than 150 manufacturers of solar cells and modules. In addition, several semiconductor producers and semiconductor equipment manufacturers or their customers have already announced intentions to start production of photovoltaic cells, solar modules or turnkey production lines. With the current economic climate, the fog bank makes it uncertain to determine how much additional supply will actually be coming online in the short term.



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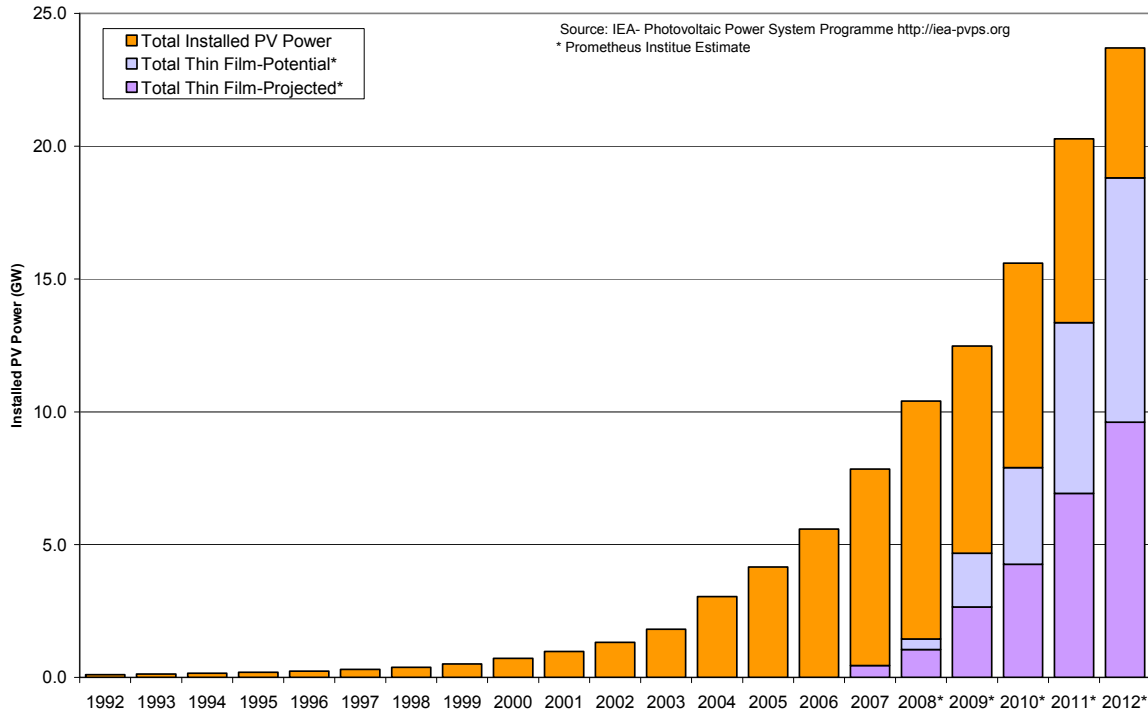
THIN FILM PV – THE NEXT DISRUPTIVE TECHNOLOGY

- The iPod, Voice over IP (VoIP) and the Blackberry have been described as “disruptive technologies”, which on their own were not that groundbreaking in their concept, but when woven into the fabric of society have had a dramatic effect on the markets and the consumers. The same comments are being made about “**Thin Film**” **solar photovoltaic technologies**⁴.
- During 2007 and the first half of 2008, surging PV demand accelerated already aggressive worldwide capital expenditure in new manufacturing plants. By Q3'2008 it became apparent that the industry was heading towards a short term overcapacity condition by mid 2009.
- The overcapacity problem was compounded when the global credit crisis bore down on the PV industry making it difficult to finance its projects, and forcing cells and modules manufacturers to deal with excess inventory.
- The combination of weaker demand growth as the industry participants struggle with financing – especially for large projects – and a record volume of PV supply are hitting the market, resulted in substantial margin compression for the crystalline suppliers in Q4'2008.
- Lower prices generally drive increase in demand. Evidence is starting to emerge that the PV industry will resume its very high rates of growth when the fog of the credit crisis dissipates⁵. **With lower module prices, private investors could expect double digit returns ranging from 10% to 30% or more in some markets for essentially risk free 20 year term contracts.**
- Governments have shown a growing interest in providing necessary stimulation to help spur economic recovery on the back of the credit crisis, but changing dynamics bring changing conditions. In mid-2007 module manufacturers could sell everything they produced and were mostly faced with issues of:
 - silicon availability and
 - plant construction requirements
- In the current business environment the same manufacturers are concerned with:
 - pressures from new competitors with no feed stock issues
 - price competition from new low cost producers with billions already invested in manufacturing capacity
 - decline in module prices and disappearing margins for a high cost products
 - are their customers still in business and are they viable?
 - the need to develop new business models in order to sell products on something other than price
 - the need to lower cost per Watt by building leading edge plant and improving cell efficiencies
 - sourcing the now abundant material



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Figure 3: Cumulative Installed PV Power (MW) 1992-2012



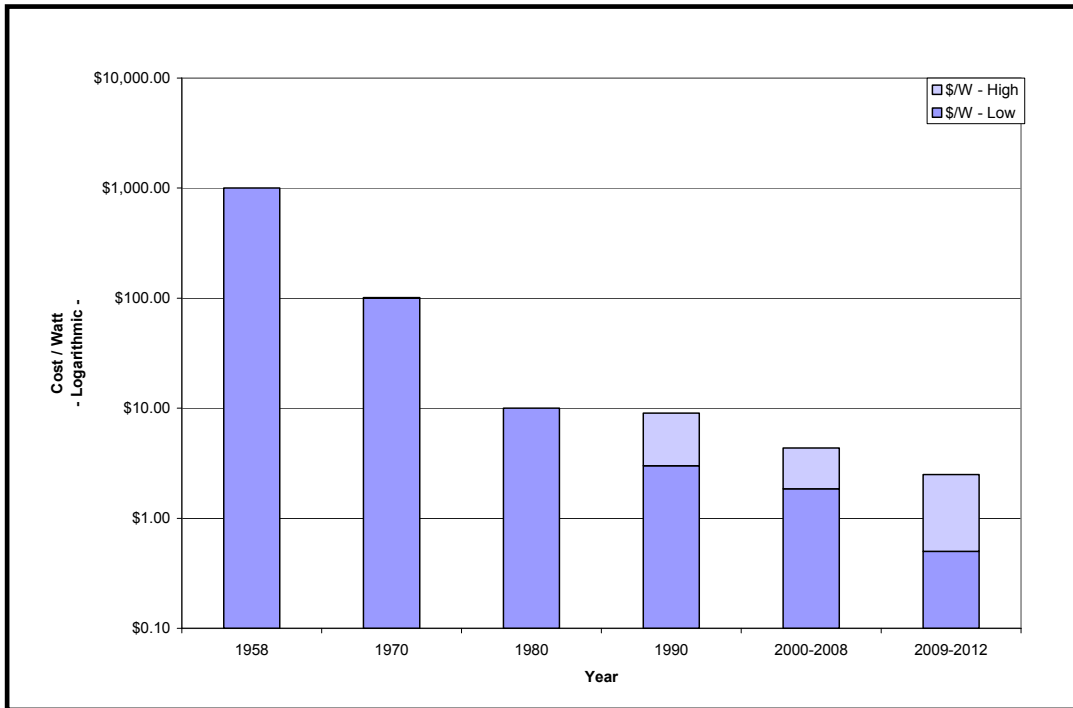
Source: IEA & Prometheus

- Low cost thin film PV manufacturing will place growing pressure on the c-Si wafer and panel manufacturers. Recently Q-CELLS SE (DAX: "QCE") – the world leader manufacturer of c-Si – acknowledged a growing interest in thin film technologies. Sharp – once the world market leader – has announced plans to build a 1,000 MW thin film plant by 2010.
- The lower production cost is very appealing and its manufacturers argue that thin film technology will take 40% of market share in the coming three (3) years, growing to 65% by 2015.
- Thin film offers fundamentally lower manufacturing costs. Conventional crystalline module and cell manufacturers, especially in the undifferentiated mid-tier companies, will be hard pressed to remain competitive. Mr. Bradford from Prometheus Institute estimates 50% margins for thin film and 15% for c-Si.
- Recently, First Solar completed an all-paper takeover of OptiSolar ("OPTI"), adding up to 19 GW of potential production to First Solar's project pipeline, entrenching First Solar not only as the world leader in thin film, but potentially a leader in utility-size power installations.



