Jefferies CleanTech **Review**

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About Jefferies

Jefferies, a global investment bank and institutional securities firm, has served growing and mid-sized companies and their investors for over 40 years. Headquartered in New York, with more than 25 offices around the world, Jefferies provides clients with capital markets and financial advisory services, institutional brokerage, securities research and asset management. The firm is a leading provider of trade execution in equity, high yield, convertible and international securities for institutional investors and high net worth individuals. Jefferies & Company, Inc. is the principal operating subsidiary of Jefferies Group, Inc. (NYSE: JEF; www.jefferies.com), a NYSE listed company with an equity market capitalization of over $3.0 billion.

About Jefferies CleanTech Practice

Jefferies CleanTech Investment Banking Practice is composed of a team of three experienced senior bankers in North America and one each in Europe and Asia that focus on the alternative energy and clean technology sectors. The North American team is led by Jeff Lipton, a Managing Director with over eight years of experience in the alternative energy and chemicals sectors. Jeff is joined by Robert Jaworski, a Senior Vice President, who holds a Ph.D. in Chemistry and has five years of investment banking experience and over seven years of hands-on industry experience with alternative energy generation and storage technologies while working at Bellcore / Telcordia and Adam Bergman, a Vice President, with over eight years of corporate finance experience covering alternative energy, industrial and technology companies. In Europe, the team is led by Bruce Huber, a Managing Director with over 23 years of experience working with technology companies, including solar, wind and other alternative energy. In Asia, the team is led by Wei Hopeman, a Vice President with over eight years' cross-border corporate finance and M&A experience working with technology and industrial companies.

Since initiating the CleanTech practice at Jefferies in November 2003, the team has worked as Lead Placement Agent for an $88 million PIPE transaction for Energy Conversion Devices; Sole Placement Agent for a $37 million Convertible Notes transaction for Solar Integrated Technologies and Sole Bookrunner on a $66 million combined Convertible Notes and Follow-on Equity Offering for Solon AG. The Jefferies team in currently involved in numerous public and private financing transactions as well as strategic advisory assignments.

Jefferies CleanTech **Review**

Jefferies is pleased to introduce the *Jefferies CleanTech Review,* our newsletter highlighting the developing trends that are impacting the sector. This effort will track both financing and strategic activity and will also examine key technical topics and public policy themes that are particularly relevant to industry players and observers. We anticipate this newsletter will be produced on a quarterly basis. For more information, please contact the Jefferies CleanTech Investment Banking Group at (212) 284-3431.

Trends & Updates

Incentives for renewables continue to expand globally. From Europe to North America to Asia, national and local governments have initiated new incentives to fund the growth and adoption of renewable energy. California and Spain both recently increased the size of their incentive programs and China is adopting a new regime, which is likely to drive growth in sales of solar panels, building integrated Photovoltaics ("PV") ("BIPV") components and systems, wind power, biomass and other emerging technologies.

Recent IPOs are bringing a new class of investors into the sector. Recent IPO offerings from SunTech and SunPower in the U.S. and Q-Cells and ErSol in Europe were significantly oversubscribed leading to one-day gains reminiscent of the equity market in 1999 and 2000.

Private equity interest in alternative energy companies continues to increase. Nine investments of at least $10 million were made in U.S. alternative energy companies in 2005, 50% more than in 2004. Additionally, a number of VC and private equity firms raised new funds specifically focused on the alternative energy sector.

Solar energy continues to lead the way among alternative energy technologies. Solar energy is at the forefront of the current alternative energy movement globally due to the successful commercialization of products, huge product demand and targeted incentive programs; but fuel cell, advanced batteries, wind power and other emerging technologies continue to receive increasing levels of interest from governments and investors.

London Stock Exchange's ("LSE") Alternative Investment Market ("AIM") has grown in popularity among alternative energy companies. In 2005, seven alternative energy companies listed on the AIM, representing 133% growth over 2004.

Numerous investments are being made in emerging solar technologies. Advent Solar, Energy Innovations, Miasole and Nanosolar all raised capital in 2005 to help fund next generation solar products.

The largest industrial firms are beginning to take notice of the CleanTech market. General Electric has a focused marketing campaign on "Ecomagination" and DuPont has announced that by 2010 it plans to derive at least 25% of its revenue from non-depletable resources.

Valuations continue to rise higher and higher. In 2005, trading multiples for U.S. public solar companies increased two-fold as product commercialization proceeded and companies showed the ability to capitalize on the projected 30% annual growth in the industry through the next decade. Other areas have seen far more modest appreciation given anticipated time to commercialization.

The U.S. government is beginning to get serious about alternative energy. After lagging behind Europe and Japan for the past decade, the U.S. government, through the enactment of the 2005 Energy Act, and many state governments (California, New Jersey, Arizona, et al.) are beginning to get serious about providing proper incentives to increase alternative energy and decrease our dependence on foreign oil.

U.S. companies are focusing on alternative energy despite the lack of acceptance of the Kyoto Protocol by the U.S. Government. Large, global U.S. companies including Wal*Mart and Coca Cola have initiated major renewable energy initiatives to be seen as compliant in markets where Kyoto has been adopted.

For solar companies, silicon supply has become the elephant in the room. With serious supply concerns already mounting for 2006 prior to California's new solar incentives plan, many of the traditional crystalline solar cell manufacturers are worried about meeting demand and are locking in silicon supplies at all-time high prices. Supply constraints are expected to last through at least 2008.

U.S. Trading Comparables

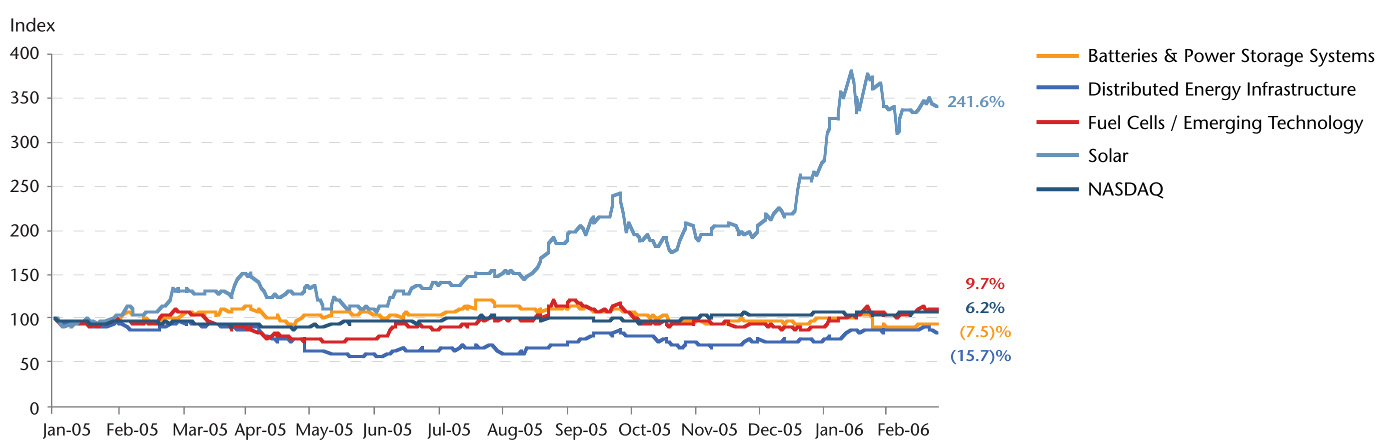
2005 witnessed a mixed performance in the alternative energy sector. While solar companies were up anywhere from 50% to 200%, many fuel cell, battery and emerging technology firms ended the year flat overall. Stocks remain highly volatile and tend to be news event driven apart from fundamental financial performance.

