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Photovoltaic Industry Progress through 1984

R. L. Watts
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April 1985

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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SUMMARY AND FORECAST

The world photovoltaic (PV) industry continued to grow modestly during 1984 sparked by the increased use of amorphous silicon (A-Si) in consumer goods. Although single crystal silicon (Cz) continued to dominate the world market with 44%, several factors indicate that the Cz technology is approaching maturity.

- o Module prices stabilized at about $7/watt for commercial quantity purchases.
- o ARCO Solar extended a 10 year warranty on Cz modules.
- o Flat plate Cz production about equaled the 1983 level.
- o Major producers (Photowatt & Solar Power Corp) completed their withdrawal from US production and Solenergy merged with Entropy Ltd. of Boulder, CO.
- o No production scale-up occurred or is planned for Cz facilities although modest reductions in production costs resulted from incremental improvements in cell efficiency and from process improvements.
- o Spire Corporation has sold Cz manufacturing equipment to 17 foreign countries.
- o Commercial R&D emphasis shifted to other technologies such as amorphous silicon.

Single crystal production in 1985 is expected to equal to that of 1984 even though other technologies are challenging its dominance.

Amorphous silicon production was 25% of the world market (about six megawatts) but was primarily confined to the specialty market such as watches and calculators. The Japanese clearly lead in the specialty market; however, the US may lead in the amorphous silicon power module market.

- o ARCO Solar introduced the first A-Si power module with 5% efficiency.
- o Chronar reported opening of their Port Jervis, NY facility.
- o Energy Conversion Devices (ECD) built a cell production facility in Michigan and a module assembly plant in Ohio.
- o Solarex was the first US manufacturer to sell A-Si to the Japanese.

Overall the outlook for 1985 for A-Si is for substantial growth most of which will come from the specialty market. Power modules will be produced in modest quantities (100-200 kW) in 1985 in the US, and larger quantities should be expected in 1986 as confidence in their performance grows.

Semicrystalline flat plate modules constituted another 17% of total shipments (over 20% of power modules). There are several indications of vigor in the semicrystalline market:

- o Solarex introduced a nominal power guarantee for their modules.
- o Solavolt International is using semicrystalline cells because its characteristics are similar to that produced by their new ribbon process in finished modules.
- o Solec International now offers both single and semicrystalline cells.
- o Kyocera of Japan is agressively marketing semicrystalline modules in the US.

Modest growth of the semicrystalline market is expected in 1985.

In 1984 the concentrator market share was only 13%, much lower than 1983 expectations. A primary factor in the slow growth of concentrators may havebeen the legal questions reported to have been raised over some third party arrangements by the IRS. It is not expected that any major commercial markets will develop for concentrators in 1985. Ribbon production was less than 1% of the market and will probably remain so in 1985.

China has indicated serious interest in exploiting the potential for PV to supply its remote electricity needs through domestic manufacture of PV electric systems.

On a regional basis, the US continued to be the world leader in PV with 50% of the market. However, Japanese production of PV grew by 45% in 1984, and if this production growth rate continues, Japan will become the world leader by the end of 1985.

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1.0 INTRODUCTION

The growth of the U.S. photovoltaics (PV) industry over the past decade has been impressive. First designed to provide power for satellites using high-cost production techniques, PV is now the economical choice in many remote terrestrial applications. The remarkable growth of PV in terms of quality of cells and modules, production techniques, and system design, was initiated by a cooperative effort of the U.S. Government and the domestic PV manufacturers.

European and Japanese firms entered the PV industry later, but are also growing rapidy. The Europeans continue to supply PV systems for village electrification and water pumping to many Third World countries. The Japanese have been developing the amorphous silicon (A-Si) technology by expanding its use in consumer goods. The world PV industry saw dramatic changes in industry ownership and in the emphasis on developing new and improved technology during 1984.

The objective of this report is to present information on the developments of the world PV industry and focuses on developments occurring in 1984. Information is presented on a regional basis (U.S., Europe, Japan, other) to avoid disclosing company-confidential data. All information was gleaned from several sources, including a review of the technical literature and direct contacts with PV manufacturers. Prior to publishing the regional totals, all numbers were compared with those of other sources.

The information contained in this report is prepared for use by the Department of Energy for their use in long-term R&D planning. However, this information should also be of interest to PV manufacturers and to those who may be contemplating entering the PV market.

This report is divided into five chapters: Chapter 2.0 summarizes PV shipments for 1984, Chapter 3.0 presents information on government support of PV, and Chapter 4.0 describes the various PV market sectors. Appendix A lists the major PV events for 1984.

2.0 WORLD PHOTOVOLTAICS INDUSTRY

In 1984 the world photovoltaic (PV) industry continued to grow, with shipments of PV modules and cells increasing from 21.5 MW in 1983 to 23.2 MW (see Table 2.1 and Figure 2.1). This represents an increase in revenues from module sales of $200 million in 1983 to $250 million in 1984 (all in constant 1984 dollars). Revenue to all sectors of the PV industry (includes revenues to systems houses, dealers, distributors and BOS suppliers) increased from $365 million in 1983 to $394 million in 1984 (figure 2.2). The primary reason for the increase in revenues was the growth of PV usage in consumer goods. The most significant increase in PV shipmments during 1984 was made by the Japanese. U.S. shipments fell by 7% and European PV shipments remained unchanged.

For many firms, the market growth and technology development of PV did not meet expectations for 1984. Czochralski (Cz) cell cost reductions were not as significant as they had been in previous years. The following sections provide information on PV shipments and the major firms within the industry on a regional basis.

Table 2.1. World PV Shipments

Region	Shipments (MW)					Percent Change From
	1980	1981	1982	1983	1984	1983-1984
US Flate Plate	2.5	2.9	4.4	9.7	8.6	
US Conc.	.0	.6	.5	2.8	3.0	
Total US	2.5	3.5	4.9	12.5	11.6	-7
Europe	.4	.9	1.7	3.3	3.3	0
Japan	.5	1.1	1.7	5.3	7.7	45
Other	.1	.1	.1	.4	.6	33
TOTAL	3.4	5.5	8.4	21.5	23.2	

2.1 U.S. PV INDUSTRY

Since 1980 the U.S. has dominated the world PV industry. PNL estimates that the shipments of PV by U.S. manufacturers have grown from 2.5 MW in 1980 to 11.6 MW in 1984 (Figure 2.3).

Table 2.2. Summary of World PV Shipments According to Strategies Unlimited

Region	1983 Shipments (MW)	1984 Shipments (MW)
US	9.3	8.5
Japan	3.8	6.6
Europe	2.2	2.6
Other	0.3	0.8
Total	15.6	18.5

Source: Best, D. 1985. "Profiling 1984's World Market". Solar Age April, 1985. pp. 22-23.

Other estimates of world PV shipments are available from a variety of sources. Estimates of world PV shipments for 1983 and 1984 by Strategies Unlimited are presented in Table 2.2. For both 1983 and 1984 the estimates provided by Strategies Unlimited are lower than the PNL estimates. The primary reason for these differences is in the accounting of augmented PV systems, and in estimating the amount of PV in consumer goods.

Although U.S. shipments declined from 1983 to 1984, the U.S. continues to be the leader in PV technology, and was the first to introduce A-Si modules to the commercial power module market. The rapid expansion of the U.S. industry primarily reflects the growth of two companies: ARCO Solar and United Energy Corporation (UEC).

ARCO Solar continued to be the world leader in PV manufacturing in 1984 serving a variety of commercial markets. A substantial portion of their production was installed at the utility-scale Cariso Plains installation and at Sacramento Municipal Utility District. The Cariso Plains project currently has an installed capacity of 6.5 MW and could ultimately have a capacity of up to 16.5 MW. The power produced is being sold to Pacific Gas and Electric.

UEC continued during early 1984 to market its PV/solar thermal generator concentrator that is capable of producing 2.5 kWh and 40,000 Btus of hot water per hour. The majority of UEC sales have been financed through third-party arrangements.

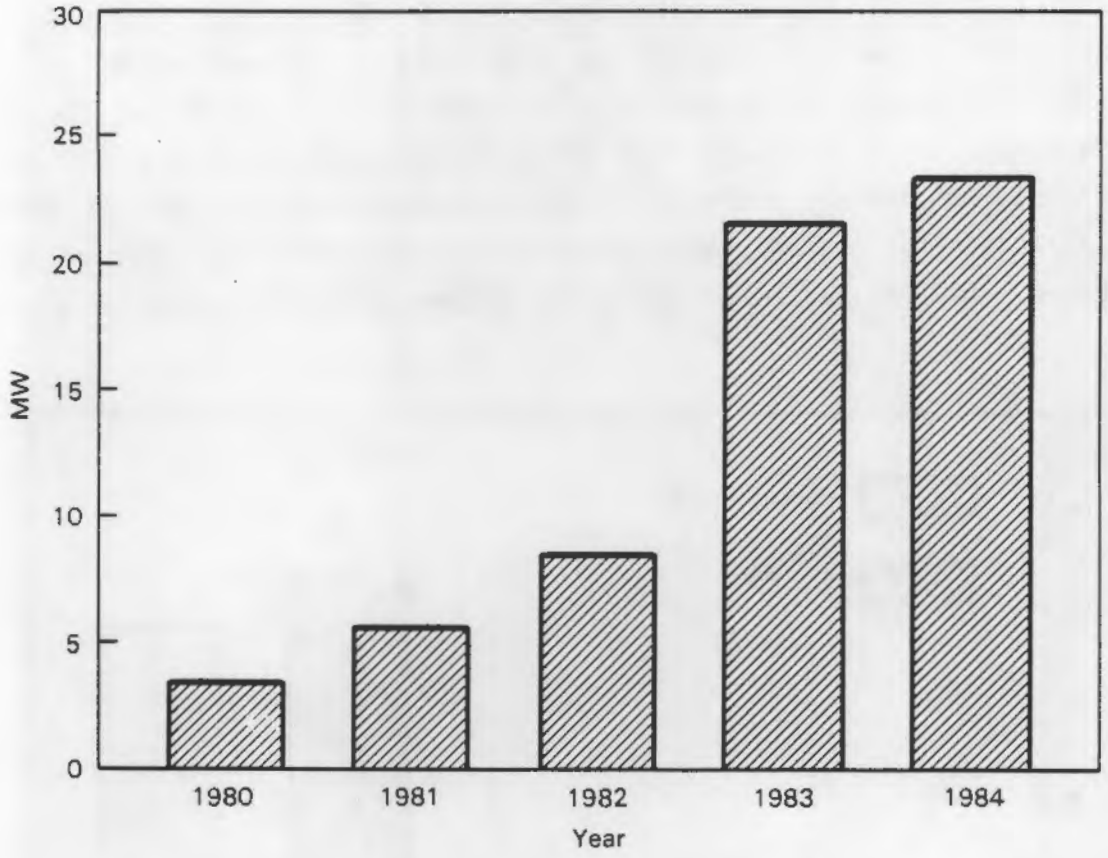


Figure 2.1 World PV Shipments

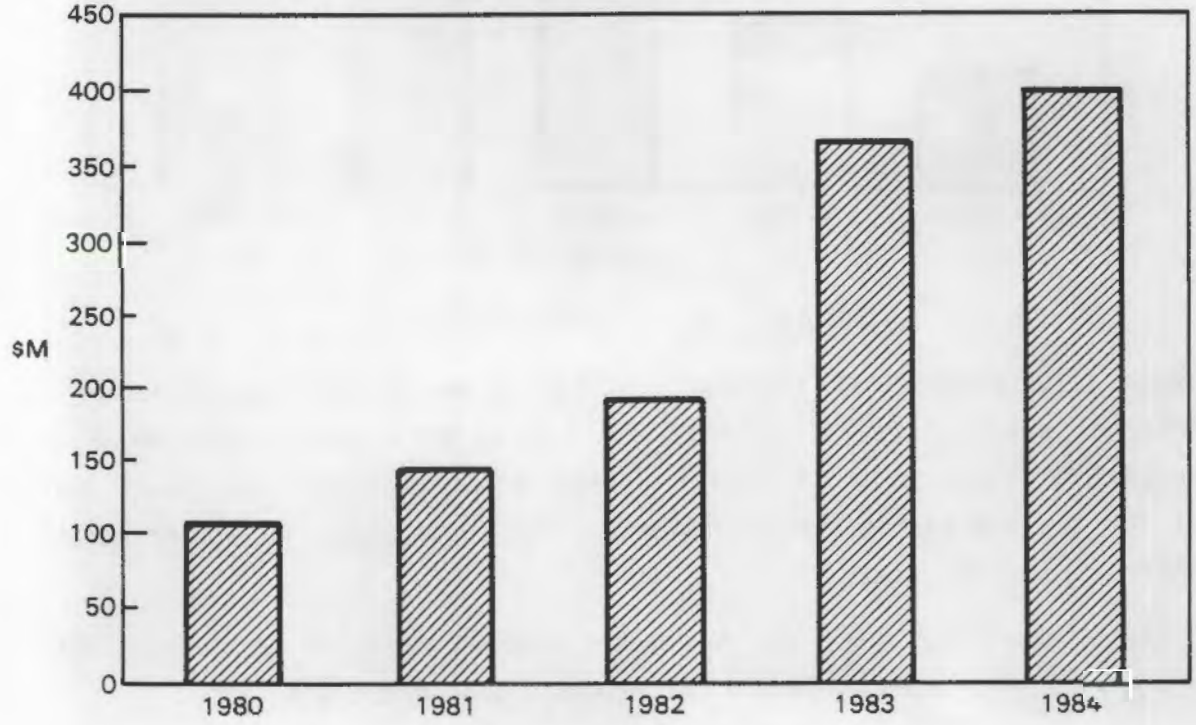


Figure 2.2 World PV Revenues

During 1983 the U.S. market was stimulated by a combination of direct government purchases and those heavily dependent on financial incentives (figure 2.4). It is estimated that these shipments amounted to 8.5 MW in 1983 (70% of U.S. shipments). This MW estimate is conservative since it does not include residential systems whose purchase may have been dependent on the tax incentives. In 1984 Federally subsidized shipments had decreased to about 5.5 MW.