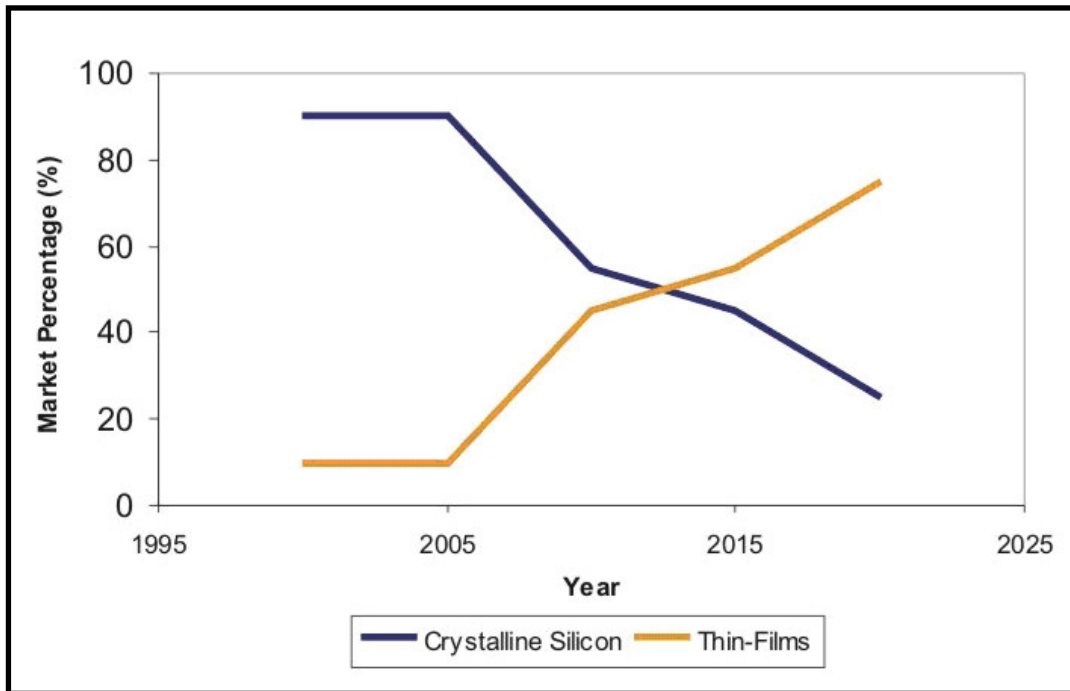
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Figure 4: Historical Real PV Module Prices



Source: Estimated by D&D Securities and attributed to Solar Thin Films

Figure 5: Estimated Crossover of Thin Film vs. Crystalline PV



Source: Solar Thin Films

Table 2: Thin Film Manufacturing Companies

Company	Country	Technology	2008	2009	2010	2011	2012
			Production (MW)E	Production (MW)E	Production (MW)E	Production (MW)E	Production (MW)E
Ascent Solar Technologies	US	CIGS	7	33	63	91	120
AVA Solar Inc	US	CdTe	1	27	100	125	200
Avancis GmbH	Germany	CIS	1	15	35	100	115
Bangkok Solar	Thailand	a-Si	28	49^a	70	88^a	105
Best Solar	China	a-Si	0	25^a	50	90^a	130
Calixo GmbH	Germany	CdTe	17	45	75	105	138
Daystar Technologies	US	CIGS	0	18	39	85	105
Energy Photovoltaics (EPV)	US	a-Si	15	82	165	265	465
Ersol Thin Film GmbH	Germany	a-Si	19	56^a	92	130^a	168
First Solar	US	CdTe	448	630	1035	1035	1035
Flexcell	Switzerland	a-Si	3	13	37	56	81
Fuji Electric	Japan	a-Si	16	31^a	45	79^a	112.5
G24 Inovations, LTD	UK	DSC	24	160	213	263	300
Global Solar	US	CIGS	16	60	80	140	200
HelioVolt	US	CIGS	5	35	98	238	575
Honda Soltec Co. LTD	Japan	CIS	22	28	33	56	81
Johanna Solar Technology, GmbH	Germany	CIGS	30	38	60	68	90
Kaneka Silicon PV	Japan	a-Si	57	70	130	130	130
Miasolé	US	CIGS	29	63	223	625	1125
Mitsubishi Heavy Industries	Japan	a-Si/ μ cSi	42	101	130	140	177
Moser Baer	India	a-Si	5	78^a	150	238^a	325
Nanosolar	US	CIGS	50	258	498	750	975
Powerfilm Inc.	US	a-Si	6	10	14	24	31
Primestar Solar, Inc.	US	CdTe	1	9	31	56	80
QS Solar	China	a-Si	12	148	330	430	430
Scheuten Solar	Netherlands	CIS	0	10	70	250	438
Sharp	Japan	a-Si/ μ cSi	59	210	500	925	1000
Showa Shell Sekiyu	Japan	CIS	16	35	98	238	563
Solibro, GmbH	Germany	CIGS	6	25	31	50	56
Solopower, INC.	US	CIGS	3	13	25	45	65
Sunwell Solar (CMC)	Taiwan	a-Si	2	14^a	25	75^a	125
United Solar	US	a-Si	96	148	254	375	700
Wuerth Solar GmbH	Germany	CIS	15	19	30	35	50