Investors in solar companies are rewarding these firms for their ability to commercialize products, increase production capacity and exhibit a path to profitability. Failure to exhibit these same characteristics is the main reason that most other U.S. alternative energy companies continue to trade at multiples below their solar peers.

($MM, except per share data)							TOTAL ENTERPRISE VALUE /				
COMPANY	STOCK PRICE 3/10/06	% OF 52-WEEK HIGH	EQUITY VALUE	TOTAL ENTERPRISE VALUE	REVENUE CY2006E	REVENUE CY2007E	REVENUE CY2006E	REVENUE CY2007E	EBITDA CY2006E	EBITDA CY2007E	REVENUE CAGR 2005-2007E
Batteries & Power Storage Systems											
American Power Conversion	$20.65	72.3%	$4,019.5	$3,259.6	$2,230.5	$2,509.1	1.5x	1.3x	13.0x	10.0x	12.8%
C&D Technologies	8.42	59.9%	211.4	328.3	503.1	567.9	0.7x	0.6x	10.2x	7.5x	6.4%
EnerSys	13.13	83.6%	605.2	1,006.0	1,260.4	1,374.0	0.8x	0.7x	8.3x	7.3x	4.8%
Maxwell Technologies	17.11	85.6%	284.0	273.5	63.8	85.5	4.3x	3.2x	NA	NA	36.3%
Ultralife Batteries	11.39	61.3%	162.7	172.1	94.4	123.1	1.8x	1.4x	NM	NA	30.7%
Valence Technology	2.31	69.0%	201.9	265.9	NA	NA	NA	NA	NA	NA	NA
				Mean	**830.4**	**931.9**	**1.8x**	**1.4x**	**10.5x**	**8.3x**	**18.2%**
				Median	**503.1**	**567.9**	**1.5x**	**1.3x**	**10.2x**	**7.5x**	**12.8%**
Distributed Energy Infrastructure											
Magnetek	$3.90	63.9%	$110.8	$153.5	$238.4	$254.5	0.6x	0.6x	8.1x	NA	2.3%
Spire	8.70	64.9%	63.2	60.8	NA	NA	NA	NA	NA	NA	NA
Xantrex Technology	5.94	63.2%	173.7	113.7	160.1	173.8	0.7x	0.7x	11.3x	2.5x	30.6%
				Mean	**199.2**	**214.2**	**0.7x**	**0.6x**	**9.7x**	**2.5x**	**16.5%**
				Median	**199.2**	**214.2**	**0.7x**	**0.6x**	**9.7x**	**2.5x**	**16.5%**
Fuel Cells/Emerging Technologies											
Active Power	$4.32	86.9%	$214.1	$171.7	$26.7	$43.2	6.4x	4.0x	NM	NM	55.1%
Ballard Power Systems	5.96	87.0%	677.6	439.0	68.8	79.5	6.4x	5.5x	NM	NM	23.0%
Beacon Power	1.57	29.3%	88.6	90.8	NA	NA	NA	NA	NA	NA	NA
Capstone Turbine	3.14	53.3%	321.6	256.5	24.5	39.3	10.4x	6.5x	NA	NA	30.6%
Distributed Energy Systems	6.37	57.9%	241.0	200.3	52.5	67.9	3.8x	3.0x	NM	NM	42.3%
FuelCell Energy	9.93	81.1%	484.4	375.4	34.1	NA	11.0x	NA	NM	NM	25.3%
Hydrogenics	3.45	64.1%	316.3	230.8	59.3	71.7	3.9x	3.2x	NM	NM	29.8%
Mechanical Technology	3.34	61.9%	108.2	64.8	14.3	NA	4.5x	NA	NA	NA	NA
Medis Technologies	18.41	85.2%	503.4	505.2	0.6	NM	NM	NM	NA	NA	NA
Millennium Cell	1.60	50.8%	74.7	70.0	0.6	NA	NM	NA	NA	NA	NA
Plug Power	4.59	56.0%	403.3	300.2	19.8	35.5	15.2x	8.5x	NM	NM	52.6%
				Mean	**30.1**	**56.2**	**7.7x**	**5.1x**	**NM**	**NM**	**37.0%**
				Median	**25.6**	**55.5**	**6.4x**	**4.7x**	**NM**	**NM**	**30.6%**
Solar											
Daystar Technologies	$12.67	72.4%	$81.2	$65.6	NA	NA	NA	NA	NA	NA	NA
Energy Conversion Devices	42.34	73.2%	1,587.6	1,518.7	149.1	260.6	10.2x	5.8x	NM	NM	59.8%
Evergreen Solar	15.63	95.9%	954.9	947.6	102.6	206.3	9.2x	4.6x	NM	NM	118.3%
SunPower	38.08	84.5%	2,277.6	2,134.0	214.7	350.6	9.9x	6.1x	NM	NM	111.0%
Suntech Power Holdings	33.90	73.8%	5,091.3	4,692.7	484.3	925.4	9.7x	5.1x	NM	NM	108.0%
				Mean	**237.7**	**435.7**	**9.8x**	**5.4x**	**NM**	**NM**	**99.3%**
				Median	**181.9**	**305.6**	**9.8x**	**5.4x**	**NM**	**NM**	**109.5%**