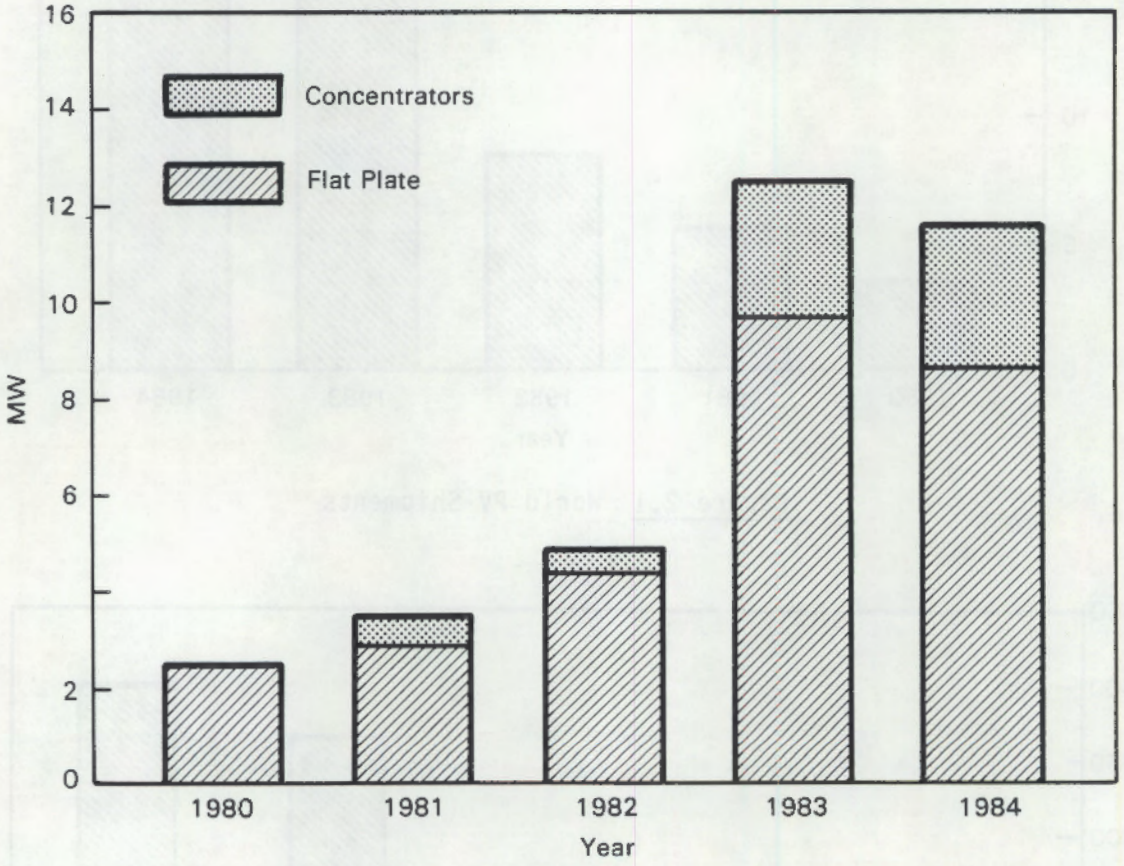


Figure 2.3 U.S. PV Shipments

There were substantial increases in the domestic and export market for conventional stand alone PV applications. These sales increased from about 4 MW in 1983 to about 6 MW in 1984. These increases would have been larger except for the continuing strong dollar and the continuing shortage of money in the international markets.

Overall, the U.S. share of the market dropped from 58% in 1983 to 50% in 1984 (figure 2.5) primarily due to the decrease subsidized shipments.

During the early 1980s, module prices for large government purchases were in the range of $10-$12/Wp. By 1983 module prices had fallen to about $5.00/Wp, with the SMUD II bids. During 1984, price competition was moderate at the retail level.

Unfortunately Cz production costs have not declined sufficiently during the last two years to provide adequate profits to module manufacturers. Unprofitable operations forced several firms to reorganize their ownership arrangements including:

- o Photowatt - left the PV business in 1983
- o Solar Power Corp. - left the business early in 1984
- o Solarex - purchased by Standard Oil of Indiana (AMOCO) in 1983 (Solarex name continued)
- o Applied Solar Energy Corp - in 1982 shifted emphasis from terrestial to space
- o E-System - sold its PV division to its employees, who renamed the company ENTECH in 1983
- o Martin-Marietta - left the PV industry in 1984
- o Solarex - layed off 100 employees in 1984
- o ARCO - layed off about 140 employees in 1984.

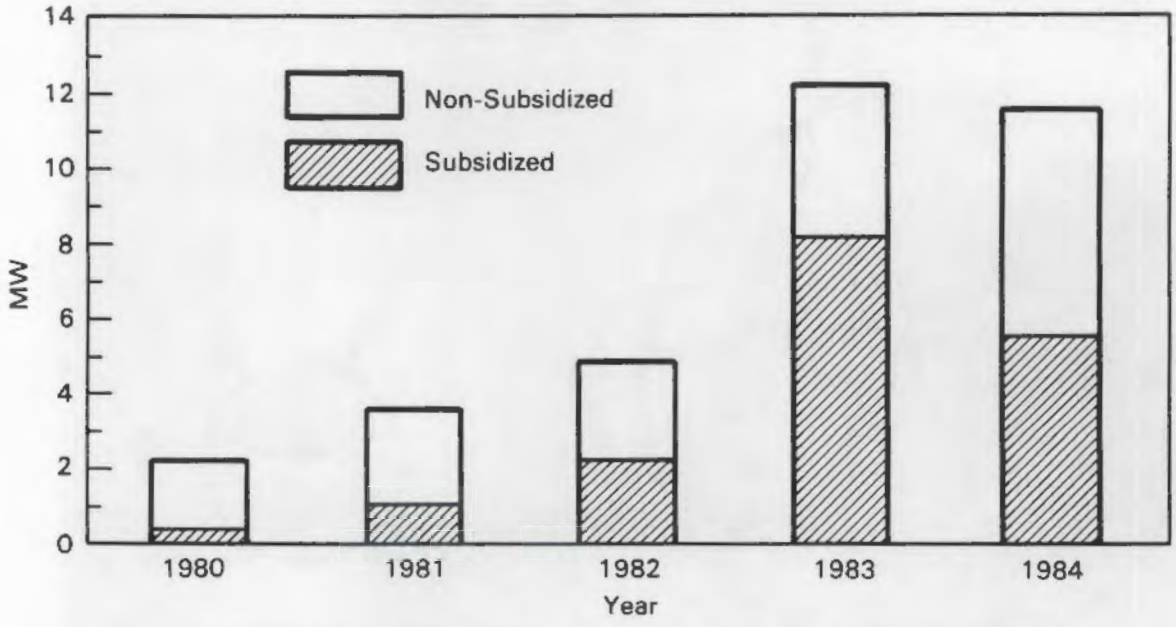
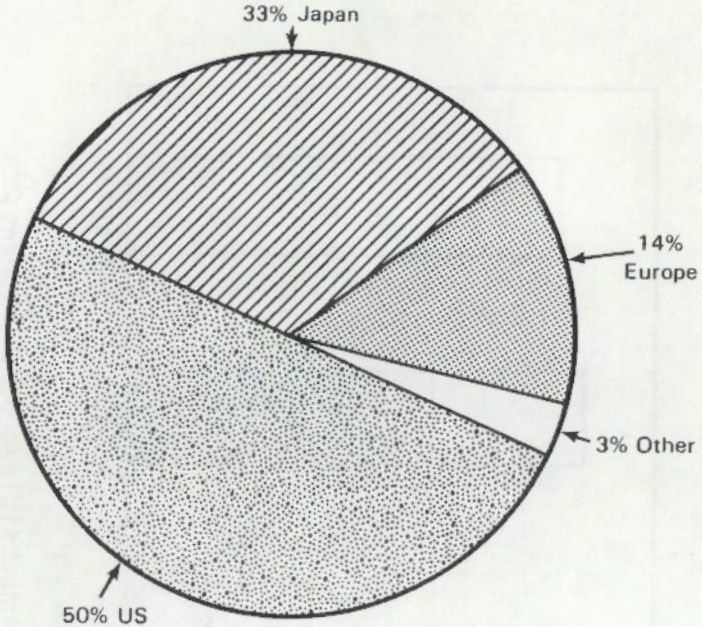
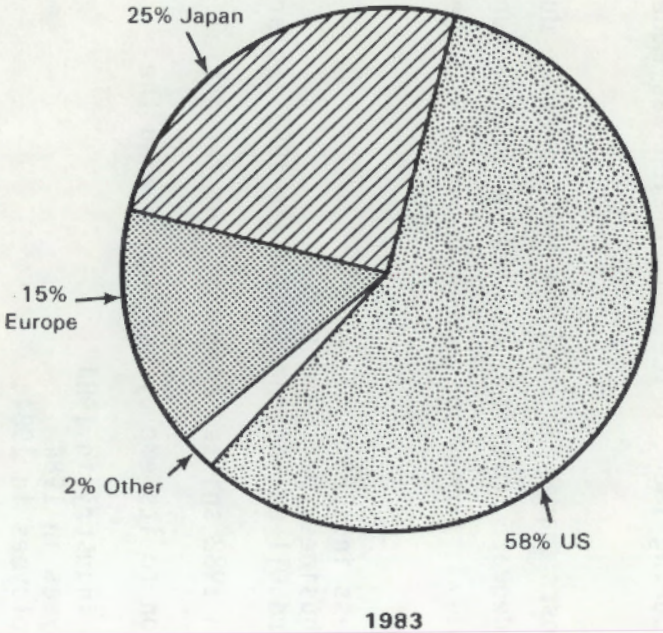
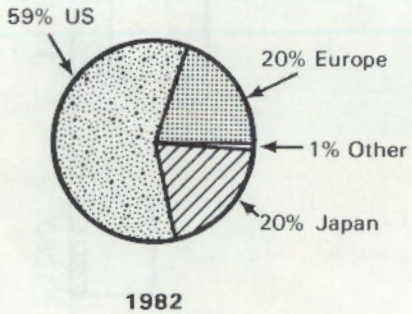


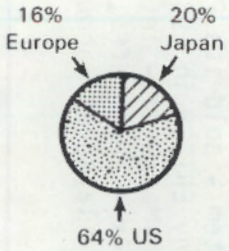
Figure 2.4 Subsidized and Nonsubsidized U.S. Shipments

Table 2.3 lists PV module manufacturers in the U.S. during 1984. The following section provides background information on U.S. manufacturers.









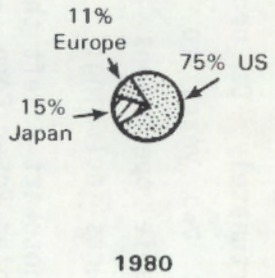


Figure 2.5 World Market Share

TABLE 2.3. U.S. Module Manufacturers in 1984

ARCO Solar	Silicon Sensors
Applied Solar Energy Corp.	Solar Power Corporation
Chronar	Solarex Corporation
Entech	Solavolt International
Free Energy Systems	Solenergy
Intersol	Solec International
Martin-Marietta Aerospace	Tideland Signal
Mobil Solar Energy	United Energy Corporation
Photowatt International	

ARCO Solar, Inc. This company is a wholly owned subsidiary of ARCO Solar Industries, which is a subsidiary of the Atlantic Richfield Company. In 1978, ARCO Solar, Inc., purchased a small photovoltaic manufacturer, Solar Technology International, which had been founded three years earlier. ARCO proceeded to install a modern, automated assembly line to produce silicon cells and modules.

In January 1980, the Atlantic Richfield Company signed a multi-million dollar product development and licensing agreement with Energy Conversion Devices, Inc. (ECD), aimed at accelerating the commercialization of ECD's amorphous devices. In May 1981, ARCO decided to let the ECD PV contract expire and decided to support its own amorphous silicon R&D.

During 1983 ARCO built the first 1 MW central station PV system in Hesperia, California and announced plans for a 16 MW PV facility at Carissa Plains. In 1984 ARCO introduced the world's first commercial A-Si power module, the "Genesis". This module is 5% efficient and carries a 1 year warranty. ARCO also increased the warranty on many of its single crystal Si power modules to 10 years, and received the Underwriter's Laboratory approval on its M53 and M73 modules. ARCO layed-off about 140 of their 600 employees during 1984; however, most lay-offs were in non-research areas.

Chronar Corporation This company was incorporated in 1976 with the purpose of developing commercial PV manufacturing facilities. To date, Chronar has developed a batch process for producing A-Si cells and modules. PV production equipment has been sold to several organizations through joint venture agreements with Chronar.

- AFG Industries - In 1983 signed an agreement to install a 1 MW production line in Tennessee. Chronar retained 51% ownership and AFG 49%. Financing for the sale came from $5 million in industrial revenue bonds.
- Port Jervis, NY - Chronar and a group of private investors joined together to establish a batch processing facility. This $6 million installation was opened in December, 1984.
- Alabama Power - Signed an agreement in March 1984 to build a batch processing facility. Alabama power will pay $6.1 million for 85% ownership in the joint venture, and Chronar will pay $1.1 million for a 15% ownership share.
- Chronar Ltd., Bridgend Wales - This wholly owned subsidiary was financed through grants and low interest loans from Wales. The 1 MW facility opened April 17, 1985 and will operate 3 shifts by the Fall of 1985.
- Chronar France - This plant is owned by Chronar, SOMDIAA, Charbonnages de France, and Groupe Drout. The $10 million, 1 MW facility will come online by late 1985.

During 1984 Chronar acquired Tri Solar Corporation, a PV-powered pump manufacturer. In December Chronar opened the Port Jervis facility.

Chronar's stock is sold through the over-the-counter market and is reported in the NASDAQ exchange under the symbol CRNR. The closing bids for Chronar stock during 1984 went from a low of $6.50/share to a high of $21.25/share. Currently, the stock has a market value of $9.25/share (3/1/85).

Chronar currently has 140 employees in the US and 25 employees in the UK.

Energy Conversion Devices (ECD) This company was established in 1960 and has developed a continuous roll production technique to produce A-Si cells. The development of this technique was partially funded by $9.3 million received from ARCO in 1980. This technology was incorporated into the production equipment that was sold to a Sharp/ECD joint venture of Japan.

ECO has established two partnership agreements with Standard Oil of Ohio (1981): technology partnership and an operating partnership, Sovonics Solar Systems. The purposes of these agreements is to perform further research on the production of PV cells, to commercialize the PV technology and to grant royalty-bearing leases. Since 1981 SOHIO has contributed $44 million to ECD through their operating partnership.

During 1984 Sovonics Solar Systems announced its plans to build a cell production facility in Michigan and a module assembly plant in Ohio. Sovonics also signed a memorandum of understanding with China to establish a joint venture to manufacture and market A-Si.

ECD stock is traded on the over-the-counter market under the symbol ENER. The closing bids for ECD stock during 1984 went from a low of $20.88/share to a high of $42.00/share. Currently, the stock has a market value of $27.50/share (3/1/85). ECD currently employs 459 full time employees with approximately 100 on PV.

Mobil Solar Energy Corporation This was originally a joint venture formed in 1974 by Tyco Laboratories, Inc. (20%), and Mobil Oil Corporation (80%). In 1983 Mobil purchased Tyco Labs' interest in the company and the company was renamed Mobil Solar Energy Corp. After several years of research and development, Mobil has opened a new manufacturing facility as a part of a major expansion plan to produce 10 MW per year within the next few years. In 1983 Mobil introduced a new ribbon technology called the nonagon. This technique produces a nine-sided tube of Si that is cut by a laser to produce rectangular cells. During the past year Mobil was awarded a $245,000 contract to supply 37 kW of ribbon silicon modules for Phase II of the SMUD project. The parent organization, Mobil Corporation, was incorporated in 1882 and is a major energy company ($60 billion in sales in 1984), with products and services in oil, gas, chemicals, and paperboard.

Photowatt International Photowatt first entered the PV industry in 1974 as the PV division of Sensor Technology of Chatsworth, California. In 1979, Sensor Technology moved their operations to Phoenix, Arizona and Photowatt International was formed. Sensor Technology retained ownership of one-half of the new company and GESA of France controlled the other half. GESA subsequently started Photowatt SA in France and Photowatt Afrique.

In 1983 Photowatt sold its PV inventory and left the industry.

Solec International, Inc. This company was started by Ishaq Shahrayar with the purpose of manufacturing PV cells and modules. In 1980, Pilkington Brothers, a British glass manufacturer, purchased 80% interest in Solec. This acquisition proved to be quite beneficial to Solec since it provided the company with worldwide sales outlets and Solec's sales increased by 300%.