Source: Prometheus Institute

^a D&D Securities
Company Infill Estimates



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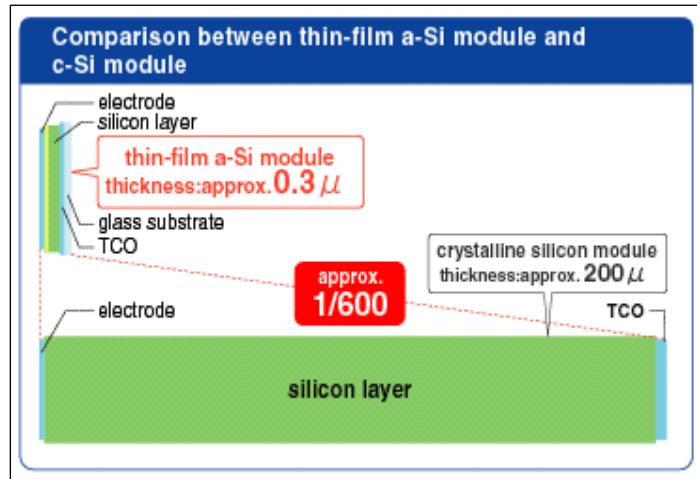
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- Three thin film technologies are currently being commercialized:
 - **a-Si – Amorphous Silicon**
 - This was the first technology which manufactured thin film in large volumes.
 - The silicon has no shape therefore, can be deposited onto a substrate in thin layers.
 - It shows very good performance in dispersed light conditions (i.e. cloudy days).
 - **CdTe – Cadmium Telluride**
 - Mature and well understood thin film PV material.
 - Able to adsorb a wide swath of the optical spectrum.
 - There is a perceived health risk associated with Cadmium. In 2006 Cadmium became one of six (6) chemicals banned in Europe under the Restriction of Hazardous Substances Directive (RoHS). Although, the CdTe compound is much less toxic, there is still a need for an effective tracking and recycling program.
 - **CIGS – Copper; Indium; Gallium; di-Selenide**
 - It has shown the highest laboratory electrical conversion efficiency of 19.2%.
 - It can be produced on low cost hard and flexible substrates, holding promise for low cost manufacturing.
 - Highly scalable for use in large volume manufacturing on a variety of substrates using commonly available manufacturing equipment.
- Thin film products exhibit a number of attributes. They are:
 - **Scalable** – Offering low cost, large scale automated manufacturing. The deposition of the thin film material for solar cells and modules require a structural "substrate" to support them, with a glass identified as the most suitable material. Applying the thin film can be done in a continuously, scalable manufacturing process; technology adopted out of the flat screen television manufactures.

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- **Lower material cost** – The substrate and raw materials used in thin film products are less expensive than the cost of most semiconductor materials. Thin film uses a fraction of the materials required in c-Si. The average thickness of a Thin Film layer is $\sim 0.3\mu$ versus the typical c-Si cell which is $\sim 200\mu$, or $1/600^{\text{th}}$ the thickness.

Figure 6: Thin film thickness



Source: Kaneka

- **Performance attributes** – Thin film technologies exhibit performance advantages in generating energy in dispersed light levels such as on cloudy days and perform better in higher ambient temperature, causing less thermal degradation than c-Si modules.
- To-date the growth of the PV electrical market has been nurtured by factors beyond simple economics such as:
 - Increased demand for clean sources of energy, reduction of the carbon foot print in the environment and global warming concerns.
 - Security of energy supply, i.e. growing dependence of European countries on Russian natural gas.
 - An inherent concern of transfer of wealth from the secular world to increasingly radicalized Persian Gulf; the world's largest supplier of world oil exports.
 - Promoting new job opportunities, in what is seen as a new ascending industry especially in the current global economic contraction.

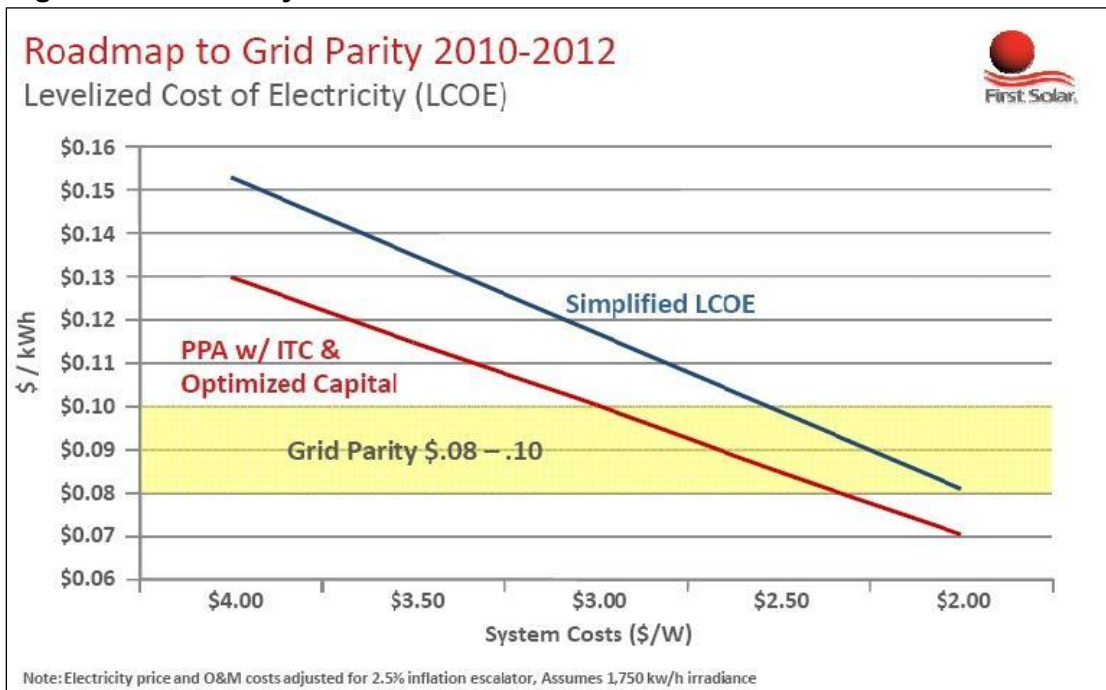


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GRID PARITY – ALREADY HERE

- Germany – the world leader in PV electricity – introduced preferential feed-in tariffs in 2004 which have been adopted by a growing number of countries around the world. The United States, especially in California have a combination of Investment Tax Credits and Feed-in Tariffs.
- Also, the introduction of Net Metering and the Smart (electric) Meter has provided consumer-based renewable energy incentives. However, as important as these incentives have been in kick-starting PV electrical industry, the ultimate goal is to reach manufacturing and installation costs that would support a grid-parity economic option.

Figure 7: Grid Parity



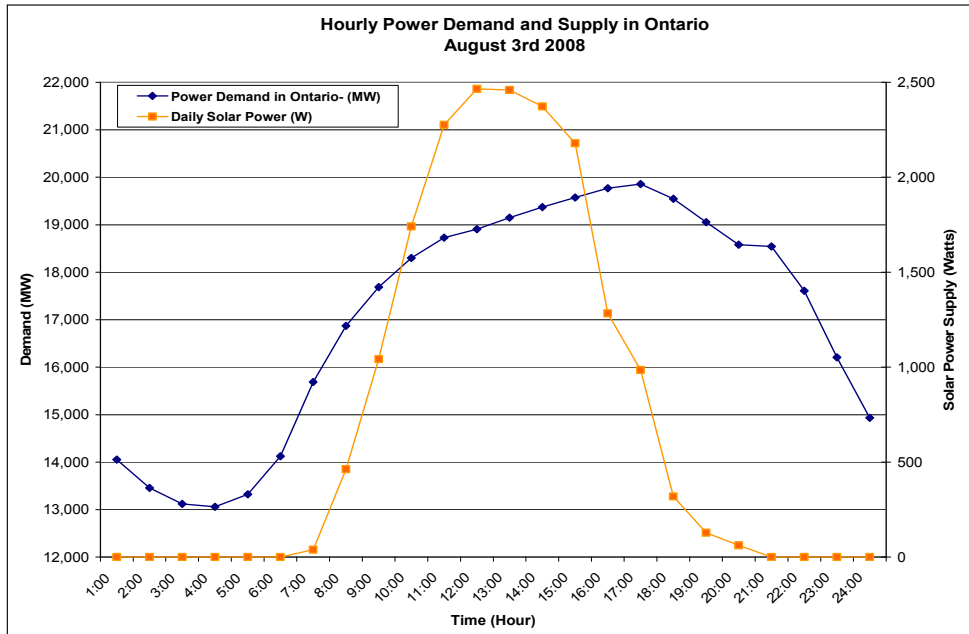
Source: First Solar

- Grid parity is the point at which photovoltaic electricity is equal to or cheaper than grid power. There is growing evidence that thin film technology will offer grid parity within the next 2 to 5 years. In certain markets such as Hawaii and other islands that use diesel fuel for electricity generation, thin film technology is already at grid parity.
- The waste in the electrical grid is enormous. It is acknowledged that the coal and nuclear power plants need to keep running even when electricity demand is lower than its production. These base-load electrical sources are essential and can not be replaced by solar, however solar can be an excellent peak shaver.
- Electricity is the biggest source of power for the U.S. homes. The U.S. Energy Information Administration estimated that for every 1 kWh utilized, 2.2 kWh are lost during energy production and its transportation along the transmission lines.