Source: Company Filings, Factset, Projections from I/B/E/S

Sector's Relative Price Performance



Source: Factset

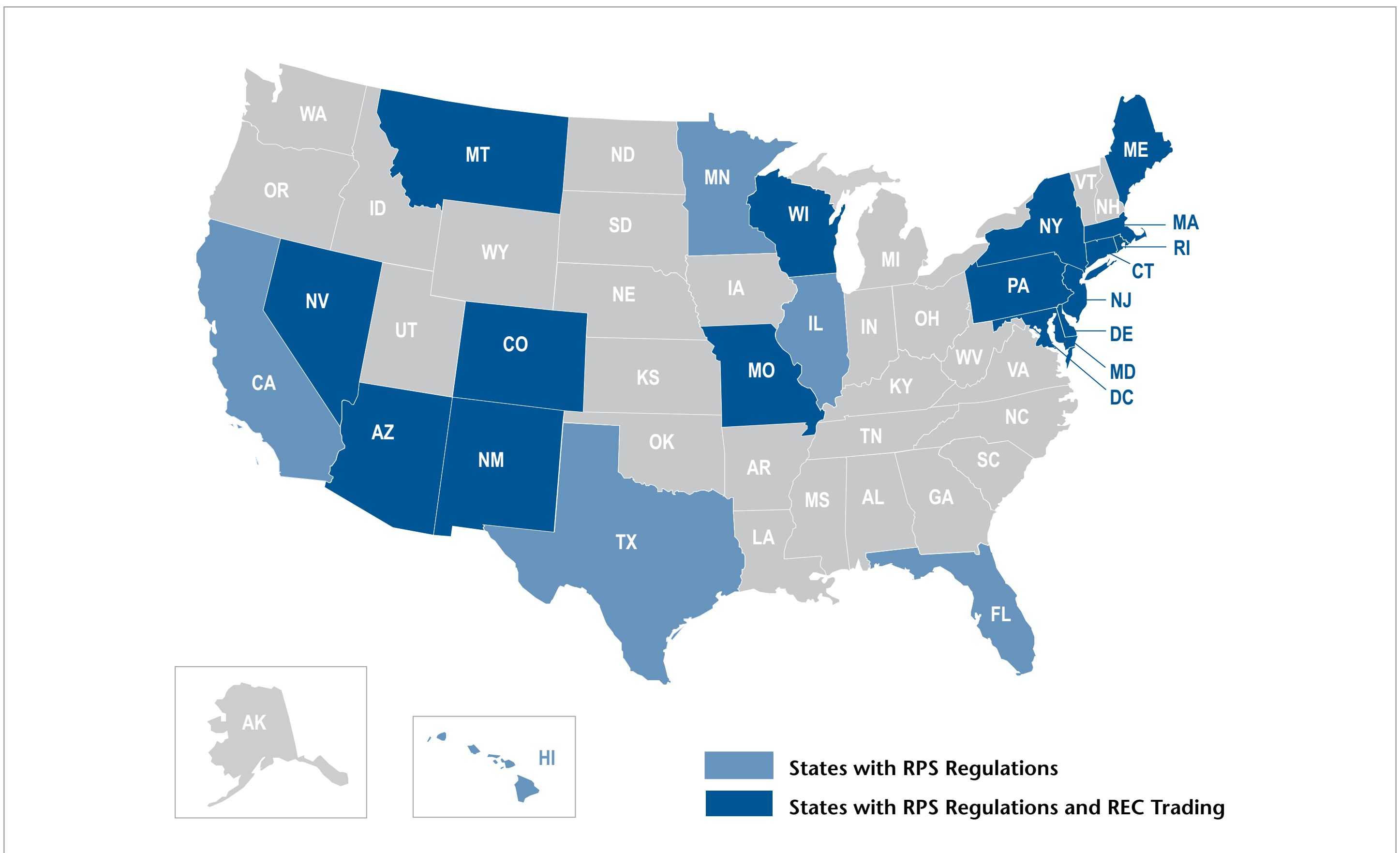
Trading Green

Electrical energy generated from alternative/renewable sources is no different from traditional electricity produced in conventional power plants in terms of its performance characteristics. However, its nontraditional origin gives alternative energy the potential for additional economic value that may be monetizable.

Numerous factors are behind governments' efforts to encourage increased use of renewable energy. They range from the risk of dependence on foreign energy supply to concerns about the environment including pollution and climate change. Governments have a number of policy tools at their disposal with the Renewable Portfolio Standard ("RPS") being one of the more recent emerging developments. RPS requires public utilities to generate or purchase a certain percentage of electricity they sell from specifically defined renewable sources. For example, if RPS calls for 5% of electricity to be generated from renewable sources and a utility sells 50,000 megawatt hour ("MWh") annually, 2,500 MWh of this amount will have to be procured from approved sources. In the U.S., 22 states and the District of Columbia currently have RPS rules in place (see the map below).

In general, an electric utility has three ways to satisfy the RPS requirements: 1) it can build its own renewable energy generating capacity; 2) it can buy renewable energy from another supplier; or 3) it can generate or buy traditionally generated electricity and then buy a proof of generation & sale to customers of a given amount of energy generated from approved renewable sources. This last method is the most flexible since it detaches physical attributes of energy from its "green" origins. The certificates used to prove the renewable origins of a given amount of energy (usually in 1 MWh increments) have a number of names: Renewable Energy Credits ("REC"), Tradable Renewable Energy Credits ("TRC") and green tags.

The overall effect of these three ways to satisfy the RPS requirement is the same to the energy market and has the same impact on the environment. In each case the energy is generated from an approved renewable source and it is sold to a consumer, displacing the same amount of traditional power-plant generation. However, the flexibility that REC trading provides is significant and should help both traditional energy suppliers and alternative energy producers. REC trading lets market forces determine the most economical renewable energy technology (from the list of approved source types) and the most economical provider of the renewable energy. From the buyers' perspective, REC trading allows power producers to reduce compliance costs. From the perspective of renewable-energy generators, the market forces them to minimize production costs to compete for buyers, rewarding the most efficient technologies and operators. Most of the RPS states allow REC trading to satisfy regulatory requirements.



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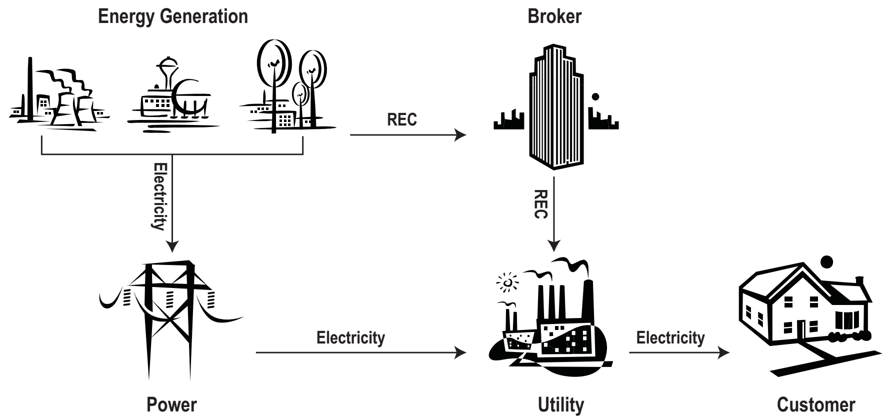
Trading Green *(Continued)*

The REC price offsets the higher cost of energy generation from alternative sources, allowing renewable-energy generators to sell their product at market prices. REC prices will decrease over time as the market price of non-renewable electricity increases or as the cost of alternative generation decreases and will be close to zero at the grid parity point.