Currently, Solec purchases wafers and manufactures cells and panels. The company intends to establish module assembly plants overseas while continuing to manufacture cells in the U.S. Solec employes about 50 people.

Solenergy Corporation. This is a small, privately held business established in 1978 by Robert Willis to manufacture PV devices. Solenergy purchases silicon slices, produces a wide variety of products, and has a staff of 25 people. Kayex Corporation is a 20% shareholder in the company and has annual sales of about $20 million. Kayex is a General Signal Corporation company specializing in material processing equipment for the PV and silicon industries. In 1983 Solenergy merged with Entropy, Ltd. via a stock exchange,and in 1984 they signed a letter of intent with China to build a PV manufacturing plant.

Spire Corporation. Founded in 1969 as a small business, this high technology company is engaged in research, engineering, and manufacturing of PV cells and processing equipment for high-volume production of cells and modules. The company has produced cells and modules for the DOE program, but its primary interest is manufacturing PV production equipment. The company is also developing thin film processes for low-cost substrate fabrication, thin film deposition, and cell structure formation. In 1983 Spire began to sell its SPI-LINE™ system to Saudia Arabia and to India. They also developed a process for depositing GaAs directly onto a silicon substrate. This process may significantly reduce the cost of GaAs cells. Spire signed a $4 million agreement with China in 1984 to sell 1 MW of PV manufacturing equipment. Spire sold a 1 MW PV module manufacturing system to Solarpac of Canada.

Spire Corporation stock is traded on the NASDAQ exchange under the symbol SPIR. The closing bids for Spire stock went from a low of $8.50/share to a high of $14.50/share in 1984. Currently the stock has a market value of $15.25/share (3/1/85).

Solar Power Corporation. Established in 1969 as a small business, Solar Power Corporation was acquired by Exxon in 1975. In 1983 the company reduced the size of its production facility and distribution channels and organized to operate with less than 100 employees. Solar Power concentrated on manufacturing PV devices for today's market. Advanced R&D was conducted in other areas of the parent company. Solar Power Corporation provided the PV system at the Universe of Energy Pavilion at Disney World. Exxon Corporation, with $103 billion in sales (1980), is a major multi-national integrated company in the areas of oil and gas, energy, information systems, and chemicals. The company supported considerable internal research in advanced PV materials, with particular emphasis on amorphous silicon.

In 1983, Exxon announced that Solar Power Corporation was for sale. In 1984 Solar Power Corporation's inventories were sold to Solarex and its employees layed off. Exxon Corp. also closed Solar Power Corporation's amorphous silicon research program in Linden, NJ in 1983. To date, Solar Power Corporation has not been sold. Solarex is providing service to Solar Power Corp. customers.

Solarex Corporation. Solarex Corporation entered the PV industry in 1973, and soon became known for its technological leadership with such developments as the most efficient solar cell, the first high density modules, vertical junction cells and the ultra light 2 mil cell among others. The most significant development was the semicrystalline silicon material for solar cell use. Prior to this development single crystal silicon was the only material used for solar cell mass production. Solarex started a wholly owned subsidiary, Semix, to manufacture the semicrystalline material.

Until 1983 Solarex was a widely held company with corporate investors from such countries as Italy. Holland, and France. In 1983 Solarex became a totally owned subsidiary of Standard Oil Company (Indiana) and Semix became a division of Solarex Corporation. Solarex has a manufacturing facility in Australia (Solarex Pty) and one in Hong Kong (Solarex Electric) for its consumer products. It also has sales offices in Geneva, Switzerland and from coast to coast in the U.S.

In 1983, Solarex acquired RCA's amorphous silicon technology now known as the Solarex Thin Film Division. Solarex Thin Film Division was the first U.S. Company to commercially ship amorphous products. Additionally, Solarex has an Aerospace division which manufactures solar cells for use on satellites and spacecraft and was recently chosen to supply the PV modules for NASA's COBE spacecraft. In 1984 Solarex introduced the industry's only minimum wattage guarantee for PV modules. Solarex has 600 employees.

Solavolt International. This company was formed as a joint venture of Motorola (1984 sales of $5 billion) and Shell Oil Co. subsidiaries (1984 sales of $21 billion) in 1981. Both companies had been working in PV since the mid 1970's.

Solavolt originally had two divisions -- one to concentrate on thin film technologies and the second to develop their continuous ribbon production process. The thin film research was phased out in 1983. Currently they are using conventional and polycrystalline silicon technology to produce a limited number of high-quality modules. Production of these modules allows Solavolt to gain both produciton and marketing experience. It is expected that Solavolt will introduce their ribbon modules in the second half of 1985.

Solavolt currently has 175 employees.

Tideland Signal. Tideland has been supplying PV systems for powering offshore navigational aids since 1972. Tideland has developed and patented a very durable all-glass solar module. Cells for these modules are manufactured by Tideland Energy Pty., Ltd., a wholly owned subsidiary in Sydney, Australia. More than 12,000 Tideland Solaviva navigational aids have been installed world wide. Tideland also has wholly owned subsidiaries in Canada, Mexico, and the United Kingdom.

United Energy Corp. UEC, a privately owned enterprise operated under the leadership of Ernest Lampert, originated in Hawaii in 1978. UEC began the manufacture and sale of PV panels and systems. In 1981 the company moved its primary operations to California where it became a diversified developer and manufacturer of renewable energy equipment systems.

UEC markets a solar electrothermal generator equipped with Point Focus Fresnel Lenses and actively cooled PV concentrator cells. The generators are mounted on dual-axis tracking system rated at 2.5 kW and 33,000 btu per hour. 1984 sales of this product were reported to be approximately $45 million which would place UEC second in the world ranking of PV manufacturers. The company had a staff of 1500 employees during its period of peak production.

UEC is vertically integrating its manufacturing operations. Manufacturing units are located in California (Foster City), Mexico (Mexicali) and India (Madras).

UEC has sponsored "The Solar Revolution" which is an educational program describing the many benefits of using renewable energy resources.

The majority of their sales have been financed through third party arrangements. Two of UEC's major sites in 1983-84 were Barstow and Borego Springs, California.

2.2 EUROPEAN PV INDUSTRY

Shipments of PV modules by European firms increased from 0.5 MW in 1980 to approximately 3.3 MW in 1984 (figure 2.6). However, there was no apparent growth in shipments between 1983 and 1984. A portion of this previous increase in shipments can be attributed to the assistance of the Commission of European Communities (CEC). The CEC has assisted European PV manufacturers in establishing 15 pilot projects under cost-sharing arrangements.

Table 2.4 lists the major European module manufacturers in 1984. The following section provides background information on the major European module manufacturers.

Table 2.4. Major European Module Manufacturers in 1984

Belgsolar	BP Solar
Energie Nouvelle	Andratica Componeti
France Photon	Ansaldo
Photowatt SA	Helios Technology
AEG Telefunken	Pragma
Siemens A.G.	Isophoton

AEG Telefunken. AEG Telefunken has been involved in PV for the past 20 years and is currently Germany's largest PV manufacturer. In the past, AEG purchased polycrystalline Si from other manufacturers for their PV modules. However, AEG has been working with Heliotronic, a Wacker Chemitronic subsidiary, on the development of low cost polycrystalline silicon.

Currently, AEG markets a wide range of PV systems such as hazard beacons, water pumping systems, and telecommunications relay stations. AEG was the primary contractor for the 300 kW Pellworm Island PV system that was partially funded by the CEC.

Ansaldo. Ansaldo is a state owned electromechanical company appointed by the government of Italy for the development and production of energy systems. They manufacture their own single crystalline cells and produce PV modules. Currently, PV production capacity is about 200 kW. Some research is being conducted on A-Si; however, they have no plans to introudce A-Si modules in the near future.

Ansaldo has been involved in the construction of a 35 kW hybrid thermal/PV plant in Australia.

BP Solar. Prior to 1983, BP Solar was a joint venture between British Petroleum (BP) and Lucas. In 1983, BP purchased Lucas' interest in the company. Currently they purchase cells and produce modules. Their marketing objective is not to sell individual modules, but complete PV systems. In 1983 BP Solar began installing the largest PV system in the U.K. near Southampton. The 30 kW installation is estimated to cost $1.5 million and is financed by BP Solar and the Department of Industry. During 1984 BP Solar acquired the film division of Monosolar as well as the technology to manufacture the mercury, cadmium, and tellurium cells.

France Photon. France Photon is a wholly owned subsidiary of Leroy-Somers, a medium sized electrical company with 4000 employees. The subsidiary was formed in 1978 with the purpose of producing single and polycrystalline cells and modules using the Solarex technology. The design and marketing of complete PV systems is performed by two other Leroy-Somers groups: Pompes Guinard and Systemes Solaires.

France Photon has built a 44 kW village electric system at Rondolinu Cargese, Corsica.

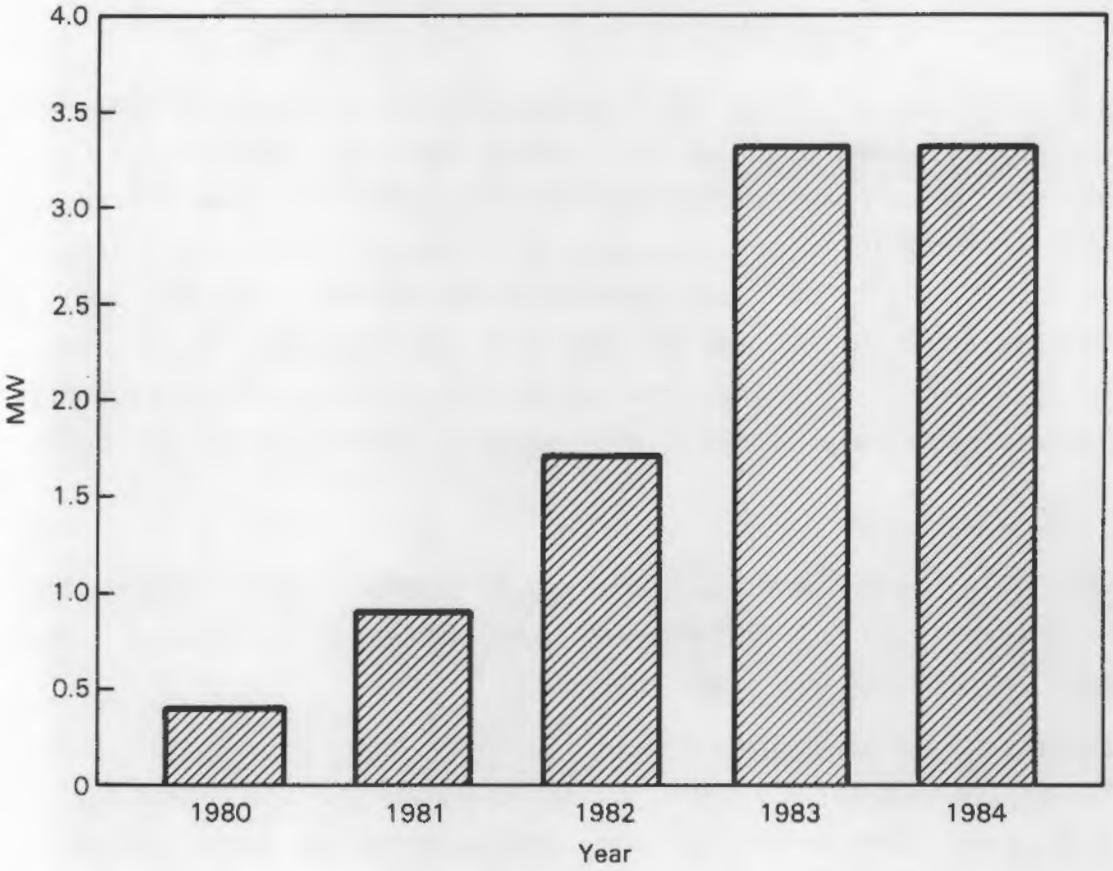


Figure 2.6 European PV Shipments

Helios. Helios is located in Italy and is one of the few non-oil, non-government funded module producers in Europe. Helios purchased it's PV technology from Solec International and has an advanced, low cost, automated cell and module manufacturing line. Their cell production process is unique in that wafers are etched until small tetrahedra are formed on the surface, thus reducing reflection and increasing efficiency.

Helios has been a major cell supplier for BP Solar, and they have concentrated their marketing efforts in southern Europe.

Photowatt, SA. This company is a subsidiary of SAFT (CGE group), ELF (a major oil company) and RTC (the Philips group) with its headquarters located in Revie - Malmaison, near Paris. Photowatt has also established a company, Photowatt Afrique, in Abidjan, Ivory Coast, to sell small PV powered systems to neighboring countries. In 1984 Photowatt started steps toward commercialization of "polyx" ingot casting process developed by Photowatt and Laboratories de Marcousses. Photowatt will manufacture about 50% of their modules in 1985 using Polyx multicrystalline si, and 100% of their modules in 1986. By switching to the Polyx multicrystalline, Photowatt will be able to achieve the PV cost reduction goals set by the government agency, Agence Francaise Pour la Maitrise de l'Energie, of $2.75/Wp.

Pragma. Pragma of Italy was formed by the state owned oil company ENI. Pragma originally owned a share of Solarex and thus had access to the technology for producing "semix" polycrystalline material. Pragma also owns a controlling interest in Solaris, an Italian licencee of Solarex. Pragma has assembled both single crystal and polycrystalline modules. They are working on A-Si. They reported at the end of 1983 that they had sold their production quota for 1984. Previously they had announced a capacity of 450 kW per year. They have announced plans to build an automated assembly plant for cells and modules.

Siemens A.G. Interatom is a subsidiary of Siemens that is responsible for all PV research, product development and marketing. Siemens' product development strategy has four major elements:

- o quality single crystal modules,
- o R&D on low cost silicon purification, using arc furnace technology,
- o high speed ribbon production using web-supported horizontal growth,
- o amorphous silicon R&D.

Their single crystal product is marketed worldwide and is used for communications, battery charging, remote residential power, etc. Siemens currently employs about 40 professionals in their PV business.

2.3 JAPANESE PV INDUSTRY

The Japanese PV industry has experienced rapid growth over the past four years, with shipments increasing from 0.5 MW in 1980 to 7.7 MW in 1984. However, unlike U.S. shipments, about 86% of the Japanese sales are to the non-subsidized, consumer goods market (see Figure 2.7). The Japanese have viewed this market as a testing ground for developing their thin film technology, as well as a means of expanding their PV production base. By concentrating on the consumer goods market, the Japanese share of the world PV market has increased from 15% in 1980 to 33% in 1984 (see Figure 2.5).

Although the Japanese have increased their share of the world PV market, they are still behind the rest of the world in terms of developing large-scale PV power modules. Japanese power modules are currently being test marketed in the U.S.; however, these modules are made from crystalline materials and not

thin films. In order to help narrow this technology gap, the Japanese government is still providing support to the PV industry through the Sunshine project. In 1983 the Japanese government provided over $28 million, and this funding increased to about $30 million in 1984.

Table 2.5 lists the Japanese module manufacturers in 1984. The following section provides background information on the major Japanese module manufacturers.