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Figure 8: Hourly Power Demand and Supply in Ontario



Source: Hydro One / CreativeLX Ltd.

- Although, solar energy by its nature only works when the sun is shining, the electrical demand peaks along with the solar cycle because of the day-time industrial activity and air conditioning requirements. Electrical utilities currently start up "peaking" power plants (usually powered by natural gas) in order to meet high demand loads when the sunlight and cooling requirements are at their maximum.
- Investment in PV electricity has been and will continue in larger field installations called "Solar Parks". However, the governments began to recognize the benefits of PV technology by encouraging and promoting rooftops and building integrated PV because:
 - There is no incremental transmission and grid infrastructure costs.
 - There are no land use issues.
 - Stabilizing power grid concerns by offering a perfect match peak shaver for central air conditioning and ventilation, which are becoming a major and growing factor in electricity demand.
- Spain, Germany, France and Italy have signalled that they prefer rooftop solar over ground mounted systems with higher feed-in tariffs for rooftops and building integrated solar (BIPV). Spain went even further by announcing that integrated PV systems will be required in all new constructions. As this commentary went to print, the Ontario government has tabled proposed feed-in tariffs which favour rooftop solar.
- Buildings are ideal platforms for renewable solar energy generation systems. They provide existing support structure for the technology with little or no extra costs and where the energy produced will most likely be consumed immediately on-site. It's a perfect match for harnessing solar power, its production, consumption and lowering electricity costs at the same time.

**Table 3: Feed-in Tariffs for Ground, Rooftop and BIPV**

Country	Feed-in Tariffs (\$CND/kWh)		
	Ground	Rooftop	BIPV
Canada (Ontario)	\$0.42		
France	\$0.58		\$1.09
Germany	\$0.70	\$0.84	\$0.91
Greece	\$0.72		
Israel	\$0.76		
Italy	\$0.71	\$0.79	\$0.86
Spain	\$0.51	\$0.54	

Source: D&D Securities Company Securities

Proposed feed in tariff for renewable energy in Ontario under a 20-year contract

Solar PV	Ontario (Canada)	
	Proposed Size Tranches	Proposed Price \$(CND)/kWh
Rooftop	< 10kW	\$0.802
	10-100 kW	\$0.713
	100-500 kW	\$0.635
	> 500 kW	\$0.539
Ground Mounted	< 10 MW	\$0.443

Source: Ontario Power Authority

- From the city and communities perspective rooftops and BIPV are an attractive and cost effective solution allowing Solar to subsidize electrical infrastructure of urban communities during the peak of electricity utilization, when the industrial activities, air conditioning and computers are at its maximum power draw.
- A major shake-up in the current solar space is happening because of the potential overcapacity of over 4,000 – 8,000 MW⁶ of PV modules coupled with the competitiveness of low cost thin film. This is a positive development as it will bring down the marginal costs of the system thus making it more economically attractive to a larger group of end users.
- While the industry will grow very quickly it is evident that not all the incumbents will be winners and many high cost crystalline producers will likely be squeezed out of the market. Even then; choosing winners and losers on the module side of the business will be a challenge.
- ***The value for investors may not be in the PV system as a whole, but rather in the peripheral devices required to make the system operate more efficiently with lower input costs.***



PV SYSTEMS NEED AN OPERATING SYSTEM

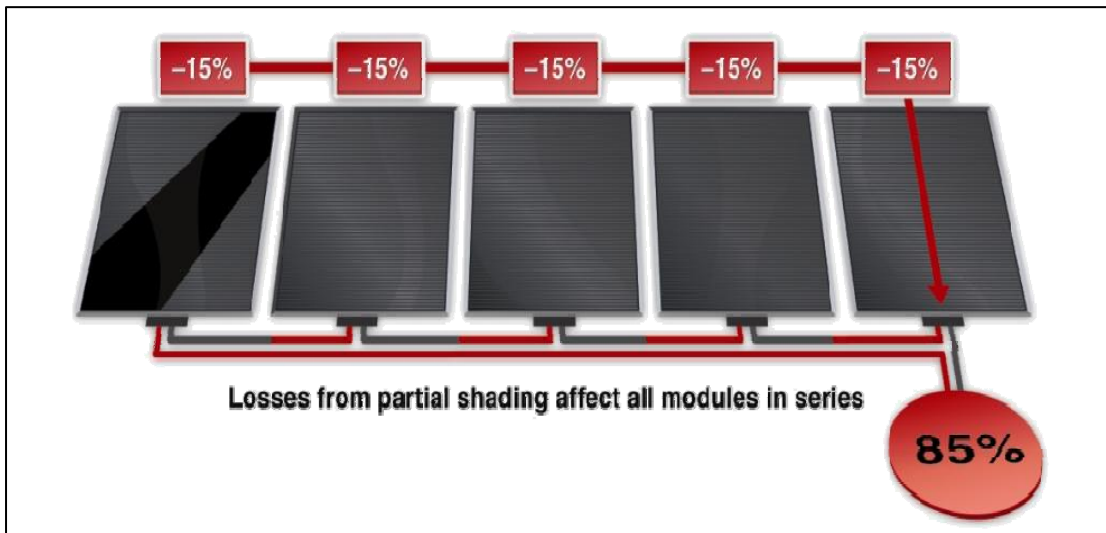
- The PV industry is in the early stages of development similar to the personal computer (PC) industry in the early 1980's. The revolution that took place 25 years ago in the computer industry offers some insight into investment return. An investor in the 1980's considering the PC world would have been well rewarded for looking not only at the actual computer manufacturers but at some peripheral players as well.
- One key enabler that comes to mind would have been Microsoft (Nasdaq: "MSFT") with current sales of \$17 billion and capitalization of approximately \$170 billion. What Microsoft offered was an "operating system" called DOS (Disc Operating System) which in many ways set the stage for success of the **personal computers (PC)**.
- Similarly, the PV technology requires such an operating system (OS). **The operating systems for PV are advanced power inverters which are critical enablers of all modern solar PV power systems, converting the direct current ("DC") from the Solar Panels to Alternating Current ("AC") used in the current electrical infrastructure.**
- This is where the most interesting opportunities perhaps could be found as new approaches are developed to improve total system power output and even simplify and reduce the cost of the system installation.
- Inverters call for much higher level of real time control over the power conversion process, since they must precisely match the AC wave shape (the sinusoidal wave shape that characterizes AC power) to the AC wave shape of the power grid in real time.
- Also, inverters have to meet a variety of power quality standards (harmonic distortion, power factor etc.), have the ability to detect grid outages and disconnect the energy source from the power grid for safety and grid control reasons.
- Until recently there has been little innovation in the inverter technologies with most companies followed a pattern developed over the last 10 years.