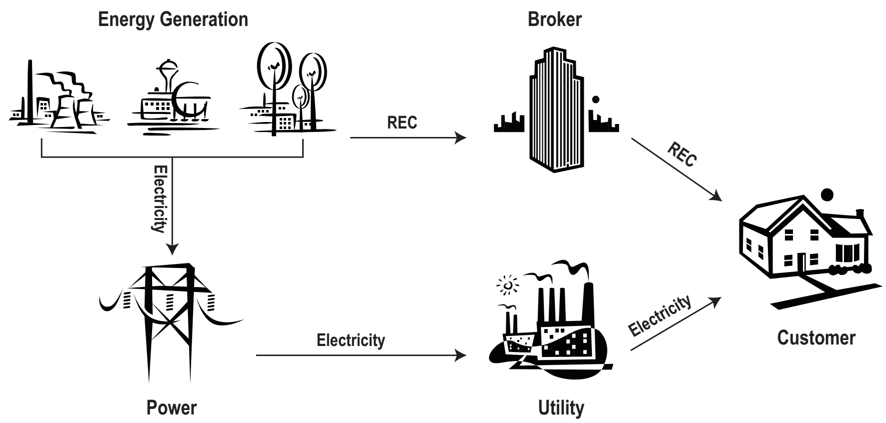
The trading of RECs to satisfy RPS requirements is only a part of the demand in this market. The other part comes from buyers (usually corporations and government agencies) who purchase green tags voluntarily. These buyers usually try to meet corporate goals of renewable energy usage with the objective of helping to reduce greenhouse gas emissions, or to enhance their environmental image with clients or stakeholders. Similar to compliance REC purchases, voluntary purchases displace traditional generation from the electric grid and reduce associated pollution. However, unlike the compliance market, the voluntary market is not limited to the states that have enacted RPS regulations. This market is currently four times the size of the compliance market. Purchasers in the voluntary market include major corporations and government agencies.

In early January 2006, Whole Foods Market purchased RECs representing 458 gigawatt hours ("GWh") of wind–generated electricity (approximately 6% of the U.S. wind power generation built last year). This was the largest ever purchase of wind energy credits in the voluntary market, equivalent to the amount of electricity used in all of the company's buildings. It would be impossible simply to purchase electricity obtained from renewable sources for every building owned by Whole Foods. By purchasing the credits, the company effectively acquired wind-generated electricity for these properties. Examples of other large U.S. companies active in the voluntary REC market include Alcoa, Cargill, Delphi, Dow Chemical, DuPont, General Motors, IBM, Interface, Johnson & Johnson, FedEx Kinko's, Pitney Bowes, Safeway, Staples, Starbucks and many others. Large government-related users of green energy (and RECs) include the U.S. Air Force, U.S. Environmental Protection Agency, U.S. Department of Energy and the U.S. General Services Administration.

Compliance Market



Voluntary Market



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Solar Technology Landscape

Most of us are familiar with the sight of PV solar modules installed on commercial and residential roofs. However, the breadth of technologies that can be used to produce solar cells is less well-known. In this article we briefly discuss the basics of how solar cells operate, followed by a general discussion of cell materials and design. We will not cover thermal aspects of solar energy, which we plan to address in a subsequent newsletter.

1. How does a solar cell work?

A solar cell is a device capable of converting the energy contained in sunlight into electricity in a single step process. Inside a PV cell, photons from sunlight are absorbed by the PV material. Photons transfer their energy[1] to electrons in the PV material, elevating (exciting) the electrons to a higher energy level. In this excited state, negatively-charged electrons become mobile and can travel through the cell. In the same process, positively charged holes are also created inside the PV material. The property of the cell material that allows the extraction of energy from the excited electrons is the existence of an energy gap (in practical systems it is called a band gap) that allows the electron to be separated from its associated hole. Only photons with energies at least as high as the band gap of the cell material can be used in solar cell energy conversion. Therefore, only a portion of the solar spectrum is used in PV energy conversion. In order for an electron to deliver the acquired energy to the external electrical circuit, a solar cell must be spatially asymmetric. In practice, the internal asymmetry is obtained by creating an electric field at a junction of two different semiconductor materials. Separation of charges at such a junction can create strong electric fields driving negatively-charged electrons and positively-charged holes in opposite directions and accumulating them at the opposite contacts of the solar cell, thus generating voltage and current.

This generic mechanism outlines how solar energy conversion occurs in systems where only one band gap exists. Its efficiency depends on the actual solar spectrum and the value of the band gap of the PV material. The maximum theoretical efficiency[2] of a single band gap terrestrial solar cell is approximately 33%. We will discuss various photovoltaic materials later in this article.

2. Multi-junction (multi-gap) solar cells

In order to overcome the limitations of single band gap solar cells, developers have been working with devices having two or even three different band gaps. These systems are simply multiple solar cells made of materials with different band gap values. Multiple band gap materials extend the lower limit of useful photon energy found in sunlight allowing more of the sun's spectrum to be converted into electricity. These material combinations also provide more efficient energy conversion from higher energy photons by reducing the amount of their energy dissipated as heat. The most commonly used approach is to stack the cells on top of each other with the lowest band gap cell at the bottom (the last cell reached by the light). The first cell exposed to light has the highest energy band gap. This cell absorbs only the most energetic photons while the other photons pass through it. The next cell underneath has a smaller band gap, which allows for some of the lower energy photons to be absorbed. This mechanism is repeated until the last cell (with the smallest band gap) is reached. The voltage generated by such a system is the sum of voltages of each individual cell.

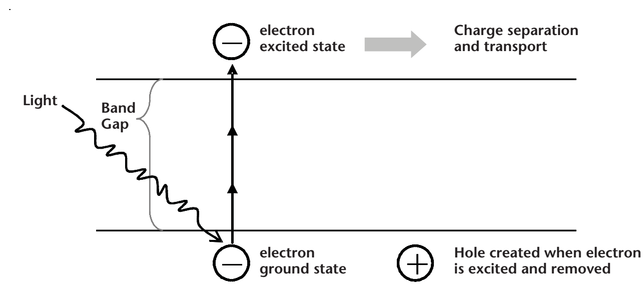

Figure 1. Absorption of light and creation of excited electron and hole.