TABLE 2.5. Major Japanese Module Manufacturers in 1984

Fuji Electric Co.	Maisushia Electric
Hitachi Electric Co.	Mitaka Electronics
Hoxan Co.	Nippon Electric
Japan Solar Energy Co.	Sanyo Electric
Kodenshi	Sharp
Komatsu Electronics	Taiyo Yuden
Kyoto Ceramic	Toshiba

Fuji Electric was one of the first Japanese PV companies to fabricate large unit A-Si cells on a metallic substrate. Fuji has also constructed a PV residence that uses 3 kW of modules and a Fuji Power conditioning system. During 1984 Fuji signed an agreement to share A-Si developments with Photowatt of France. Fuji is one of the world's leading producers of A-Si modules for use in calculators and watches.

Hoxan started in 1929 in Sapporo Hokkaida Province as an oxygen production plant. Since then, Hoxan has grown to be a manufacturer of a wide range of industrial and specialty gases, liquid petroleum gas, medical gases and handling equipment.

In 1963, in a joint venture with American Standard, they began production of Bath-All bathroom units.

In 1982, Hoxan entered the PV industry with modest production. They recently have dedicated a 9 MW, fully-automated PV production facility. This facility is the largest PV manufacturing facility in the world and it converts single crystal silicon slices into 36-cell, 40 watt modules. A unique feature of this plant is that no people ever contact the modules or cells.

Kyocera entered the photovoltaics industry in 1979 and has produced modules in the four major PV technologies: polycrystalline silicon single cryustal silicon, amorphous silicon and ribbon. Their ribbon PV technology was developed through a joint venture with Mobil Solar (then Mobil Tyco) in 1979. Kyocera entered the US market vigorously in 1984 selling both modules (multicrystalline) and systems.

Sanyo is reported to be the leading producer of PV in Japan. Sanyo has established an energy division involved in both PV and solar thermal technologies. They recently constructed a $50 million PV production plant that is capable of producing 1 million calculator-type modules per month.

Sharp has been in the PV business longer than any other Japanese firm. Currently, Sharp is the principal manufacturer of PV cells for Japanese spacecraft. The company is also involved in manufacturing cells and modules for use in remote stand-alone applications and pocket calculators.

They joined ECD of the USA in a venture with Sharp-ECD developing a roll-to-roll A-Si production machine that fabricates A-Si cells on a 180 cm stainless steel sheet.

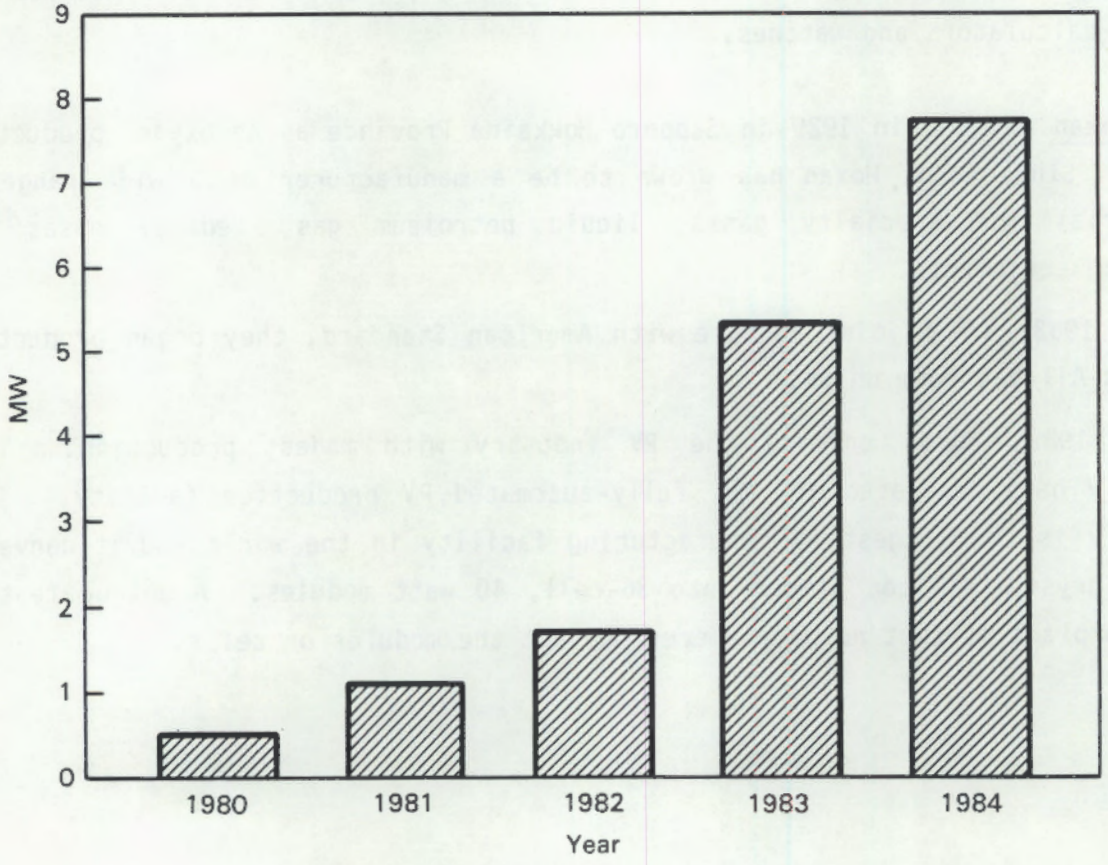


Figure 2.7 Japanese PV Shipments

2.4 "OTHER" PV REGION

The "other" PV region includes primarily those PV companies in Asia and South America. The growth in PV activity in this region has been modestlyincreasing from 400 kW in 1983 to about 600 kW in 1984. Two companies are responsible for the growth of this region: CEL and Heliodinamica.

CEL (New Delhi, India). CEL is a government owned PV manufacturer who produces crystalline PV cells, modules, and systems. The technology used was US developed, but the production equipment was made in India. CEL has developed and manufactured PV systems for offshore well-head platforms, telecommunications, weather monitoring and various other industrial applicaitons.

Heliodinamica. This company is a privately-owned PV manufacturer located in Cotia (22 miles outside Sao Paulo) Brazil that entered the PV industry in 1980. Heliodinamica is the first Third World company to manufacture cells, modules and complete PV systems.

They installed Brazil's first PV powered water pumping system in 1981 at Rio Grande do Norte. Since then the company has developed a new motor for its submersible tube well pump as well as an extremely simple priming device for its surface-mounted pumps. Telebras, the government telecommunictions company, is replacing many of its diesel generators at remote sites with PV powered systems, supplied by Heliodinamica.

3.0 GOVERNMENT SUPPORT OF PHOTOVOLTAICS

The world PV industry continued to grow modestly during 1984, and government support of the industry continued to play a major role in this expansion. The financial support given by various governments included direct government purchase, cost-sharing with industry, and indirect government support such as tax credits. This chapter summarizes the various forms of support given to the PV industry during 1984.

3.1 DIRECT FEDERAL PURCHASES

In the U.S., the Federal Photovoltaic Utilization Program (FPUP) was initiated and funded long before PV shipments actually occurred. This is a natural result of the process of identifying the specific installations to be funded, designing the installations, and procuring the needed equipment. In Figure 3.1, the shipments to FPUP projects are shown for 1980 through 1983. Since only a few PV systems were shipped in 1980, the shipments for 1980 and 1981 are combined. It is interesting to note that shipments actually peaked in 1982.

Other federal purchases included those resulting from the Program Research Development Announcement (PRDA) and other large projects. The funding for large projects may have been fairly uniform year by year, but some projects lagged behind others, and the result is that actual shipments were much higher some years than others (Figure 3.2).

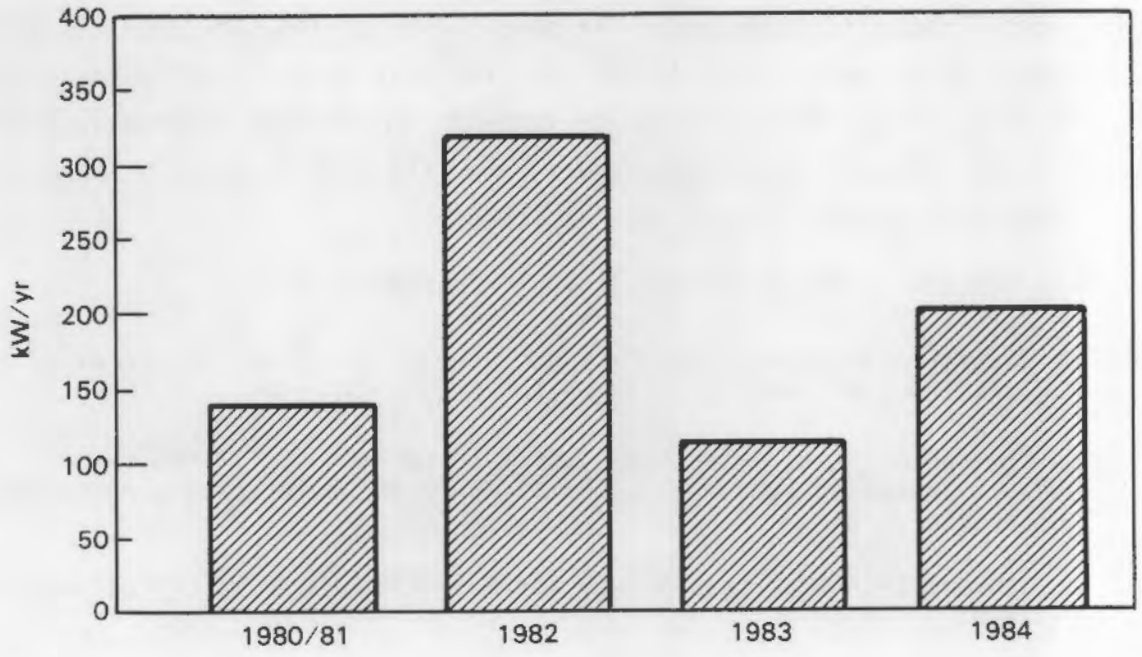


Figure 3.1 Annual FPUP PV Purchases

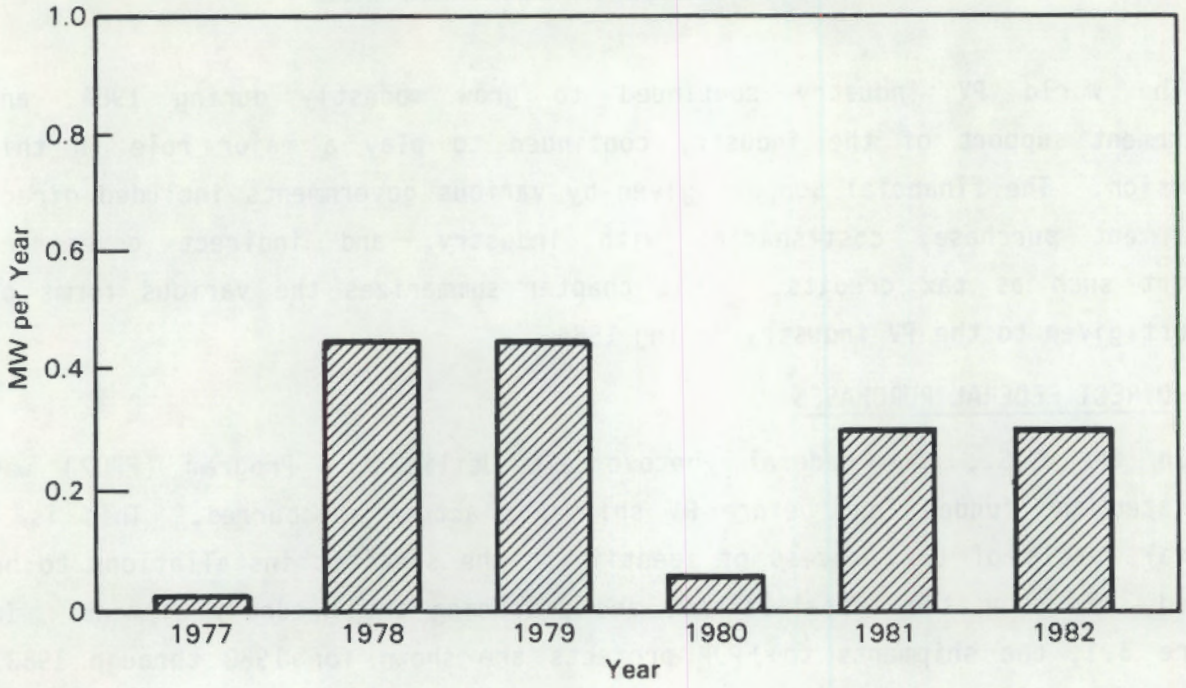


Figure 3.2 Federal, Non FPUP PV Purchases

3.1.1 U.S. Government Spending

The U.S. Government, through the Department of Energy's Photovoltaics Division, has been sponsoring PV R&D for more than 10 years. This funding grew from $10 million in 1973 to $130 million in 1981. In 1984, the DOE provided more than $50 million for PV R&D.

This federal support, along with the cooperation of industry, has helped to reduce PV electricity costs from $15/kWh to less than $1 kWh; to increase cell efficiences from 11% to 18%; to increase domestic PV production from less than 1 MW/year to 11.6 MW/year; and to improve module life from 2 years to more than 10 years (more than 20 year life is now expected).

In 1982, the goals and objectives of DOE's PV program were:

- to develop new materials by FY 1985 in order to establish technical feasibility for industry-produced $0.77/Wp collectors,
- to develop critical balance of system components by FY 1985 that support installed system costs of $1.75-$2.45/Wp in utility-connected applications, and
- to achieve technical feasibility for less than $0.45/Wp collectors by FY 1990.

Program goals and objectives were revised for the FY 1984-1988 program. These goals and objectives are:

- o to achieve flat plate system module costs and efficiences in the range of 13-17% and $40-$75/sq. M., and
- o to achieve concentrator system module costs and efficiency in the range of 23-29% and $90-$160/sq. M.

The program's emphasis has changed from aggressive market development activities prior to 1982 to concentrating on advanced R&D.

3.1.2 European Funding

For several years individual European governments have been funding PV R&D activities. However, in 1975 the eight member countries of the European Economic Community (EEC) joined together to fund PV R&D through the Commission of European Communities (CEC). In 1982 approximately $49 million of CEC funding and indirect industry cost sharing were available for PV research. This funding is used by universities for advanced cell research activities, and by industry for PV technology development.

The CEC also sponsors 15 PV pilots, 13 of which are operating (see Table 3.1). The objectives of these experiments are:

- o to develop and demonstrate PV system design for specific applications;
- o to promote user acceptance by aesthetic designs of PV arrays which blend in with the environment;
- o to develop new technologies; and
- o to provide incentives to European industry, utilities, and national regional authorities in the PV program.

All pilot programs are co-sponsored by the respective national governments, with the CEC contributing about 30% of the cost of these projects. About 50% of the funding is from the PV industry and national governments. The CEC's future budget for PV R&D activities is expected to be determined by the end of 1984 or early 1985. It is also expected that proposals will be invited in 1985 for a new series of pilot projects including hybrid, wind/PV or diesel/PV, systems.