SERIES CONFIGURATION ISSUES

- Conventional inverter technologies require solar panels to be installed using "series" architecture utilizing high voltage-low current design resulting in each panel operating at the level of the poorest performing panel – just as it happens with Christmas tree lights. The **series** technology brings some inherent design flaws:
 - It is susceptible to Panel Mismatch
 - Shading Loss
 - High Voltage (300-600 VDC)
 - Thermal roll-back
 - Complex panel wiring installation



Figure 9: Losses from partial shading affect all modules in series



Source: Sustainable Energy

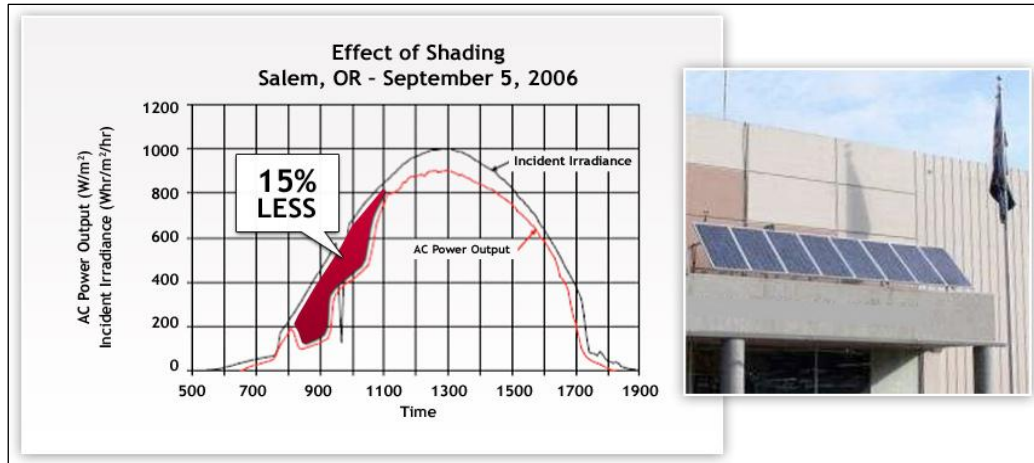
- Variances in module to module output (+/- 3% to 5%) due to variances in manufacturing tolerances do not offset each other but result in the entire string forced to be operating at the output of the poorest performing module showing a disproportionate reduction in power output from the system.
- The inverter has to choose between optimizing the voltage for the underperforming string or maximize the energy harvest from the unaffected strings. In most cases the inverter chooses the former, causing the energy harvest of the impaired string to drop at times to near zero.
- Variances in the module to module power output also could be due to variances in solar intensity where modules in a string are not identically aligned – as it happens around building curves and corners – reducing the power output of every module in the “series” to the level of the lowest power output.
- To prevent the whole string of cells failing when one cell underperforms, the typical installation is equipped with "bypass diodes." These are solid state circuits which re-route the electric current around the underperforming cells. The catch is that during the re-routing the inverter loses not only the potential energy from these cells, but it also lowers the entire string's voltage, therefore reducing the entire strings and the systems yield.
- Single PV module losses also arise out of shading from normal building congestions such as chimneys, parapets, railings of power lines, telecommunication towers as well as occasional dust and debris from poor system maintenance. These landscape and environmental elements reduce power output from all the modules in the series by 20% to 40% of the potential output of their solar installations. **Just 10% shading of a solar array can lead to a 50% decline in efficiency and even, on occasion, total system shutdown.**



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- The chart below shows field test results revealing how large and disproportionate power losses can be caused by a tiny amount of shading.

Figure 10: Effect of Shading



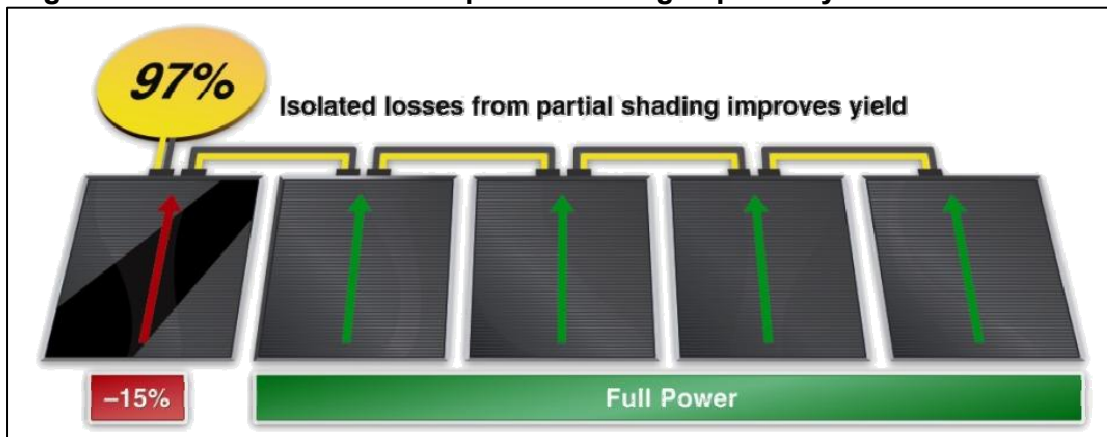
Source: Sustainable Energy

- The shading that causes loss of efficiency comes in many forms. Depending on the object causing the shading, it may be seasonal, or can last for a few hours each day, resulting in apparently “mysterious” fluctuations in the power supply.
- The loss of energy caused by partial shading of solar modules is difficult to predict because it depends on several variables such as internal module-cell interconnections, module orientation, how modules are connected within an array and the configuration of the inverter.
- Currently, prior to installation, installers use custom analysis to determine the pattern of shadows crossing a roof and how they change seasonally. Shading analysis software programs with three-dimensional simulation capabilities are available to analyze shading dynamics.
- However, this approach can be inadequate as it can result in a corresponding loss of PV surface area, awkward non-centered panel rooftop designs, or large swaths of the installation site left bare reducing total system yield and increasing its costs.
- The challenge is made more complex by the fact that conventional inverter technologies require a minimum number of modules in each string ranging from 5 to 15 PV modules in order to get high enough voltage necessary to meet the inverters requirements.
- The requirement for fixed number of modules per string means that some areas will not be covered if it does not accommodate the ideal number of modules, decreasing yield and increasing design limitations and system costs. Currently, virtually all inverters distributed to the market use the same series technology.

PARALLEL SYSTEM ARCHITECTURE OFFERS ENHANCED PERFORMANCE

- The alternative to the **series** architecture is a **parallel** architecture where each PV panel operates at its optimum power point independently from the other panels in the string. As a result, shading of one module does not affect the performance of other modules in the string.
- Similarly, for variances in orientation, each module produces the most power in the given conditions without impacting performance of other modules in the string. Finally, with a parallel architecture normal variances in manufacturing tolerances do offset each other in the string.

Figure 11: Isolated losses from partial shading improves yield



Source: Sustainable Energy

- A parallel architecture also allows PV modules to be installed in increments of one or two modules at a time instead of the long strings of identically matched modules required by conventional inverter technologies. The result is greater flexibility in system design and much higher penetration of the available rooftop area resulting in expanding the range of sites where solar PV installation could become economically appealing.
- The arguments in favor of the parallel architecture are compelling. The only issue has been whether the architecture can be delivered at a cost and with a maintenance paradigm that is competitive with the more common series architecture.
- It is estimated that the current global installed solar photovoltaic capacity exceeds 10,400 MW⁷, virtually all of which, relies on a “series” configuration (High Voltage – Low Current).
- In 2007, approximately 2,900 MW of grid connected solar PV generators were installed globally, representing approximately 2.1% of new power generation capacity world-wide. At the end of 2007, there was an estimated total of 10,400 MW of solar PV generating capacity representing less than 4/10 of 1% of total electrical generating capacity and less than 2/10 of 1% of worldwide power generation. It is estimated that as much as 2,600 MW may have been installed during 2008⁸.