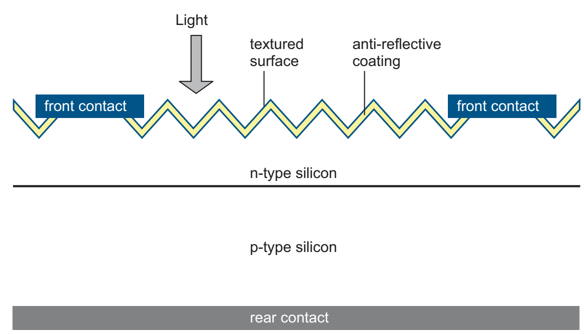

Figure 2. Typical p-n junction based solar cell.

3. Concentration

One way to increase the amount of energy generated by a solar cell is to increase its area. The idea is simple – a bigger solar cell can convert more sunlight into electricity. However, as we discuss below, solar cell materials require very advanced manufacturing processes and are expensive to produce.

Therefore, rather than increasing the physical area of the cell, it is often cheaper to increase the amount of light reaching a given cell. Most current light-concentrating systems use either mirrors or plastic Fresnel lenses and can achieve concentration factors of over a thousand times. Such concentrating systems are most effective with high efficiency solar cells, where cost savings from decreasing the effective solar cell size are greatest. These reflective or lens-based concentrating systems are imaging systems and require direct sunlight. These systems cannot use light that is either diffused (scattered by the atmosphere) or that is not illuminating the concentrator from the proper direction. Tracking mechanisms must be added (increasing overall system cost) and these systems are best deployed in sunny regions, where the amount of diffused light is relatively small. Non-imaging concentrating systems have also been demonstrated but produce much lower concentration levels than imaging systems, though they do not require sun-tracking mechanisms.

[1] Note that when we talk about light's energy, we refer to its color. For example, in the visible range, blue photons carry higher energy than red photons.
[2] Efficiency of the solar cell is typically defined as a ratio of power density delivered by the device to the power density of the light illuminating the cell.

4. Silicon – the solar cell material of choice

Over 90% of all solar cells manufactured today for terrestrial applications are made of various forms of silicon. The reasons for the popularity of silicon as a solar cell material are its wide application in electronics, its physical robustness required in original space based applications and its long track record of use. Silicon was not initially intended for solar applications, but has benefited from the tremendous amount of investment in process development provided by the semiconductor industry. Fortunately, silicon's band gap is only slightly lower than the optimum for terrestrial solar energy conversion, resulting in a theoretical efficiency of 29% for silicon-based cells.

Polycrystalline Silicon

The most common form of silicon used in solar cells is polycrystalline silicon found in over 60% of PV systems. The starting material in polycrystalline silicon manufacturing is pure sand (SiO_2), which is heated with carbon in a reducing-gas atmosphere. The resulting metallurgical-grade silicon is approximately 98% pure that needs to be further purified for PV applications. In a commonly used process, metallurgical-grade silicon is converted into trichlorosilane gas ($SiHCl_3$) by reacting it with hydrogen chloride. The silicon-bearing gas is then reacted with hydrogen in a Siemens reactor to form high purity polycrystalline silicon. Silicon used in solar cells is usually doped with carefully selected elements to increase the amount of desired charge carriers (electrons or holes) in the material. Polycrystalline silicon wafers are either cut from ingots of the material or pulled in a ribbon form from a crucible of molten material. In the ribbon process, two parallel strings are slowly pulled from the silicon melt. Molten silicon forms a thin ribbon between these strings by surface tension and is subsequently allowed to solidify. The thin ribbon technique eliminates the waste created in the sawing process. Polycrystalline silicon solar cells have demonstrated 18% efficiency under laboratory conditions and 13% - 15% efficiency in production. Polycrystalline silicon cells have lower efficiency than monocrystalline silicon systems (see below). However, polycrystalline cells are less expensive to manufacture. Leading manufacturers of polycrystalline solar cells include Evergreen Solar, Kyocera, Mitsubishi, Motech, QCells, RWE Schott, Sharp and SolarWorld.

Monocrystalline Silicon

Despite its relatively high cost, monocrystalline silicon is used in approximately 1/3 of solar cells manufactured today. Single crystal silicon is manufactured using either the Czochralski ("CZ") or the float zone ("FZ") method. Both methods use polycrystalline silicon as a starting material. In the CZ growth method, a small single crystal is placed at the surface of molten silicon (and appropriate doping materials) in a crucible and slowly pulled away and rotated. The liquid silicon attaches to the seed crystal by surface tension and, as it is drawn, it crystallizes with the same crystal orientation as the seed. In the FZ method, sections of an appropriately doped polycrystalline silicon ingot are slowly heated using a radio-frequency coil and then allowed to cool. The heating starts at the point of contact with a small seed single crystal. The molten section solidifies with the seed's crystal orientation. Individual wafers used as the base of a PV cell, approximately 100 to 300 micrometers thick, are cut from the monocrystalline ingot. The cutting process wastes almost 20% of the material. The thickness of the wafer cannot be reduced indefinitely because silicon is a relatively weak absorber of light and is also quite fragile, making it subject to breakage. A sufficient wafer thickness is required to assure that the light illuminating the cell is absorbed inside the cell.

Materials used in solar cell manufacturing can vary in their physical organization. The three forms, in decreasing order of organization, are single crystal, polycrystalline and amorphous. For a given chemical composition, these forms will have different properties affecting their performance in PV systems.
A single crystal is a homogeneous solid in which atoms, ions or molecules are arranged in a single three-dimensional lattice with a basic pattern between adjacent elements repeating itself in three dimensions. Physical properties of single crystal materials are well defined and reproducible across the entire crystal.

The structure of a polycrystalline solid is more disorganized – it is composed of randomly-oriented smaller single crystals forming a larger system. Grain boundaries in polycrystalline materials are often a source of structural defects negatively affecting properties of a solar cell. However, the manufacture of polycrystalline materials is significantly easier and less expensive than of monocrystalline substances.

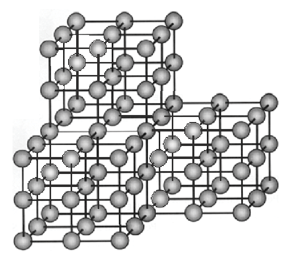

Figure 3. Single crystal structure.

A)

B)

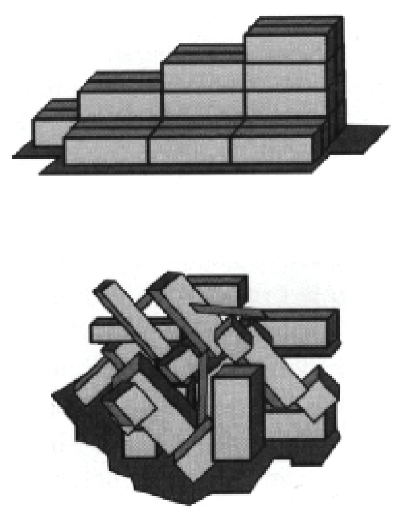

Figure 4. Single crystal (A) vs. polycrystalline (B) solid.