TABLE 3.1 Operating European Pilot Plants

Location	Power KW	Application	Leading Contractor	Co-Sponsor
Pellworm Island, West Germany	300	Power for recreation center	AEG Telefunken	West German government
Kthos Island, Greece	100	Island grid	Siemens AG	W. German govt. and Greek utility
Chevetogne, Belgium	63	Pumps for swimming pool and lighting	IDE-ACEC	Belgium government
Aghia Roumell, Greece	50	Village grid	Renault	French govt. and Chamber/Commerce
Mont Bouquet, France	50	TV transmitters	Photowatt, Inc.	French govt. and Chamber/Commerce
Nice Airport, France	50	Tower control	Photowatt, Inc.	French govt. and Chamber/Commerce
Fota Island, Ireland	50	Dairy farm	U. of Cork, AEG	Irish & German govt & Irish utility
Terschelling Island, The Netherlands	50	Marine school	Holec	Dutch & German governments
Kaw, French Guyana	35	Village grid	Renault	French government
Hoboken, Belgium	30	Electrolysis	ENI	Belgian government
Rondulinu, Corsica	30	Village power	Leroy-Somer	French govt. and French utility
Tremiti Island, Italy	65	Seawater desalination	Italenergie	Italian government
Giglio Island, Italy	45	Water disinfection and cold storage	Pragma	Italian govt. and Toscana Giglio community
Vulcano Island, Italy	80	Village power	ENEL	Italian utility
Marchwood, UK	30	Grid interaction	BP Solar	British government
TOTAL	1028			

Source: Starr, M.R. 1983. Photovoltaic Power for Europe. D. Reidel Publishing. Appendix B. pp. 194-195.

3.1.3 Japanese Funding

The majority of Japanese support of PV is provided by the Sunshine Project which is administered by the Agency of Industrial Science and Technology under the Ministry of International Trade and Industry. The Sunshine Project is formulated after the U.S./DOE PV program in terms of discipline areas. The three major areas of PV research are

- o PV technology development
- o PV system technology, including PV applications, and
- o PV materials research.

The objective of the Japanese PV research is to make the best use of U.S.-developed silicon technologies for the development of viable silicon crystaline mass production capabilities, and to make Japan a leader in A-Si cell technology. Japan's emphasis on A-Si is due to their silicon availability problems and the high costs of silicon refinement.

PV funding by the Sunshine Project has increased rapidly since 1980 to over $30 million for 1984 (see Table 3.2). These funds are used by about 14 companies for performing PV production-related work, and by 6 universities for PV device physics research. Funds cover the purchase of capital equipment, expendables, and a portion of direct labor costs. The contractors provide internal funds for the majority of labor costs.

TABLE 3.2 Sunshine Project vs. U.S. PV Funding

Year	Sunshine Project $ Million/Year	U.S./DOE $ Million/Year	CEC $ Million
1980	9.9	151.0	
1981	25.3	133.2	
1982	28.9	74.0	$12.0 *
1983	28.7	59.0	
1984	30.5	50.0	

* $12 million was allocated for 1980-83; however, some of this money was carried over to 1984.

3.2 INDIRECT FEDERAL SUPPORT

In addition to the direct U.S. Government purchases, there is a large part of the total sales that contains federal or state tax subsidies. Large private sales, such as the 200 kW solar breeder by Solarex, the 1.0 MW Lugo station installation by ARCO, and the majority of the PV concentrators being installed by UEC, are subsidized by federal and state tax incentives. Dealers and distributors indicate the tax credits are still an important consideration when selling to the residential market.

To encourage the use of renewable energy sources in the U.S., the Federal Government and many states are offering energy tax credits of one form or another. These tax credits have a great effect on sales in some areas and almost no effect in others. Tax credits are available for PV-powered communications equipment but are not a consideration of primary importance in their purchase because PV currently offers the most economically viable option for providing power to repeaters in remote locations. Dealers and distributors contacted indicated that only a very small percentage of sales made in the communications area is due to the availability of tax credits.

Sales in other market segments are highly dependent on tax breaks given to PV purchasers. Currently, the timing of many sales to residential remote power users is determined by the availability of tax credits. This is very apparent to dealers and distributors, as December is the largest sales month for many of them, and fourth-quarter sales can easily equal total sales for the rest of the year. Expanding US sales in the areas of residential grid-connected applications (selling the excess power to utilities at the utility's avoided cost of power) and agricultural water pumping and irrigation are going to be largely contingent on tax credits until the cost per watt of a PV system falls.

Federal tax incentives for installing PV systems are available in many forms. First, eligible non-residential systems receive a 10% investment tax credit in the first year of operation. Residential systems do not qualify for this credit. The term "non-residential" is used to represent commercial, industrial, and agricultural uses as stated in the tax laws. Also available to non-residential users in the first year of operation is the federal energy tax

credit of 15% which expires at the end of 1985. Non-residential PV systems are currently able to be depreciated over five years under the accelerated cost recovery system (ACRS). However, the depreciable basis of the system must now be reduced by 50% of the regular and investment tax credits according to the Tax Equity and Fiscal Responsibility Act of 1982.

Residential PV systems are eligible for a federal residential energy credit of 40% of expenditures up to $10,000. This is a maximum credit of $4,000 which is applied on a cumulative basis. The credit is available to the person making the qualified expenditure, and thus ownership of the residence is not a requirement. This credit is also due to expire at the end of 1985.

To show the effects of the various tax credits, two examples--residential and non-residential--will be presented. The California tax laws will be used because of the large PV market in California and the liberal tax credits.

According to the California Energy Commission, residential and non-residential tax incentives are available through the end of 1986. For residential users, a 50% tax credit is available on equipment purchases, with a tax credit limit of $3000. This credit is taken net of the federal credit to make the maximum combined tax credit 50%. For apartment buildings, this credit is applied on a per-unit basis. For non-residential users only, there is a 25% solar tax credit. This credit is added to any federal tax credits that the equipment is eligible for and has no dollar limit. Equipment purchased by non-residential users can also be depreciated over three years, using the double-declining-balance method; however, the depreciable basis must be reduced by the amount of the state tax credit taken.

Figures 3.3 and 3.4 show the impact of tax credits on the effective (after tax) cost/watt and on total dollar tax savings for the residential PV purchaser. In figure 3.3, the effective cost per peak watt for PV systems is shown to fall slowly with increasing numbers of panels purchased. At 30 panels, the cost per peak watt begins to rise as the available tax credits have been exhausted as seen in Figure 3.4. The reason for the downward trend in price per watt before 30 panels is due to balance-of-system costs falling as a percentage of total cost. The discontinuities in Figure 3.3 at 5 and 50 panels are due to quantity discounts.

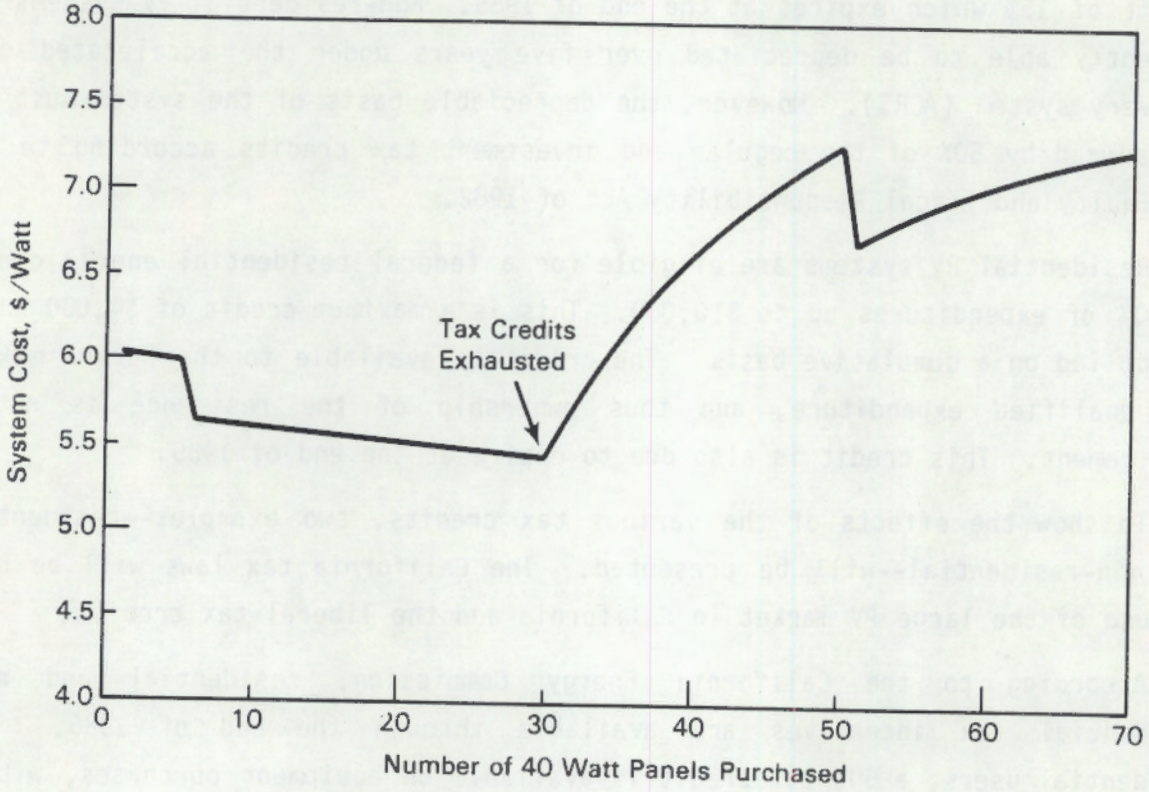


Figure 3.3 Effective (after tax) Cost Per Watt for Residential PV Systems

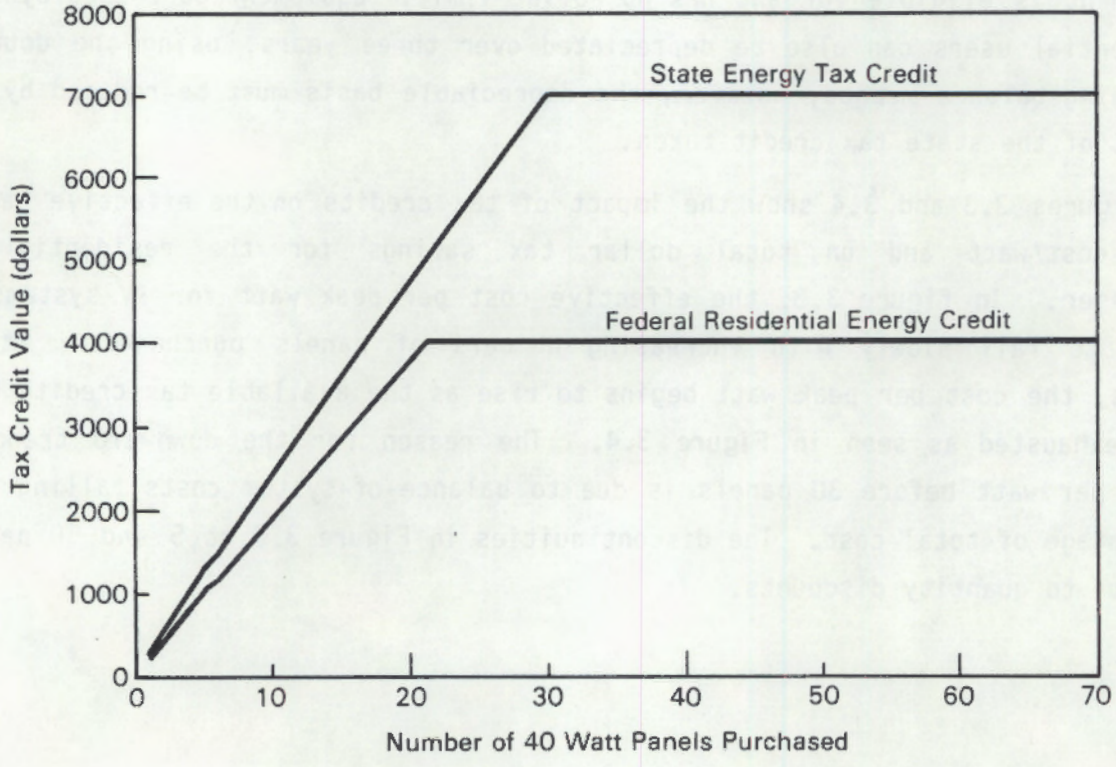


Figure 3.4 Dollar Value of Tax Credits (Residential)

In Figure 3.5, the effect of a $1/Wp reduction in the price of modules is shown for residential PV system purchases. Due to state and federal tax credits, the effective system cost is lowered by only $.50 per watt for purchases of 30 modules or less. As the quantity of modules purchased increases, the savings approach $1 per watt. But because residential purchasers normally buy less than 30 modules, small decreases in the price of modules cannot be expected to result in large increases in the quantity of modules sold to residential users.

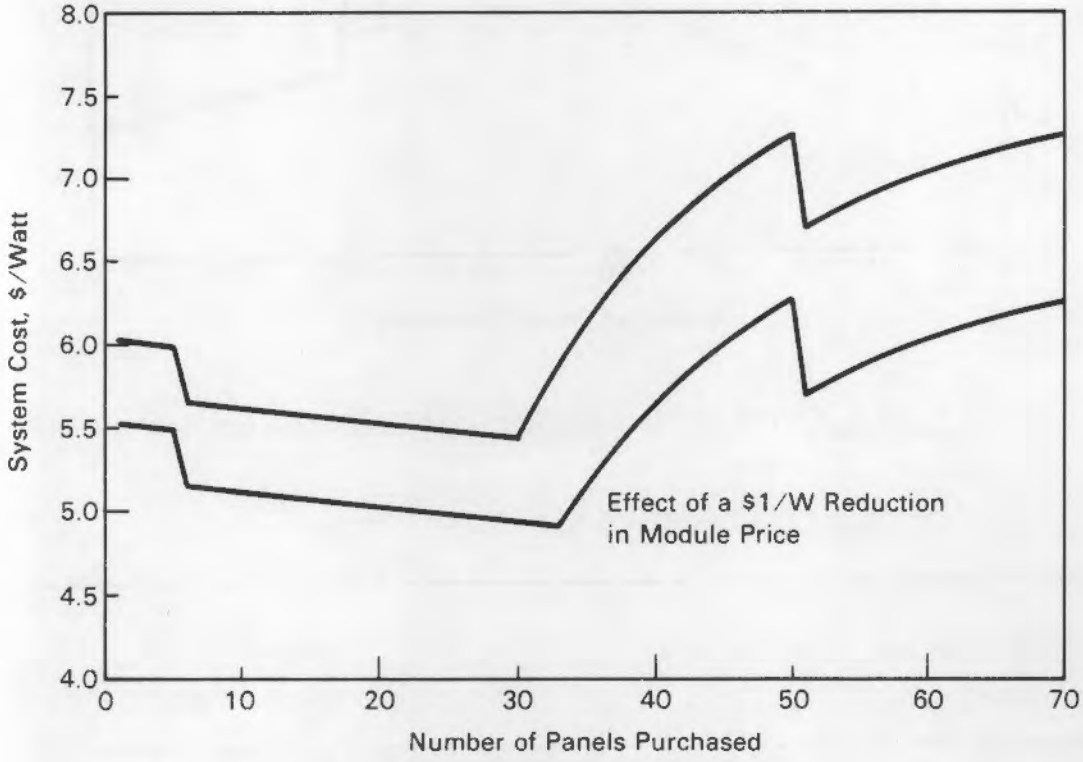


Figure 3.5 Effect of Module Cost Reductions (Residential)

Figures 3.6 and 3.7 show the impact of tax incentives on the effective cost/watt and the percentage of the cost actually paid by the government for non-residential PV system purchases. In Figure 3.6, the effective cost per peak watt slowly falls with increasing numbers of panels purchased. Again, the reason for the downward trend is the decreasing percentage of total cost that balance-of-system costs represent; as before, the discontinuities at 5 and 50 panels are due to quantity discounts. Figure 3.7 shows that since there is no dollar limit on the amount of tax incentives for non-residential purchasers, the government pays a full 72% of the cost regardless of the number of panels.