Thin Film PV

- According to ISM Research, the value of solar inverters realized by manufacturers – “the factory gate value” – in 2007 was US\$1.2 billion, or an average of **\$0.41 per Watt** (USD) based on 2,900 MW of production. In 2007, more than 65% of the total value of inverters sold was for inverters with power ratings less than 30kW.
- Growth forecasts for the solar PV industry are optimistic. According to a report released January 27, 2009 by Greentech Media and the prestigious Prometheus Institute, (PV Technology, Production and Cost 2009 Forecast), global PV module capacity will grow from 5,700 MW in 2008 to 27,000 MW in 2012, enough to produce 23,000 – 24,000 MW. Assuming an average 5% year over year erosion in factory gate prices for solar inverters, the total addressable market could be between US\$6.5 and US\$7.7 billion per year in 2012 depending on the distribution of power ratings.



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SUSTAINABLE ENERGY TECHNOLOGIES LTD.

- Sustainable Energy Technologies Ltd. (listed on the TSX-Venture under the symbol “STG”) a Canadian company based in Calgary, Alberta has developed and patented a parallel voltage inverter, SUNERGY™ for the photovoltaic industry. This technology allows for realization of the true cost advantages for Rooftop Thin Film and Building Intergraded Photovoltaic (BIPV).
- **The Company has developed patented technology which enables a “parallel” architecture for high power grid-connected solar PV systems with the form factor, high electrical conversion efficiencies and at a cost appealing to the industry.**
- Sustainable Energy’s parallel inverter design breaks through the conventional inverter paradigm with its ability to accept much higher electrical current inputs without compromising electrical conversion efficiencies. For every one unit of current increase there is a square increase of electrical loss in the form of heat. STG software enables the Company’s inverters to operate using a parallel architecture in high power ratings without compromising conversion efficiencies.
- It achieves this by combining a common **step wave architecture** creating the basic sinusoidal wave shape and the same pulsed width modulation approach utilized for conventional inverters, to pulse the steps and convert a comparatively poor quality wave shape into the high quality sine wave that the grid and the utilities require. This technique is referred to as a **pulsed step wave design** and is covered by one of STG’s patents. Other patents cover the software algorithms that are used to control the operation of the platform.
- Sustainable Energy has designed a platform which is a breakthrough in inverter technology. The Company’s technologies are the subject to nine (9) U.S. and Canadian Patents and others are pending. The Sustainable Energy’s **parallel** inverter technology adds value to any application where low voltage – high current systems must interconnect with the power grid and where high electrical conversion efficiencies are a critical driver.
- The Sustainable Energy’s parallel inverter technologies have very limited drawbacks. Their efficiency ranges between 94% and 96% and though, it is not as high as some transformerless inverters showing 97% efficiencies, these cannot be used with thin film technologies whereas the Sustainable Energy’s inverters do work extremely well.
- The parallel architecture can require additional wiring for the second circuit adding a few cents a watt, but the Company is working with module suppliers to integrate the circuit into the module itself. Two companies – **Honda and Mitsubishi Heavy Industries – have already adopted this approach for their modules therefore offsetting the additional wiring costs.** STG inverters also provide cost savings expressed in the ease of installation coupled with the reduced system design expenses.

**GEN I AND GEN II – THE SUNERGY™ LINE**

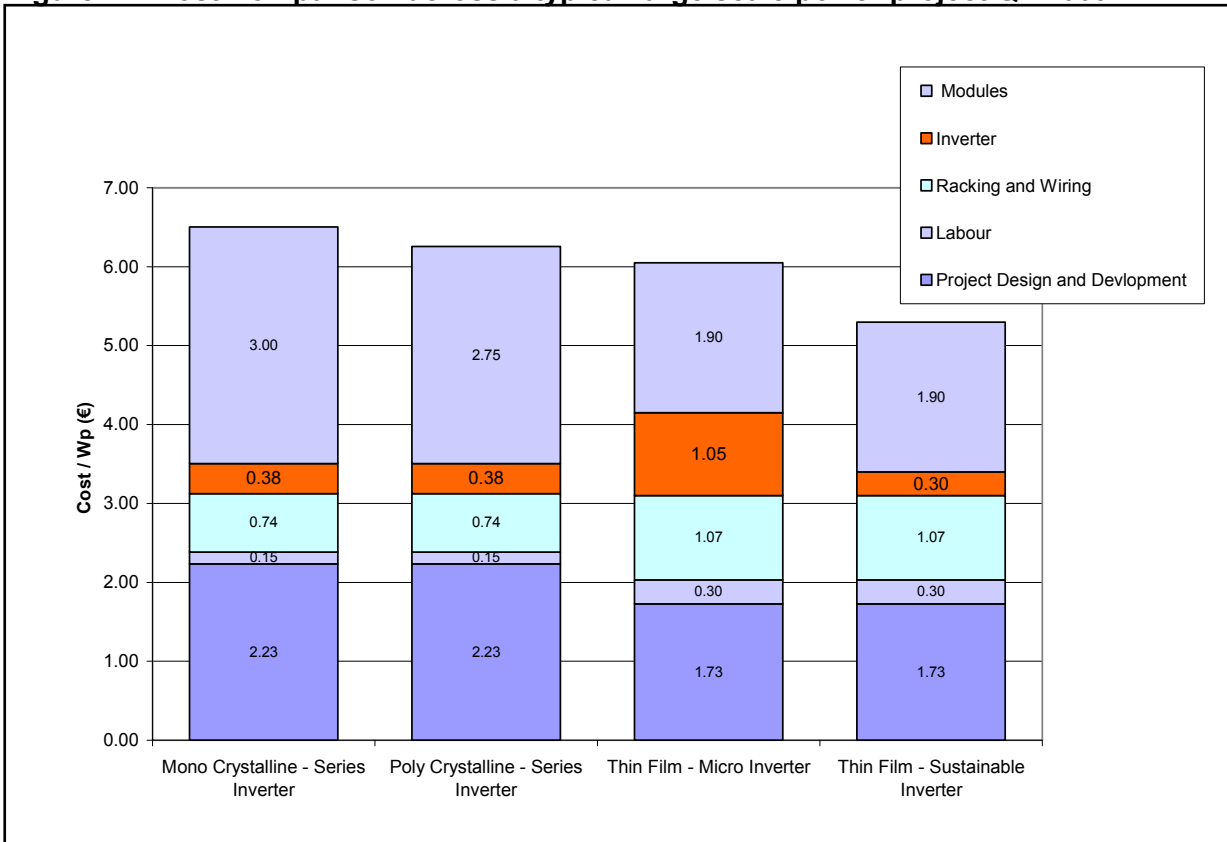
- The Sustainable Energy's first product for the grid-connected solar PV market was a 5,000 Watt grid interactive inverter which was introduced into the Spanish and Greek markets in 2007. Since then, the Company has manufactured more than 2,000 units of which 1,200 units are powering a solar tracker project in Spain.
- Analysis supports the argument that the STG inverter is showing the lowest cost per Watt in its class in the industry. By Q2'2009 the company will release their 2nd generation of inverter aptly named "Gen II". Building on their first generation SUNERGY, the company will be seeking approval for "Gen II" from UL, CSA, and VDE to obtain endorsement in German market. This will allow Sustainable Energy to compete in markets now closed to their current SUNERGY inverter.
- The Gen II has a unique modular design that uses a single electronics module to support multiple power ratings and voltages enabling the company to quickly achieve economies of scale from the mass production of their products. It also enables a much simpler operating cost structure delivering more earnings to the bottom line.
- The modular platform enables a "call center" approach to product support similar to the approach taken by many computer manufacturers. If the fault cannot be fixed over the phone the electronics are removed and swapped with new electronics delivered overnight by courier. Most inverter companies must rely on field service technicians therefore, increasing customer support costs.
- STG has adopted an outsource subcontract manufacturing model, currently widely followed by the electronics industry. For all practical purposes, this approach enables an unlimited production capacity with minimal capital investment.
- STG believes that its manufactured cost per Watt will be among the lowest in the industry. Its cost is currently below US\$0.20/Watt and it has a clear path to cutting this in half to US\$0.10/Watt in the next two years. The Company has a very strong manufacturing team lead by its Chief Operating Officer Greg Nelson.
- STG's low cost per Watt enables it to use a private labelling strategy to access established distribution channels in the major markets while still achieving very robust product margins. Sustainable Energy is validating this model in Spain with its recently announced deal with Salicru S.A., the largest power electronics company in that market. Its aim is to repeat this model in all major markets around the world.