Amorphous materials exhibit a range of bond lengths, sometimes even with missing bonds between adjacent structure elements. These variations may not affect the short-range (among the closest atoms or molecules) structure of an amorphous solid, which is often similar to that of a single crystal. However, this correlation quickly disappears among more distant atoms or molecules. Amorphous materials are normally used in thin film solar cells which can be either single or multi junction.

A)

B)

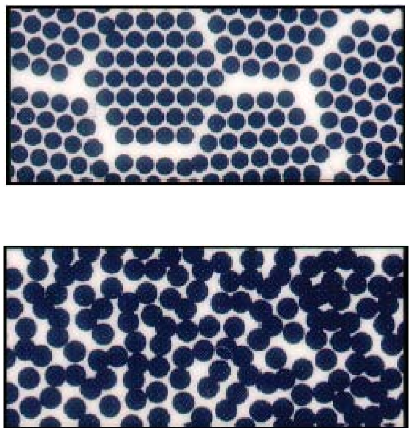

Figure 5. Crystalline (A) vs. amorphous (B) material.

Monocrystalline solar cells have reported lab efficiency as high as 25% and production unit efficiency of 14% - 22%. The standard design with electrical contacts on both sides of the cell is still commonly used, but recently more advanced designs aimed at increasing overall efficiency have been introduced. These new configurations include texturing the front surface, optimization of electrical contacts, and differential doping. One such design places both electrical contacts on the backside of the cell, exposing the entire light-absorbing surface to sunlight. Some of these new cell designs require the highest quality monocrystalline wafers derived from the FZ growth method. Companies manufacturing monocrystalline silicon cells include Amonix, BP Solar, Isofoton, Motech, Sanyo, Sharp, SolarWorld and SunPower.

Amorphous Silicon

Amorphous silicon is a much better light absorber than other forms of silicon (approximately 40 times stronger than the monocrystalline type). This stronger absorption allows cells using amorphous silicon to be much thinner and more flexible.

Other advantages include its relatively low cost, low manufacturing process temperature and ability to be deposited on a variety of substrate materials, including glass, metal or plastic. Amorphous silicon can form alloys with other elements (like germanium). Different compositions of the alloy can be used as PV materials in multi-junction solar cells. The manufacturing process is based on the chemical vapor deposition ("CVD") of silicon on a substrate material.

The CVD process uses silane gas (SiH_4) to deliver silicon to the reaction (deposition) site. At the reaction site, silicon is released from the decomposing silane gas and deposited onto the substrate. In one variation of chemical vapor deposition, radio-frequency plasma enhanced CVD (rfPECVD), radio frequency energy is used to sustain chemical reactions in the CVD process. Radio frequency PECVD can be carried out at a relatively low temperature (250° - 350°C or 482° - 662°F) allowing deposition on a number of temperature sensitive substrates. Amorphous silicon films are less efficient solar energy converters than crystalline silicon materials. Reported laboratory and production efficiencies are 13% and 8%-10%, respectively. Solar cells using amorphous silicon are manufactured by Energy Conversion Devices, Energy Photovoltaics, Fuji, Kaneka and Spheral Solar Power.

5. Beyond silicon

Silicon is not the optimal PV material because its band gap of 1.1 eV is below the 1.4 eV level, the optimal value for terrestrial single gap solar materials. Furthermore, crystalline silicon's weak light absorption makes it necessary to use relatively thick wafers. Another issue is the temperature dependence of cell efficiency, which is especially important in concentrating systems. Given these drawbacks, numerous companies are actively pursuing alternative materials.

GaAs and other III-V compound semiconductors

Gallium arsenide ("GaAs") is the most widely-used material from a class of semiconductors containing chemical elements from groups III and V in the periodic table[3]. Elements from each group contribute the same number of atoms to the structure of the PV material. III-V semiconductors are better absorbers of light than silicon, resulting in thinner solar cells. Additionally, the chemical composition of the material can be changed by selecting different chemical elements in the structure in order to control the band gap of the crystal[4].

GaAs' band gap is very close to the optimum value for terrestrial spectrum applications and the material is approximately 10 times more efficient as a visible light absorber than silicon. However, solar grade GaAs is very expensive and, despite its much lower thickness, the cells are still more costly than silicon today. Nevertheless, GaAs technology is continuously being improved and its costs have been decreasing. III-V compound semiconductors have been used in triple junction structures. Examples of such solar cells being developed by Emcore Photovoltaics and Spectrolab are InGaP/GaAs/Ge, InGaP/InGaAs/Ge, and AlInGaP/InGaAs/Ge with the highest reported laboratory efficiency of 37.3% and production unit efficiency of 27%.

CIS and CIGS

Copper indium diselenide ($CuInSe_2$ or "CIS") belongs to the class of compounds called chalcogenides. Its light absorption is among the highest of all semiconductors, which makes it usable in very thin layer solar cell structures. In most photovoltaic applications, an alloy of CIS including gallium ($CuInGaSe_2$ or "CIGS") is used to improve CIS' photovoltaic and electronic properties. The cells are manufactured using two general methods. The first is based on co-deposition of copper, indium, gallium, and selenium. The other method includes the selenization of copper-indium films. After the deposition of the CIGS layer, a layer of cadmium sulfide (CdS) is deposited, typically by chemical bath, to form a p-n junction. CIGS

[3] Group III includes boron, aluminum, gallium, indium, and titanium. Group V includes nitrogen, phosphorus, arsenic, antimony, and bismuth.

[4] Other materials in this class include indium phosphide (InP), gallium antimonide (GaSb), as well as ternary alloys: aluminum gallium arsenide ($Al_xGa_{1-x}A_s$), indium gallium phosphide ($In_xGa_{1-x}P$), and indium gallium nitride ($In_xGa_{1-x}N$). The first two elements of these ternary materials come from group III so the general rule of an equal number of atoms from group III and group V is still preserved.

solar cells have reported laboratory conversion efficiency of 20%. While they are less efficient than monocrystalline silicon, CIGS cells are less expensive on a per watt basis of generated electricity and are relatively easy to manufacture. The thin layer design makes this cell type both light and flexible. CIGS solar cells are currently manufactured by DayStar Technologies, MiaSole and Nanosolar.