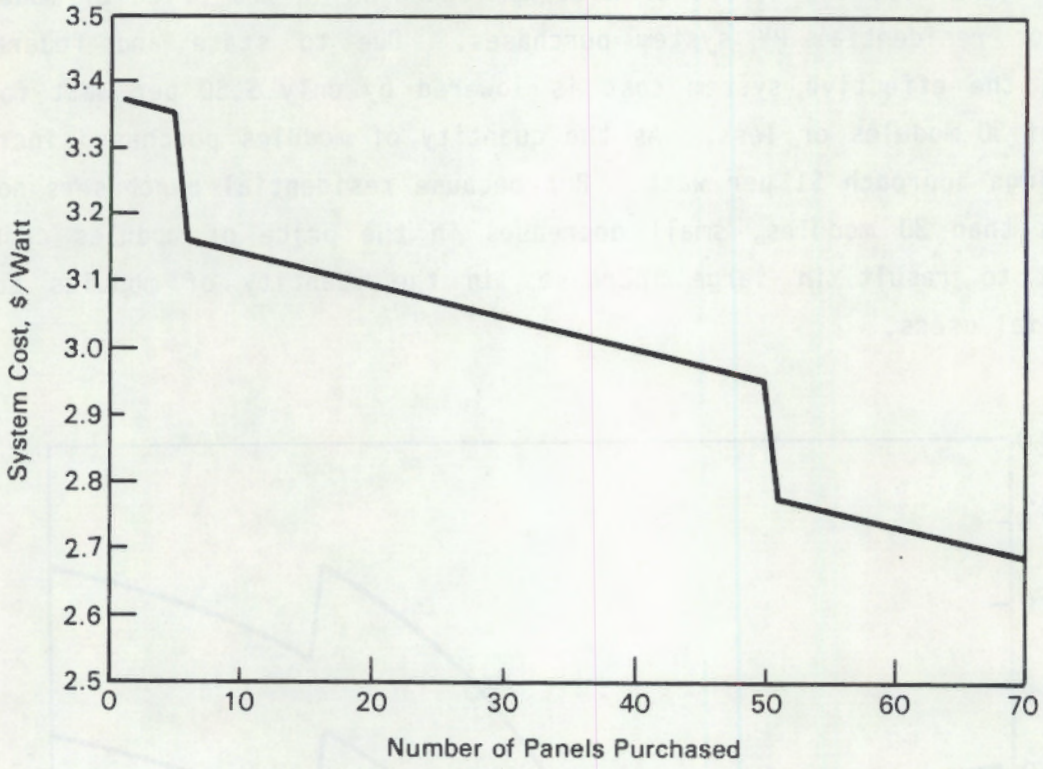


Figure 3.6 Effectife Cost Per Watt (Non-Residential)

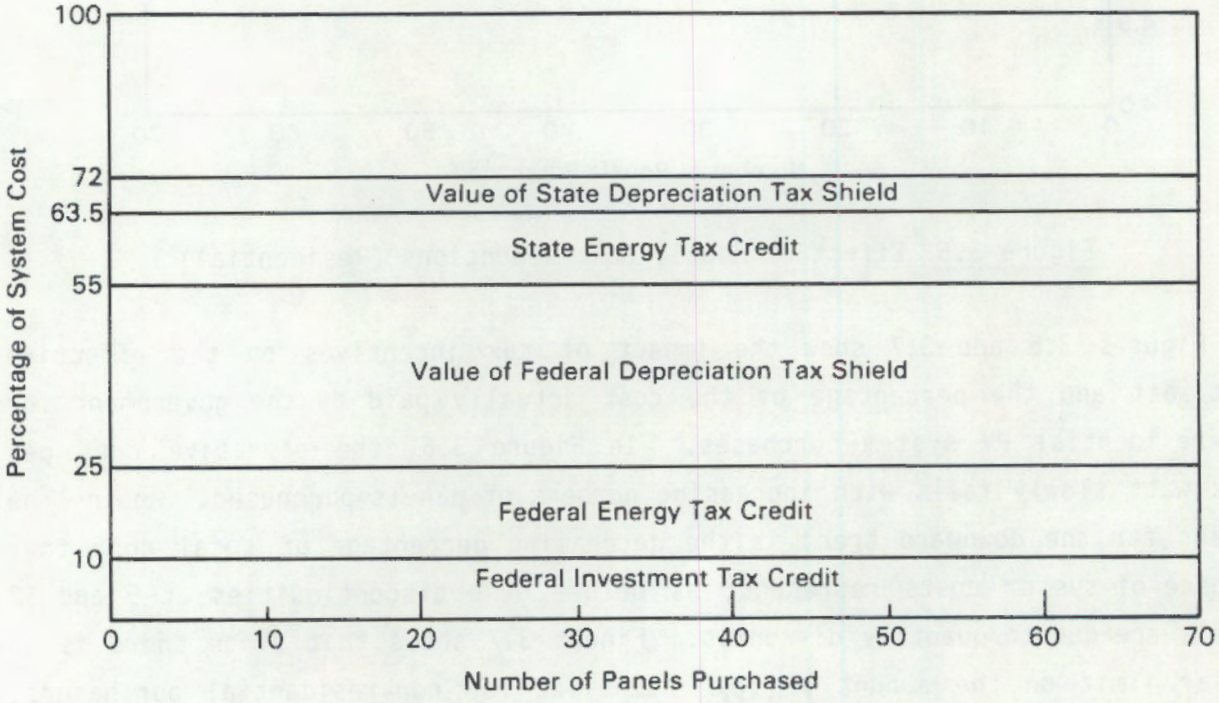


Figure 3.7 Tax Incentives for Non-Residential Systems

Since the payment of state taxes is deductible from income for federal income tax purposes, the value of the state tax credit and state depreciation tax shield is reduced by the marginal federal income tax rate. For example, a 25% state tax credit will only reduce the total tax bill by 13.5% of the amount eligible for the credit if the applicable marginal federal income tax rate is 46%.

For the examples shown, certain assumptions were required, and these are listed below:

- The party making the purchase would be eligible for the credits described above.
- The marginal federal income tax rate of non-residential purchasers is 46%.
- The marginal California income tax rate of non-residential purchasers is 9.6%.
- The appropriate discount rate for depreciation is 10%.
- All parties have income great enough to fully use the tax credits and depreciation in the first year they are available.
- Residential purchasers were assumed to itemize deductions for federal income tax purposes. If a residential purchaser itemized deduction, the dollar value of the state energy tax credit shown in figure 3.4 could be reduced by up to 50%, or a maximum of $1500.
- Forty-three watt panels can be purchased for the following prices per peak watt:

Number of Panels	Price per Peak Watt
5 or less	$9.00
6 to 50	8.50
Over 50	8.00

- Balance-of-system costs were estimated from available information. They include the cost of mounting structures, wire, batteries, control equipment, and inverters. Specifically, they decreased linearly from 34 to 20% for 0 to 70 panels, respectively.
- Installation costs were not considered.

4.0 MARKET SECTOR COMPARISONS

In this section, the annual shipments of PV modules are subdivided according to customer, end-use, and technology sectors. Estimating the shipments to both the customer and end-use sector is extremely difficult since modules are often sold by the manufacturer to distributors who, in turn, sell the modules to the ultimate customer. In such cases, the original manufacturer has no information on the customer or end-use of the equipment.

The market sector designations used in this section were developed through a cooperative effort of PNL, the Jet Propulsion Laboratory (JPL), and the Energy Information Administration (EIA). Definitions of these market sectors are given below to assist the reader in interpreting and using the results.

Customer market sectors are used to identify which portion of the public has purchased PV. Customer market sectors include:

- Residential: individuals who purchase PV for use on their home and RV.
- Commercial: individuals or companies who purchase PV for use in their business or to produce power for a commercial building. It also includes systems houses who will design and assemble PV systems using off-the-shelf PV products and components.
- Agricultural: individuals or organizations who purchase PV for use on a farm or ranch.
- Industrial: individuals or organizations who purchase PV through third party arrangements, or for utility applications.
- Governmental Organizations: organizations, agencies, or villages who purchase PV.
- Consumers: individuals who purchase small appliances and products that use PV such as radios, calculators and watches.

End-use market sectors are used to help determine the amount of PV being installed in large and small, grid vs. non-grid connected applications. These sectors include:

- Stand-alone applications: includes private residences, commercial establishments and agricultural and village power systems that are not connected to the electrical power grid.

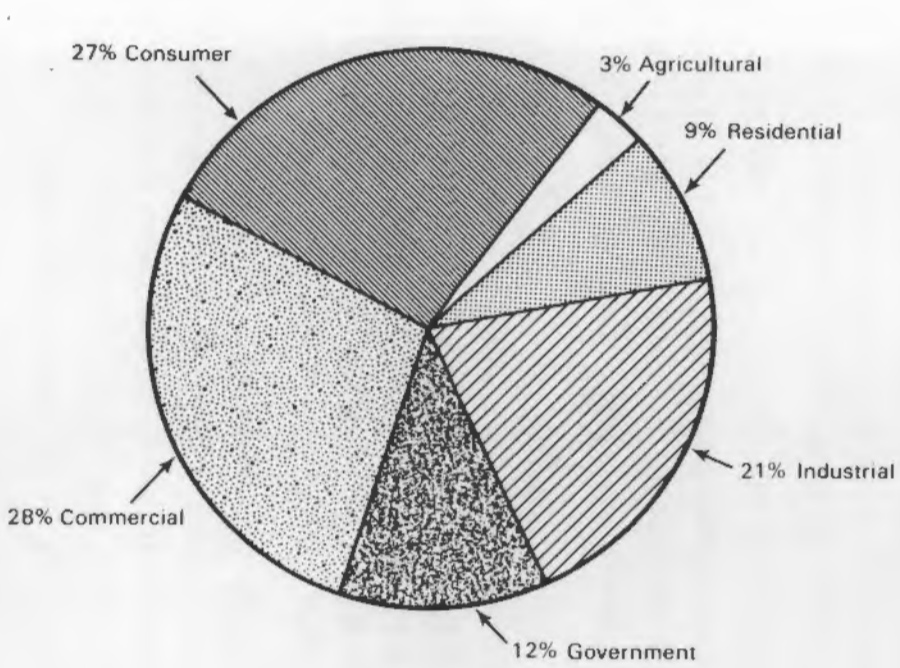
- o Grid-connected residences: includes single and multiple-family residences that generate a portion of their power requirements and use the existing power grid for additional power. Any surplus power generated by grid-connected PV systems is sold back to the utility.
- o Grid-connected, intermediate sized, commercial applications: includes power generation for use in local retailing or manufacturing facilities excess power is sold back to the utility.
- o Central station: includes facilities that produce power for sale to local utilities.
- o Specialty: includes consumer goods and appliances.

4.1 CUSTOMER MARKET SECTORS

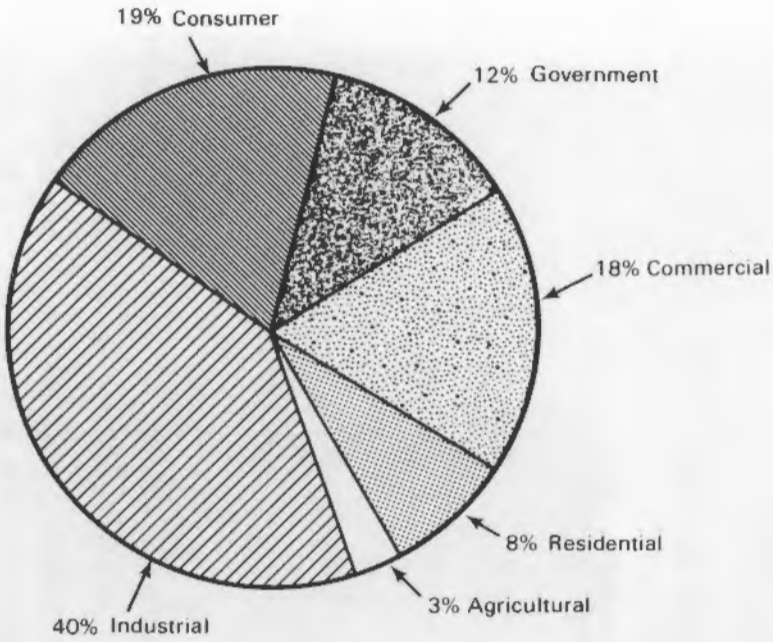
The time series break-down of PV shipments by customer market sector is presented in Table 4.1 All customers sectors have grown in absolute terms since 1981 with the most dramatic increase in PV usage by industrial customers. Growth in the industrial sector has been driven by both the attractiveness of PV in utility applications and third party arrangements. The relative importance of this market sector has increased from 4% of world sales in 1981 to 40% in 1983 (Figure 4.1). Purchases of PV by the industrial sector declined by 2.7 MW during 1984 due to questions as to the legality of some third party arrangements. Consequently, the industrial sector's market share declined to 21% in 1984 and is expected to decline further in 1985.

Use of PV by the commercial sector grew by 71% during 1984 and represents the largest growth of any customer sector. This growth is primarily due to the increased use of distributors and systems houses by PV manufacturers. Although this shift makes it much more difficult to identify the ultimate customer, it does indicate that the PV industry infrastructure is growing, and that PV manufacturers are relying more heavily on these firms to market and to sell their products.

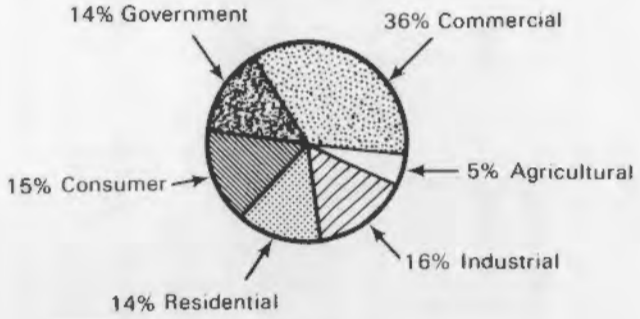
The consumer sector increased by 56% during 1984 spurred by the expanded use of PV in radios, watches and calculators manufactured by the Japanese. The share of PV shipped to the consumer market sector increased from 19% of the total market in 1983 to 27% of the market in 1984. This sector is expected to continue to grow for the next few years (in terms of MW shipped as well as market share) as new, low power uses for PV are developed, and as the Japanese continue to expand their production base.