Thin Film PV

- Sustainable Energy's milestones:
 - Proven and commercial technology – more than 1,200 Gen I units in the field.
 - Gen II modular design enables multiple single and three phase products to 20kW.
 - Cost structure is established below \$0.18/Watt in 2010 and \$0.10/Watt by 2012.
 - Minimize warranty and customer services costs.
 - CE and UL certification by Q3'2009.

Figure 12: Cost Comparison across a typical large scale power project Q1-2009



Source: D&D Securities

- During Q4'2008, Sustainable Energy will redirected its strategy to focus on positioning their inverter for use with emerging thin film PV technologies suitable for rooftop and building-integrated solar power markets using Spain as a test market for their value proposition.

**COMPETITION**

- The power of the parallel architecture has prompted other companies to create products attempting to offer the same value proposition focusing on connecting electronics solutions at the module level.
- Thus far, all parties have concentrated their attention on crystalline modules showing a much higher cost/Watt and a problematic maintenance paradigm. Fortunately, the attention paid by these companies has increased the awareness of the issues and facilitated STG's marketing.
- Researchers and engineers at National Semiconductor have been developing what is essentially a smart diode which routes the power around the shaded module and effectively takes it out of the string. National Semiconductor believes that its power optimizer technology will be able to recapture up to 50% of the energy lost due to partial shading.
- However, it is estimated that the cost of the power optimizer technology would amount to about 10% of the module cost. Once added to the cost of the system, it would essentially double the cost of the inverter.
- Another popular solution is the micro-inverter first developed by enPhase. The design philosophy of the micro-inverter incorporates one inverter per panel approach, which allows for the voltage and frequency modulation right at the source.
- Although, micro-inverters have some benefits they are about two to three times as costly as the STG solution when used with crystalline modules and double that again when used with thin film modules. The Sustainable Energy's inverter technology allows for economies of scale to work. With larger scale projects, Sustainable Energy's cost of \$0.40/Watt compared to enPhase \$1.15/Watt, offering a distinct cost advantage.
- Even more significantly the micro-inverter maintenance paradigm is dramatically different from industry norms and in the long run probably much more expensive. With all module-based solutions one would run a risk of substituting single point of failure with potentially hundreds of failure points.
- The highest costs are found not in replacing the inverters but in the cost of labour and related costs associated with each failure incident, which would be borne by the owner. Although the panels have a 20 year life span – the electronics attached to the modules could see a much reduced lifespan.

**CURRENT CO-OPERATIVE AGREEMENTS**

- **COPCISA SLU** – is one of Spain’s largest construction companies. Copcisa and Sustainable Energy agreed to jointly market thin film bundles in Spain through the Copcisa’s construction industry channels. A key goal of this relationship is to validate that the simplicity of a parallel architecture enables new channels within the building industry.
- **SOLAER SA** – is one of Spain’s leading solar power project developers who agreed to co-market massively parallel thin film PV (“TFPV”) bundles for industrial and commercial rooftops in Spain. Under signed contract SOLEAR and SUSTAINABLE will collaborate on refining system design and installation procedures, as well as sharing market intelligence gained through the co-marketing process. This agreement marks another milestone in the execution of Sustainable’s strategy to position their products and technologies within growing thin film market. It is also an important validation of the product since Solaer was STG’s first customer for its Gen I product by installing 6MW.
- **INGETEAM SA** – is a leading independent supplier of power conversion and control systems for wind turbines and solar PV systems. The company is based in Navarra, Spain and their solar division is ranked as one of the market leaders in the world. It manufactures full range of high-voltage solar inverters with power ratings as high as 500kW.
 - On May 26, 2008 – STG signed a letter of intent with INGETEAM SA where both companies will market and distribute the other company’s products and collaborate to jointly market their inverters for CPV systems in Europe and North America.
- **SALICRU S.A.** – was founded in 1965 with headquarters near Barcelona, Spain. Salicru is one of the leading manufacturers of power electronics products in Europe. It is a market leader in Spain and Portugal, supplying a complete assortment of product solutions ranging from basic AC power supplies and uninterruptible power supply systems to complex integrated DC power systems.
 - On January 22, 2009 Salicru and Sustainable Energy announced that both companies will partner to distribute Sustainable Energy’s revolutionary “parallel” inverter technology throughout the markets in Southern Europe, North Africa, the Middle East and the Asia Pacific countries.
 - Salicru has placed a purchase order estimated at \$6.2 million for Gen II inverters to be delivered in Q3’2009. Signed Agreement will also provide Sustainable Energy with expended product warranty support through Salicru’s facilities near Barcelona.
 - As an important development both companies agreed to collaborate in the development of new products, using the Sustainable Energy’s products and technologies as a platform. Salicru has a strong product development group and its facilities are among the best in Southern Europe.
 - SALICRU’s commitment validates Company’s conviction that thin film technologies will be a major part of the future of the rooftop and building integrated solar PV markets which are expecting to reach grid parity by 2010.



Thin Film PV

ASSESSMENT SUMMARY

- Growth prospects are directly related to how businesses and the consumers will embrace Photovoltaic technology which is expected to see CAGR of 45% over the next 5 years. Thin film provides a cost structure that has reached grid parity in some electrical markets and grid parity should be available in most markets in the near future⁹.
- Solar delivers many benefits. It is:
 - non-invasive
 - maintenance free
 - solution to lack of transmission capacity
 - no impact on birds or bats
 - no noise / ground vibrations
 - virtually zero environmental impact after construction
- With the decline in price per Watt and increase in demand for solar energy is very bright. Sustainable Energy Technologies Ltd. is sitting at the right place on the event horizon with its parallel architecture representing an interesting opportunity in the solar energy space.
- The pressures facing current panel producers and oversupply in the market coupled with the market downturn is squeezing the margins of all panel producers allowing for cheaper modules to flood the market, dropping the system costs and increasing demand. The inverter manufacturers including Sustainable Energy are well placed to ride the wave.
- The model below makes modest assumptions on Sustainable Energy's ability for market penetration. With the roof top market estimated to be 60% or 8,000 MW of the total market by 2012¹⁰. Thin film is estimated to make up 50% of this roof top market, . By using a market penetration of about 10% of roof top installation by 2012 or 900 MW, it is not unreasonable to expect to see the company reaching over \$240 million in sales.
- Sustainable Energy has dedicated the better part of the last 5 years to establish its patented parallel inverters as a unique value added proposition. Current trends favouring thin film roof top PV suggest it may get its opportunity. The risks facing the company and potential investors are the same every speculative venture faces, are they able to successfully execute and fund their future.