Organic Materials

Some organic substances possess optical and electronic properties that qualify them as photovoltaic materials. Certain organic crystalline PV materials behave like the inorganic semiconductors described above. In other materials (e.g., polymers), the absorption of a photon creates a negatively charged excited electron and a positively charged hole, which together are called the exciton. However, unlike in more traditional PV systems, the excited electron cannot be easily removed from its associated hole. The entire exciton must diffuse to the actual junction where the electron and the hole are separated. A competing, undesirable process is a spontaneous recombination of the exciton. Excitons can travel only a few tens of nanometers before they recombine. This limits the region of effective photoelectron generation to approximately 10 nanometers from the actual junction. However, a typical organic PV material must be a few hundred nanometers thick to provide sufficient light absorption. One way to satisfy the optical depth requirement is to create a distributed junction where the two different materials are blended, dramatically increasing the amount of interface available throughout the bulk of the light absorbing part of the cell. In some cases, nanotechnology is used to improve the electron-hole separation in such structures. The main advantage of organic solar cells is the ease of manufacturing. The cell materials can easily be deposited or even printed on a variety of surfaces. Another advantage is the mechanical flexibility of the resulting solar cell. However, the technology is still in the very early stages of development, and conversion efficiencies still require substantial improvement from the current level of 3% - 6%. Companies developing organic PV materials and cells include BP Solar, Global Photonic Energy Corporation, Konarka Technologies, Luna Innovations and Nanosys.

U.S. Financings – Notable Equity Transactions

2005 will go down as the first of what we expect will be a number of years of strong activity in the public financing market for alternative energy companies. Solar companies in particular had a strong year, raising almost $900 million in the U.S. public market through a series of IPOs (Daystar, SunPower, Suntech), follow-on offerings (Energy Conversion Devices, Evergreen Solar) and convertible offerings (Evergreen Solar, Solar Integrated Technologies). A majority of the investment in private companies was also focused on the solar sector with a number of large VCs funding multiple next-generation solar technology companies. While solar was the hottest sector in 2005, almost $600 million was invested in U.S. fuel cell, advanced battery, biomass, power technology and other renewable technology firms, including a $150 million equity offering by FuelCell Energy. Besides this investment and the two large solar IPOs mentioned previously, all other public financings were under $100 million with the median size just over $30 million. As many of the public alternative energy companies expand their operations and gain profitability, it is likely the size of these investments will continue to grow. Also, since many of these companies are only at the initial stages of commercialization and capacity expansion, capital needs will continue to be significant.

U.S. – Public Company Equity / Equity linked

COMPANY	SIZE ($MM)	DATE
Maxwell Technologies	$ 25.0	Dec-05
Suntech Power	395.7	Dec-05
C&D Technologies	75.0	Nov-05
SunPower	138.6	Nov-05
Beacon Power	15.0	Nov-05
Solar Integrated Technologies	37.0	Nov-05
Capstone Turbine	41.4	Oct-05
FuelCell Energy	153.5	Sep-05
China BAK Battery	43.0	Sep-05
Medis Technologies	31.9	Sep-05
Hoku Scientific	21.0	Aug-05
Plug Power	68.8	Aug-05
SatCon Technology	5.8	Aug-05
Medis Technologies	49.0	Jul-05
Enova Systems	20.2	Jul-05
HydroGen	13.5	Jul-05
Maxwell Technologies	5.5	Jul-05
Solicore	12.7	Jul-05
Valence Technology	20.0	Jul-05
Evergreen Solar	90.0	Jun-05
Active Power	17.3	May-05
DayStar Technologies	54.5	May-05
Millennium Cell	10.0	Apr-05
Hoku Scientific	57.5	Apr-05
Ener1	14.2	Mar-05
Deli Solar	5.8	Mar-05
Energy Conversion Devices	87.8	Feb-05
Active Power	20.0	Feb-05
Evergreen Solar	62.5	Feb-05
China BAK Battery	17.0	Jan-05
Total	**$ 1,609.2**	

U.S. – Private Company Equity / Equity linked

COMPANY	SIZE ($MM)	DATE
Advent Solar	$ 30.0	Nov-05
PowerLight	15.0	Aug-05
Lilliputian Systems	30.0	Aug-05
Seattle Biodiesel	2.0	Jul-05
Mid Atlantic Biodiesel	10.0	Jul-05
Energy Innovations	17.0	Jun-05
HelioVolt	8.0	Jun-05
Nanosolar	20.0	Jun-05
Miasole	16.0	Jun-05
Jadoo Power Systems	11.0	Apr-05
Protonex	11.0	Mar-05
Pentadyne Power	10.0	Mar-05
Franklin Fuel Cells	7.4	Feb-05
Total	**$ 187.4**	

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International Financings – Notable Equity Transactions

The international capital markets also witnessed a surge in solar financings. Germany's feed-in energy laws have made it an extremely lucrative market and additional legislation passed in Spain and France in 2005 have made those markets more rewarding destinations for PV supply. Three of the five largest public financings (Conergy, ErSol and Q-Cells) were all completed by German PV manufacturers. The only other transactions over $100 million outside of the U.S. in 2005 were the Clipper Windpower, Primary Energy Recycling and Saft IPOs and the follow-on equity offering for Canadian Hydro Developers. Additionally, unlike the U.S., the market for hydroelectric power is strong, especially in Canada and Scandinavia. In 2005, the Frankfurt Stock Exchange and the AIM in London were by far the two most active markets for alternative energy financing transactions outside of the U.S.

International – Public Company Equity / Equity linked

COMPANY	SIZE ($MM)	DATE
CMR Fuel Cells	$ 18.2	Dec-05
China Shoto	10.4	Dec-05
Canadian Hydro Developers	188.3	Dec-05
Renewable Energy Generation	53.2	Nov-05
Sunline	10.8	Oct-05
Q-Cell	324.8	Oct-05
Atlantic Power	75.0	Oct-05
Acta	15.8	Oct-05
ErSol	162.8	Sep-05
EOP Biodiesel	27.8	Sep-05
Clipper Windpower	137.7	Sep-05
Primary Energy Recycling	237.0	Aug-05
JumpIT	5.2	Jul-05
Enova Systems	9.4	Jul-05
Solon	66.3	Jun-05
Saft Group	293.8	Jun-05
Renova Energy	16.6	Jun-05
Novera Energy	9.6	Jun-05
D1 Oils	46.6	Jun-05
PolyFuel	14.0	Jun-05
Conergy	283.6	Mar-05
Freeplay Energy	6.7	Mar-05
Ceramic Fuell Cells	71.4	Mar-05
Renewable Energy Holdings	18.7	Feb-05
Voller Energy Group	17.5	Feb-05
Ballard Power	44.6	Jan-05
Total	**$ 2,165.8**	

International – Private Company Equity / Equity linked

COMPANY	SIZE ($MM)	DATE
EnOcean	$ 13.0	Mar-05
CSG Solar	31.1	Jan-05
Total	**$ 44.1**	

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Mergers & Acquisitions – Notable Transactions

With the European alternative energy market years ahead of the U.S., it is no surprise that a majority of the acquirors were located in that region. A few Canadian companies made acquisitions, with the largest being the $125 million acquisition of Stuart Energy by Hydrogenics. As the most mature of the alternative energy sectors, wind power was by far the most active area in 2005 with 16 transactions over $20 million. All the other areas combined completed only nine transactions over $20 million. Due to the emerging nature of this sector, all of the transactions were under $600 million, with an average size of just over $150 million. We expect that, as companies mature and attract more established industrial and technology firms to focus on this sector, the pace of consolidation will accelerate and the size and number of large transactions will increase.