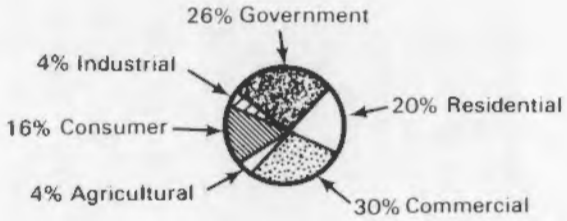
1984



1983



1982



1981

Figure 4.1 Customer Market Sectors

TABLE 4.1. Shipments to Customer Market Sectors

	1981	1982	1983	1984
	(MW/year)			
Residential	1.0	1.0	1.8	2.1
Commercial	1.4	2.7	3.8	6.5
Agricultural	.2	.4	.7	.6
Industrial	.2	1.2	8.7	5.0
Government	1.2	1.0	2.5	2.7
Consumer	.8	1.2	4.0	6.3
TOTAL	4.8	7.5	21.5	23.2

4.2 END-USE MARKET SECTORS

The time series breakdown of market sectors by end-use is presented in Table 4.2. Again, all sectors show a significant increase in MW of PV shipped between 1981 and 1984, with the most dramatic increase occuring in the central station sector. The relative importance of this end-use sector, as illustrated by its share of the total market, has increased from 0% in 1981 to 25% in 1984 (Figure 4.2). However, the shipments of PV to this sector actually declined during 1984 due to questions as to the legality of third party arrangements.

Stand-alone applications continued to be the largest end-use market in 1984 accounting for 46% of all PV modules shipped during the year. It is expected that stand-alone applications will predominate for several more years since PV has a distinct cost advantage over conventional energy sources in many of these applications.

Specialty markets increased their share of the end-use market from 1983 to 1984 growing from 19% to 27%. This growth was primarily due to the increase use of PV in consumer products such as watches and calculators. The specialty end-use sector will continue to grow as the existing markets for PV-powered products expands and as new, low power applications for PV are discovered.

The grid-connected sectors did not grow during 1984. For various reasons, tax credits do not tend to encourage the construction of small PV applications. The transaction costs involved in purchasing a PV system represent more of a hinderance and reduce the attractiveness for small residences. It is not anticipated that this end-use sector will grow in the next few years.

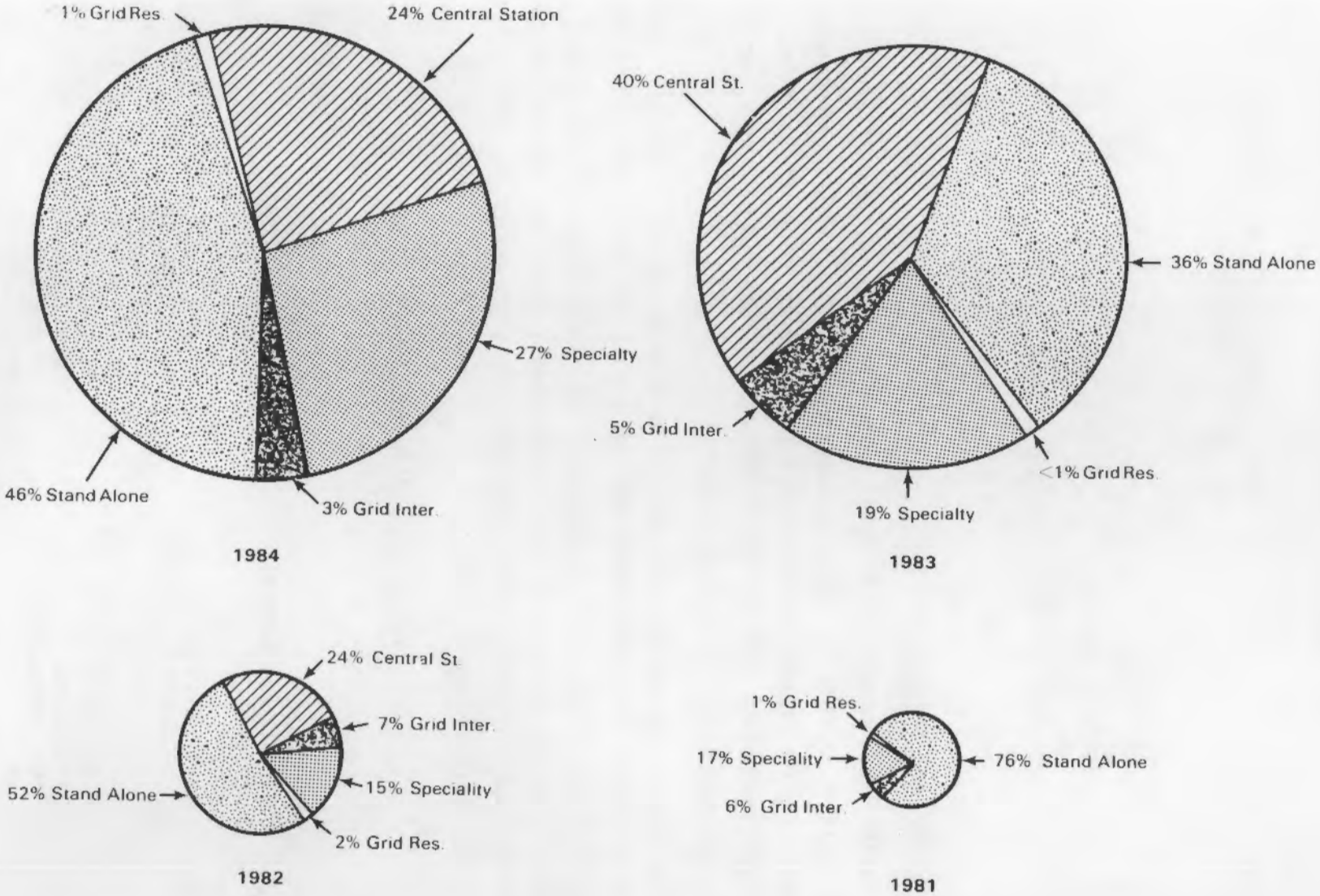


Figure 4.2 End-Use Market Sectors

TABLE 4.2. Shipments to End-Use Market Sectors

	1981	1982	1983	1984
	(MW/year)			
Specialty	.8	1.2	4.1	6.2
Stand-Alone	3.6	3.9	7.7	10.7
Grid Residential	.1	.1	<.1	<.1
Grid Intermediate	.3	.5	1.0	.6
Central Station	.0	1.8	8.7	5.7
TOTAL	4.8	7.5	21.5	23.2

4.3 TECHNOLOGY SHARE

During 1984, commercial PV cells were made by using five different technologies: single crystalline silicon, amorphous silicon, Semix, concentrators, and ribbon. Single crystalline silicon (Cz) continues to be the technology leader, although technology competition increased in 1984 reducing its market share from 49% in 1983 to 44% in 1984 (Figure 4.3).

The loss of market share by Cz can be attributed to its failure to achieve the significant cost reductions that it had in the past, and to the technical progress made in the A-Si technology. Cz could have lost additional market share in 1984 if it were not for its relatively higher efficiency and resulting lower balance of systems costs. Table 4.3 lists the major PV manufacturers who used the Cz technology in 1984.

TABLE 4.3. PV Manufacturers Using Cz Technology in 1984

Ansaldo
ARCO Solar
Baharat Heavy Electric
Belgosolar
BP Solar
Central Electronics
Continental Development
Energia Tideland S.A.
Free Energy Systems
Gem Manufacturing
Heliodynamica
Helios Technology
Hoxan
Isophoton
Kodenshi
Komatsu Electronics Technology
Nippon Electric
Photowatt S.A.
Pragma
Sharp Company
Siemens A.G.
Silicon Sensors
Solar Generators
Solar Power Corp.
Solavolt International
Solec International
Solenergy
Spire Corporation
Tideland Signal
Tideland Signal Ltd.
UEC

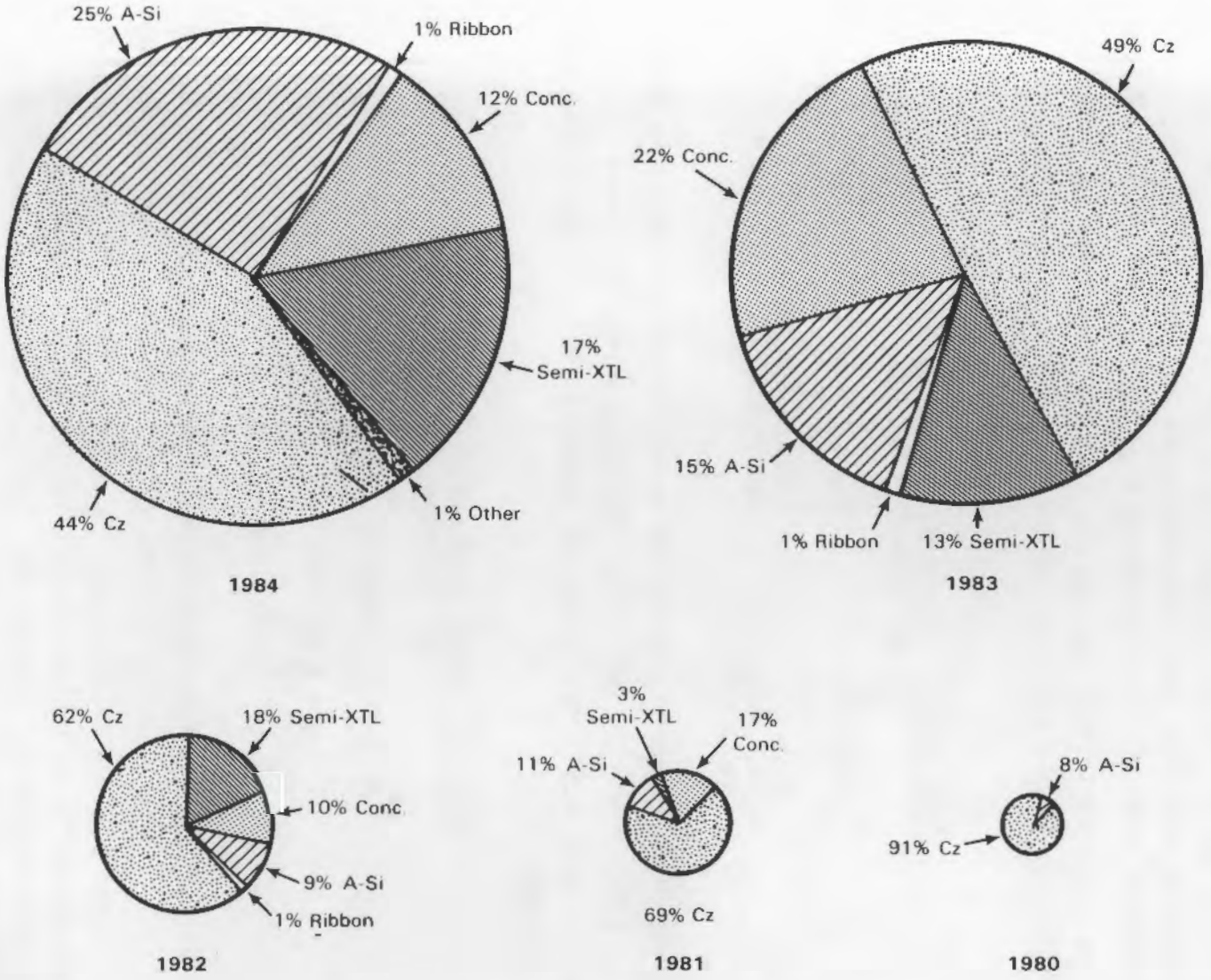


Figure 4.3 Technology Share (%MW)

The PV industry is continuing to learn more about the A-Si technology and consequently is solving many of its technical problems. As the technology improves, more low-power uses for A-Si are being discovered. During 1984 the first A-Si power module (5 watts) was introduced by ARCO Solar, and the Japanese continued to find new, low-power uses for the technology. As a result, the market share for A-Si increased from 15% in 1983 to 25% in 1984. This trend is expected to continue as the technology improves and additional uses are discovered. Table 4.4 lists the major PV manufacturers who used A-Si in 1984.

TABLE 4.4. PV Companies Developing A-Si Technology in 1984

ARCO Solar	Sanyo Electric
Chronar	Sharp
ECD	Taiyo Yuden
Fuji Electric	Tenjin Ltd.
Kyoto Ceramic	

Semix Crystalline technology market share has increased from 3% in 1981 to about 17% in 1984, primarily due to an increased number of Semix licensees world wide. Table 4.5 lists major PV manufacturers who used the Semix technology in 1984.

TABLE 4.5. Major PV Manufacturers Using Semix Technology in 1984

Adriatica Componeti	Holec Solar Energy
AEG Telefunken	Hoxan Company
Energie Nouvelle	Komatsu Electronics
France Photon	Kyoto Ceramic
Hitachi Electric Co.	Solarex Corporation

Concentrator market share has also increased dramatically, from 17% in 1981 to 22% in 1983. United Energy Corporation's third-party financed sales of their solar thermal/PV system represent the primary factor in this increase. In 1984 concentrator's market share fell to 13% due to questions as to the legality of some third party arrangements. Table 4.6 lists the major PV manufacturers who used concentractors in 1984.

TABLE 4.6. Major PV Manufacturers Using Concentrator Technology in 1984

Entech
Intersol
United Energy Corporation

Ribbon technologies have not captured a significant share of the market in 1984, since each company, Mobile, Solavolt and Westinghouse, is in the process development stage.

APPENDIX A

1984 PV CURRENT EVENTS

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 1 PVIR 3/84,1 PELLWORM ISL
03/01/84 AEG
THE 300 KWP INSTALLATION WAS COMPLETED LAST SUMMER AND WILL P ROVIDE OPERATING DATA ON A UTILITY SCALE PV INSTALLATION. TH ERE ARE 17,586 PV MODULES IN 22 SUBGROUPS.

RECORD # 75 PVIR 4/84,3
04/01/84 AEG
RECEIVED AN ORDER FROM EGYPT TO SUPPLY 400 PV POWERED NAVIGAT IONAL AIDS FOR USE IN THE SUEZ CANAL.

RECORD # 82 PV NEWS 4/84,6
04/01/84 AEG
HAS COMPLETED THEIR MULTI MW PRODUCTION FACILITY AT WEDEL. TH EY PRODUCED 900 KW IN 1983. NOW HAVE US SALES OFFICE (201) 72 2-9800, MIKE MONROE.

RECORD # 322 PV INTERN'L 10/84,1
10-01-84 AEG TELEFUNKEN WEST GERMANY
PELLWORM ISLAND PV STATION IS NOW OPERATIONAL . THE 300 KW SY STEM IS SUPPLYING POWER TO A THERAPEUTIC CENTER ON THE ISLAND . SPONSORED BY THE EEC.

RECORD # 189 SEIR 6/84,196
06/18/84 AIRTRICITY TEHACHAPI CA
PV/WIND FARM DEVELOPER CLOSED A DEAL WITH HOLEC TO ACQUIRE TH E RIGHTS TO TWO TURBINES. THEY ARE DEVELOPING A FARM USING 50 KW OF HOLECSOL'S 40 W POLY MODULES.

RECORD # 190 SEIR 6/84,196
06/18/84 APPLIED SOLAR ENERGY CITY OF INDUSTRY CA
WILL BE SUPPLYING CELLS FOR THE MILSTAR SATELLITE UNDER CONTR ACT TO LOCKHEED. SINCE 1982 THEY HAVE BEEN DEVELOPING GA AS CELLS FOR THE GOVERNMENT.

RECORD # 211 PVIR 8/84,5
08/01/84 APPLIED SOLAR ENERGY CITY OF INDUSTRY, CA
HAS BEEN SELECTED AS A MILSTAR PROJECT SUBCONTRACTOR FOR THEI R LARGE AREA WRAP ARDUND CELLS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 16 PVIR 2/84,1
02/01/84 ARCO SOLAR
HAS COMPLETED ITS FIRST 2 MW SEGMENT OF THE CARRISA PLAINS IN STALLATION. POWER WILL BE PURCHASED BY PG&E.