**TABLE 5: SUSTAINABLE ENERGY TECHNOLOGIES LTD. MODEL**

Revenue (\$MM)	2007 FY	2008 FY	2009 FY-E	2010 FY-E	2011 FY-E	2012 FY-E
MW Sold	5	3	25	125	250	900
Sales	\$1.91	\$1.38	\$10.00	\$50.62	\$80.10	\$242.08
Engineering Fees / Interest and Other	\$0.09	\$0.14	\$1.09	\$1.56	\$1.70	\$1.86
COGS	\$2.14	\$1.69	\$7.00	\$21.25	\$35.00	\$90.00
Net Sales	(\$0.13)	(\$0.16)	\$4.09	\$30.93	\$46.80	\$153.95
Expenses						
Manufacturing, Marketing and Product Development	\$2.04	\$2.34	\$2.46	\$4.23	\$4.65	\$5.12
General and Administrative	\$0.92	\$1.30	\$2.24	\$3.58	\$3.76	\$3.92
Interest / FX Loss (Gain)	\$0.22	\$0.02	\$0.04	\$1.31	\$2.05	\$2.70
Amortization of Development costs / Capital Assets	\$0.56	\$0.57	\$0.57	\$0.57	\$0.58	\$0.58
EBITDA	(\$3.09)	(\$3.80)	(\$0.61)	\$23.12	\$38.39	\$144.91
Bundled Units Sold (MW)	0	0	8	27	34	40
Total Bundled Contributions	\$0.00	\$0.00	\$2.08	\$8.67	\$10.61	\$12.54
Combined Net Income (Loss) before Tax	(\$3.87)	(\$4.38)	\$0.85	\$29.90	\$46.37	\$154.17
Tax Rate	0%	0%	0%	20%	20%	30%
Future Income Tax Expense	\$0.00	\$0.00	\$0.00	(\$5.98)	(\$9.27)	(\$46.25)
Net Income (Loss)	(\$3.87)	(\$4.38)	\$0.85	\$23.92	\$37.10	\$107.92
Capital Expenditures	n/a	n/a	\$0.36	\$10.60	\$6.13	\$5.44
Debt Financing	n/a	n/a	\$0.04	\$1.27	\$0.74	\$0.65

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CAPITALIZATION TABLE

Company	Sustainable Energy Technologies
Head Office	Calgary - AB
Year End	Sept. - 30
Price (March 5, 2009)	\$0.11
52 Week High - Low	\$0.37-\$0.05
Shares Outstanding	136,513,215
Fully Diluted	146,818,968
Market Cap - Basic (mm)	\$13.72
Total Debt - September 30 2008 (mm)	\$0.627
Working Capital (mm)	\$3.522
Enterprise Value (mm)	\$2.080
Cash and Cash Equivalents (mm)	\$2.070





APPENDIX

MANAGEMENT TEAM

Michael Carten, LLB - CEO and Chairman. Michael has more than 25 years of national and international experience in the energy industry most recently as Senior Vice President Corporate and Government Finance for Nesbitt Burns. He initiated first conceptual stages through technology and product development and the commercialization process as well as arranging financing and developing key strategic alliances.

George H. Nelson – Chief Operating Officer, Executive Vice President and Director is the latest addition to the Board of Directors and Senior Management team. Greg was formerly Executive Vice President and CCO of First Solar, the world largest manufacturer of thin film solar PV modules and was COO of ZBB Energy Corporation a manufacturer of advanced battery technologies.

Derek Howell - Director of Operations is responsible for Supply Chain Management, Manufacturing and Customer Support since 2003. Derek is a seasoned manufacturing executive with more than 20 years experience in the telecommunications and electronic sector. Derek was previously Operations Manager for the Microwave Communications Division of Harris Corporation in Alberta.

David Carten - Co-Founder of the Company and Director General of Sustainable Energy Europa S.L. based in Barcelona, Spain. Fluent in English, Spanish and French, David has identified and developed Sustainable Energy's technology applications and established several strategic partnerships for development and deployment of the Company's technologies and products. With more than 8 years experience in the solar industry he has built an extensive network of relationships with many key players in the North American and European solar power industry.

Brent Harris, P. Eng. - Director of Technology and Co-Founder has contributed to the technology and product development process since inception of the Company. He is an inventor of the Sustainable Energy's key patents and has led the commercialization of the Company's products. Brent is very knowledgeable about solar and wind power as well as the many fuel cell technologies. Brent participates in developing and marketing new product applications.

Axel Hartung - Director of Business Development is responsible for Sustainable Energy's operations in Europe and is based in Frankfurt, Germany having more than 10 years of experience in marketing and sales in Germany. In the past Axel was the Business Development Manager for Diehl Controls, a part of Diehl Group, one of Germany's leading industrial companies. Axel has a deep knowledge of the European solar power industry and relationships with many of the industry's major players.

Roger Fredette – Controller is responsible for financial reporting, internal controls, accounting and compliance requirements having more than 20 years of experience in financial management and accounting. Roger – a strategic planner – has successfully orchestrated the purchase and financing of two companies. He has been the financial controller of both private and public companies with annual sales in excess of \$40 million.



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Important Disclosures

Legal Disclosure

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Issuer Industry

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Yes No

Is D&D Securities Company a market maker in the issuer's securities at the date of this report?

Yes No

Does D&D Securities Company and its affiliates in the aggregate beneficially own more than 1% of any class of common equity of the issuer?

Yes No

Does D&D Securities Company or the Analyst have any actual material conflict of interest with the issuer?

Yes No

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Yes No

Has the Analyst received any compensation from the subject Company in the 12 months?

Yes No

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Has the Analyst had an onsite visit with the Issuer? (The extent to which the analyst has viewed the material operations is available on request).

Yes No

Has the Analyst ever been compensated for travel expenses incurred as a result of an onsite visit with an Issuer?

Yes No



Important Disclosure Footnotes for Companies Mentioned in this Report that are covered by D&D Securities Company:

Stock Price as of March 10, 2009

Sustainable Energy Technology Ltd. (STG – TSX Venture; Cdn\$0.12)

Companies Mentioned in this Report that are not covered by D&D Securities Company:

Stock Price as of March 10, 2009

Apple Inc. (AAPL – NASDAQ; US \$88.53)

First Solar Inc. (FSLR - NASDAQ; US\$120.04)

Harris Corporation (HRS – AMEX; US\$30.18)

Microsoft CP (MSFT – NASDAQ; US\$16.61)

National Semiconductor Corp. (NSM – AMEX; US\$11.70)

Q-Cells AG (QCE – DAX; €11.50)

Research in Motion Ltd. (RIMM – NASDAQ; US\$38.94)

Schneider Electric S.A. (SBGSY – NASDAQ; US\$6.00)

ZBB Energy Corporation (ZBB – AMEX; US\$0.96)

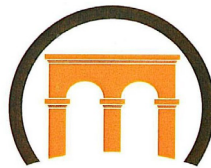


- Notes -

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¹ Sustainable Energy -

² Scientific America - www.sciam.com - **Solar Grand Plan**

³ "Global PV market demand analyses – Analyses of market demand to 2010" Edwin Koot, July 2008 www.solarplaza.com and Prometheus Institute.

⁴ Forbes - www.forbes.com/2008/11/24/solar-innovation-disruption_leadership_clayton_in_js_1125claytonchristensen_inl.html

⁵ Q-Cell – **CONFERENCE CALL PRELIMINARY FIGURES 2008**

⁶ Photo-International

⁷ Prometheus – "2009 Global PV Demand Analysis and Forecast: The Anatomy of a Shakeout II"

⁸ International Energy Association – www.iea-pvps.org

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