DATE	TARGET	TARGET SECTOR	ACQUIROR	VALUE ($MM)
12/19/2005	Solar Roofing Systems	Solar	Barnabus Energy	$ 20.8
12/17/2005	Enersis Sgps	Wind, Hydro	Babcock & Brown	562.2
12/09/2005	Desarrollos Eolicos	Wind	Novas Energias do Ocidente	564.6
12/06/2005	Ortiga and Safra Wind Farms	Wind	Enernova – Novas Energias	24.6
12/05/2005	Aktiv Gruppen Holding	Wind	EuroTrust	150.8
11/30/2005	Prowind GmbH, Three German Wind Parks	Wind	Theolia	39.5
11/25/2005	Great Yarmouth Power	Gas Turbine	RWE Power	267.1
11/08/2005	Gamesa Corporacion - Fafe Wind Farms	Wind	Electrabel	122.8
11/01/2005	Ostwind Verwaltungs (2 wind farms)	Wind	GW Energi	71.5
10/21/2005	Landfill Gas Assets	Landfill Gas	Novera Macquarie Renewable	25.9
09/29/2005	Tecnologias Energeticas (5 Wind Farms)	Wind	Enernova – Novas Energias	72.1
08/31/2005	Stijna Administratiekantoor	Wind	F.I.P. Finance Investment Project S.A.S. di Romeo Agatina Rosaria	52.6
07/20/2005	Windpark Kesfeld-Heckhuscheid	Wind	Renewable Energy Holdings	57.4
07/04/2005	REpower Systems and Denker & Wulf	Wind	GE Energy Financial Services	161.9
07/01/2005	Sydkraft (24 Power Plants)	Hydroelectric	Statkraft	569.0
06/20/2005	Eurowind International Limited	Wind	Macquarie European Infrastructure Fund	65.2
06/01/2005	FIAMM Spa., Motive Power Battery Business	Battery	EnerSys	32.7
05/12/2005	Finerge	Wind	Endesa	212.8
04/20/2005	Desarrollo de Energias Renovables	Renewable Electricty	Gas Natural SDG	355.6
03/15/2005	Energy Power Resources	Renewable Electricty	Macquarie European	155.4
03/03/2005	Gamesa (U.S. Wind Turbine Generators)	Wind	Babcock & Brown	26.0
03/02/2005	Terranova Energy Corporation	Wind	Corporacion Eolica CESA	158.2
02/03/2005	Intelligent Energy Holdings	Fuel Cell	Dickie Walker Marine	111.8
01/24/2005	IDAS	Wind	Endesa	144.8
01/06/2005	Stuart Energy	Hydrogen	Hydrogenics	125.2
			Total	**$ 4,150.5**

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Highlights of the Energy Act of 2005

The Energy Policy Act of 2005 was passed by the U.S. Congress on July 29, 2005 and signed into law on August 8, 2005 at Sandia National Laboratories in Albuquerque, New Mexico. The Act, described by proponents as an attempt to combat growing energy problems, provides tax incentives and loan guarantees for energy production of various types. It provides incentives for traditional energy production as well as newer, more efficient energy technologies, and conservation. Major items include:

Increasing the Efficiency of Appliances and Commercial Products
The Energy Policy Act sets new minimum energy efficiency standards for a range of consumer and commercial products. It also encourages the sale and production of energy efficient products, which increases the supply of available energy, helping consumers meet their bottom lines. Tax credits are available for highly efficient central air conditioners, heat pumps, and water heaters, as well as for upgrading thermostats, installing exterior windows, and stopping energy waste.

Reducing Federal Government Energy Usage
Reauthorizes the Energy Savings Performance Contract program, which allows private contractors to help Federal agencies improve the energy efficiency of their facilities. The bill also sets aggressive new goals for Federal energy efficiency and requires agencies to purchase Energy Star products.

Increasing the Use of Renewable Energy Sources
Promotes the use of renewable energy sources with tax credits for wind, solar, and biomass energy, including the first-ever tax credit for residential solar energy systems. The Act offers consumers tax credits for making energy efficiency improvements in their homes. It also offers subsidies for wind energy and other alternative energy producers.

Supporting a New Generation of Energy-Efficient Vehicles
Provides up to $3,400 per vehicle in tax credits to consumers for purchasing hybrid vehicles. Some of these cars can travel twice as far as conventional vehicles on one gallon of fuel, reducing U.S. dependence on foreign energy sources while producing lower emissions.

Modernizing Energy Infrastructure
The Energy Policy Act will help modernize the U.S.' aging energy infrastructure in an effort to reduce the risk of large-scale blackouts and minimize transmission bottlenecks. This will be accomplished by repealing outdated rules that discourage investment in new infrastructure; offering tax incentives for new transmission construction; and by encouraging the development of new technologies, such as superconducting power lines, to make the grid more efficient.

Source: http://www.whitehouse.gov/infocus/energy/

Jefferies Alternative Energy & CleanTech Conference

SAVE THE DATE:
May 16, 2006
St. Regis Hotel, New York

Jefferies will host an Alternative Energy & CleanTech Conference on Tuesday, May 16, 2006 at the St. Regis Hotel in New York City. To register, please visit http://www.jefferies.com/0506AE.

If you have any questions, please contact: Jodi Pulman 212.284.2581 jpulman@jefferies.com

At the present time, the following companies have RSVP to present at the Conference:*

- Ballard Power Systems
- Beacon Power
- Capstone Turbine
- Ceres Power
- China BAK Battery
- DayStar Technologies
- Distributed Energy Systems
- EMCORE
- Energy Conversion Devices
- Evergreen Solar
- FuelCell Energy
- Fuel Tech
- Hydrogenics
- KFx
- Maxwell Technologies
- Medis Technologies
- Quantum Fuel Systems Technologies Worldwide
- Saft
- SOLON
- Spire
- Syntroleum
- Sunpower
- Xantrex Technology

• Subject to change.

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