RECORD # 57 PV NEWS 3/84,2
03/01/84 ARCO SOLAR
IN 1984 WILL INCREASE MDO. PRICES TO DISTRIBUTORS BY $0.25/WP . WILL INTRODUCE 2 NEW MODULES: M82 A 7 WATT BATTERY CHARGER, M85 A FOLDABLE 10.8 WATT ARRAY FOR 12 OR 24 VOLT BATTERIES.

RECORD # 58 PV NEWS 3/84,2
D3/01/84 ARCO SOLAR
IN 1984 ARCO WILL MAINTAIN FACTORY OUTPUT AT 5-7 MW--WILL SHI P 1 MW TO SMUDI, .3-.6 MW TO SMUD II, AND 2 MW TO CARISSA PLA INS.

RECORD # 72 PVIR 4/84,5
04/01/84 ARCO SOLAR
INTRODUCING THEIR M53 MODULE. MADE OF SINGLE CRYSTAL SI RATED AT 43 WP AND 11.5% EFFICIENT.

RECORD # 87 PVIN 4/84,3
04/01/84 ARCO SOLAR
PVIN SPECULATES THAT ARCO IS DE-EMPHASIZING A-SI AND RELYING MORE ON FIRST GENERATION TECHNOLOGY. ARCO MAY INTRODUCE A-SI THIS SUMMER WITH FULL PRODUCTION IN 1986.

RECORD # 107 PVIN 5/84,2 CARISSA PLNS
05/01/84 ARCO SOLAR CARISSA PLAINS CA
THEIR 5 MW PLANT IS NOW GENERATING ELECTRICITY FDR PG&E. WILL INSTALL 2 MORE MW BY 12/84.

RECORD # 132 PV INTER 5/84,34
05/01/84 ARCO SOLAR
INTRODUCING THE M85 FOLD-DUT MODULE FOR CHARGING EITHER 12 OR 24 VOLT BATTERIES. THE MODULE CAN BE USED FOR REMOTE METERIN G OR TELECOMM APPLICATIONS.

1984 PV EVENTS

RECORD # 133 PV INTER 5/84,34
05/01/84 ARCO SOLAR
INTRODUCING A LOW COST MODULE FOR CHARGING 12 VOLT BATTERIES ON BOATS OR RVS.

RECORD # 134 PV INTER 5/84,34
05/01/84 ARCO SOLAR
THEIR M53 MODULE IS MADE FROM SINGLE CRYSTAL SI USING SQUARE CELL CONFIGURATION. THE MODULE IS RATED AT 43 WATTS WITH AN EFFICIENCY OF 11.5%.

RECORD # 184 PV NEWS 7/84,2 WOODLAND
07/01/84 ARCO SOLAR WOODLAND HILLS CA
140 OUT OF 600 EMPLOYEES WERE LAYED OFF. MOST OF THESE EMPLOYEES WERE FROM NON RESEARCH BRANCHES OF ARCO SOLAR.

RECORD # 191 SEIR 6/84,207
06/25/84 ARCO SOLAR
OPERATIONS OF THE COMPANY HAVE BECOME PART OF THE PARENT COMPANY AND THAT THIS REORGANIZATION RESULTED IN THE SURPLUS OF SOME EMPLOYEES.

RECORD # 227 SOLAR AGE 9/84,16
09/01/84 ARCO SOLAR CALIFORNIA
HAS LAID OFF 140 EMPLOYEES, BUT THE LAY-OFFS WILL NOT AFFECT THEIR R&D ON A-SI OR OTHER PV SYSTEMS. THE MAJORITY OF THE PERSONEL WERE ACCOUNTANTS AND PLANNERS.

RECORD # 232 ARCO NEWS 6/84,8
06/01/84 ARCO SOLAR CALIFORNIA
CARISA PLAINS FIRST PHASE HAS A 6.5 MWP CAPACITY. THIS SYSTEM PRODUCES ENOUGH ELECTRICITY FOR 2300 HOMES. THE SYSTEM WILL EVENTUALLY BE 16 MW.

RECORD # 233 ARCO NEWS 6/84,11
06/01/84 ARCO SOLAR CALIFORNIA
HAS REDESIGNED ITS ASI16-2000 MODULE USING SQUARE CELLS. THE NEW MODULE IS CALLED THE M73 AND IS RATED AT 40 WATTS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 249 PVIR 10/84,1
10/01/84 ARCO SOLAR
WILL SOON INTRODUCE THEIR A-SI PRODUCT LINE.

RECORD # 287 SEIR 10/84,339 CARISSA
10/29/84 ARCO SOLAR
ARCO IS PLANNING TO FINANCE ANOTHER 750 KW TO ITS CARISSA PLA INS INSTALLATION. THE ADDITION WILL NOT HAVE THE ENHANCERS.

RECORD # 288 SEIR 10/84,339 CARISSA
10/29/84 ARCO SOLAR
ARCO IS NOW OFFERING A 10 YEAR LIMITED WARRENTY ON ITS M53 AN O M73 MODULES. WARRENTY STATES THAT OUTPUT WILL REMAIN WITHIN 10% OF RATING FOR 10 YEARS.

RECORD # 312 PVNEWS 11/84,3 WOODLAND
11-01-84 ARCO SOLAR
FABRICATED AN A-SI SUBMODULE THAT HAS A CONVERSION EFFICIENCY OF 9%.

RECORD # 323 PV INTERN'L 10/84,1
10-01-84 ARCO SOLAR
INTRODUCES THEIR NEW MODULES, M73 RATED AT 40 WATTS, AND THE M63 RATED AT 30 WATTS. BOTH FEATURE ARCO'S 4" SQUARE CELLS.

RECORD # 325 PV NEWS 12/84,2
12-01-84 ARCO SOLAR
WILL BE THE FIRST TO ENTER THE PV MARKET WITH AN A-SI MODULE. THE GENESIS MODULE IS RATED AT 5 WATTS AND COMES WITH A FIVE YEAR WARRENTEE.

RECORD # 336 PVIR 12/84,1
12-01-84 ARCO SOLAR
INTRODUCED ITS 5 W A-SI MODULE. THE MODULE HAS AN EFFICIENCY OF 9%.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 373 PVINTER. 12/84,27
12-01-84 ARCO SOLAR
HAS BEGUN TO MARKET ITS 5 WATT A-SI MODULE CALLED THE GENESIS . THE MODULE HAS A 1 YEAR LIMITED WARRNETY AND IS AVAILABLE THROUGH ARCO DISTRIBUTORS.

RECORD # 245 PVIR 10/84,1
10/01/84 ASEC
DEVELOPEO CELLS THAT HAVE OVER 20% EFFCIENCY AT OVER 200 SUNS .

RECORD # 372 PVINTER. 12/84,12
12-01-84 ATLANTIC SOLAR POWER
HAS SUPPLIED THE PV MODULES SYSTEM SIZING AND DESIGN FOR A 4. 2 KWP SYSTEM IN GLOUCESTER, MA. THE SYSTEM COMPLIMENTS A 10 KW WIND SYSTEM WITH EXCESS POWER BEING SOLD TO MASS ELEC. CO.

RECORD # 216 SEIR 7/84,245
07/30/84 AUDUBON SOCIETY
CALLS FOR HALT TO ALL SOLAR TAX CREDITS.

RECORD # 204 PV NEWS 8/84,2 AUSTIN TX
08/01/84 AUSTIN CITY AUSTIN TX
ISSUE RFP FOR 300 KW CENTRAL STATION PV.

RECORD # 251 PVIR 10/84,2
10/01/84 AUSTIN UTILITY
WILL ISSUE RFP'S FOR 2 TO 6 20 KW PV SYSTEMS. THIS IS IN ADDI TION TO THEIR 300 KW PV SYSTEM. NEW PV SYSTEMS WILL GO ON CI TY-OWNED BUILDINGS.

RECORD # 239 PVIR 9/84,1
09/01/84 BOBIER ELECTRONICS PARKERSBURG, WV
IS OFFERING INTEREST FREE LOANS FOR ONE YEAR TO PEOPLE WHO WA NT TO PURCHASE PV EQUIPMENT. HE CLAIMS THAT HE DOES NOT RECAP TURE INTEREST BY INFLATING THE PRICES.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 28 WSM 2/84,9
02/01/84 BOEING
RECEIVED $490,000 FROM SERI TO INCREASE THE EFFICIENCY OF THE IR CU IN SE2 CELL FROM 11% TO 12%.

RECORD # 62 PV NEWS 3/84,7
03/01/84 BOSS
AWARDED $55,000 TO SUPPLY COMPLETE ELECTRONIC BOS EQUIPMENT FOR A 54 KW PV SYSTEM IN TANZANIA AFRICA.

RECORD # 97 PV INTER 3/84,15
03/01/84 BOSS
AWARDED $55,000 CONTRACT FOR 150 BATTERY CHARGE CONTROLLERS FOR USE BY TANZANIA POST AND COMM. CORP.

RECORD # 138 SOLAR ENG. 5/84,24 SCOTTSDALE
05/01/84 BOSS SCOTTSDALE AZ
AWARDED A $55,000 CONTRACT TO SUPPLY BOS FOR TANZANIA AFRICA PV INSTALLATION. USES ARCO 16-2000 MODULES.

RECORD # 280 PV INTERN'L 09/84
09/01/84 BOSS
ANNOUNCED ESTABLISHMENT OF INTERNATIONAL JOINT VENTURE AGREEMENT WITH SPK ENGINEERING LTD.

RECORD # 374 PVINTER. 12/84,27
12-01-84 BOSS LIGHTS
INTRODUCED TWO NEW PV LIGHT SYSTEMS : THE LUMASTAR FOR OUTSIDE LIGHTING NEEDS, AND THE HPS MICRO-WATT FLOOOLIGHT PACKAGE.

RECORD # 117 PVIR 5/84,1 G.BRITAIN
05/01/84 BP SOLAR GREAT BRITAIN
HAS ACQUIRED MONOSOLAR FROM NORTEK. MONOSOLAR HAS BEEN WORKING ON CO SU THIN FILM TECHNOLOGY.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 193 PV INT'L7/84,20
06/01/84 BP SOLAR
BP HAS ACQUIRED THE THIN FILM DIVISION OF MONOSOLAR.

RECORD # 292 SOLAR AGE 11/84,11
11/01/84 BP SOLAR
NOW HAS A PV POWERED MEDICAL REFRIGERATOR. THE 1 CU.FT REFRIG ERATOR WILL PROVIDE COOLING TO 36 DEG F AND HAS 5 DAYS STORAG E.

RECORD # 298 WSM 10/84,10 ENGLAND
10/01/84 BP SOLAR ENGLAND
HAS ACQUIRED THE TECHNOLOGY DEVELOPED BY MONOSOLAR TO MANUFAC TURE MERCURY, CADMIUM, TELLURIUM THIN FILM CELLS.

RECORD # 122 PV INTER 5/84,15
05/01/84 C&D POWER SYSTEMS
C&D BATTERIES HAS CHANGED ITS NAME TO C&D POWER SYSTEMS. THE NEW NAME BETTER REFLECTS THE EXTENSIVE PRODUCT LINE CARRIED B Y THE COMPANY.

RECORD # 304 PVIR 11/84,1
11-01-84 CHERRY ELECTRIC WAUKEGA, IL
HAS ACQUIRED PHOTON POWER OF EL PASO TX.

RECORD # 367 PVINTER. 12/84,11
12-01-84 CHERRY ELECTRIC PRODUCTS WAUKEGAN, IL
HAS ACQUIRED PHOTON POWER.

RECORD # 2 PVIR 3/84,5
03/01/84 CHRONAR
WILL RECEIVE $4.5 MILLION FROM DELIVERY OF PV MANUFACTURING E QUIPMENT TO PORT JERVIS NY, $1.0 MILLION FROM AFG INDUSTRIES, AND $2.6 MILLION FROM OF PV PRODUCTION EQUIPMENT.

DATE LISTED 03-08-85

1984 PV EVENTS

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:  RECORD #     11    PVIN 2/84,4                                        :
:  02/01/84      CHRONAR                                                 :
:  HAS SIGNED A JOINT VENTURE AGREEMENT WITH PAKISTAN GOVERNMENT         :
:   TO BUILD A 1 MW PV MANUFACTURING FACILITY.                           :
:                                                                        :
:  RECORD #     31    SEIR 3/84,79                                       :
:  03/05/84      CHRONAR                          PRINCTON NJ           :
:  WILL OFFER 12,000 UNITS OF STOCK FOR $1,000 PER UNIT TO OBTAI         :
:  N FUNDING FOR THEIR AUTOMATED FLOW LINE PROCESS.                      :
:                                                                        :
:  RECORD #     46    SEIR 4/84,108                                      :
:  04/02/84      CHRONAR                                                 :
:  REACH AN AGREEMENT WITH ALABAMA POWER CO TO BUILD A 1 MW CELL         :
:   FACTORY IN ALABAMA. THE $7.2 MILLION FACTORY WILL BE IN OPER         :
:  ATION IN 1985.                                                        :
:  RECORD #     90    RENEW 4/84,3                                       :
:  04/01/84      CHRONAR                          PRINCTON NJ           :
:  FORMED A JOINT VENTURE WITH ALABAMA POWER COMPANY TO BUILD A          :
:  $7.2 MILLION, 1 MW A-SI CELL MANUFACTURING PLANT. THE PLANT W         :
:  ILL BEGIN OPERATION IN JANUARY OF 1985.                               :
:  RECORD #    118    PVIR 5/84,1                 PRINCETON NJ          :
:  05/01/84      CHRONAR                          PRINCETON, NJ         :
:  WILL ESTABLISH A SUBSIDIARY CALLED CHRONAR FRANCE TO MANUFACT         :
:  URE AND MARKET PV IN EUROPE AND AFRICA. THE PLANT WILL BEGIN          :
:  WITH 1 MW AND EXPAND TO 8 MW OVER 5 YEARS.                            :
:  RECORD #    124    PV INTER 5/84,17            PRINCETON             :
:  05/01/84      CHRONAR                          PRINCETON NJ          :
:  HAD THIRD QUARTER 1983 REVENUES OF $1.2 MILLION UP FROM $.1 M         :
:  ILLION ONE YEAR AGO.                                                  :
:                                                                        :
:  RECORD #    128    PV INTER 5/84,20            BIRMINGHAM            :
:  05/01/84      CHRONAR                                                 :
:  ANNOUNCED THE SIGNING OF AN AGREEMENT WITH ALABAMA POWER TO E         :
:  NTER A JOINT VENTURE TO CONSTRUCT A PV PRODUCTION PLANT. THE          :
:  UTILITY WILL BE ABLE TO BUY PV MODS AT 85% OF SELLING PRICE.          :
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DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 139 SOLAR ENG. 5/84,24
05/01/84 CHRONAR PRINCETON NJ
AGREEMENT WITH ALABAMA POWER TO BUILD A 1 MW PRODUCTION FACIL ITY THAT WILL BE OPERATIONAL BY 1985.

RECORD # 142 SEIR 4/84,125 PRINCETON
04/16/84 CHRONAR PRINCETON NJ
HAVE SIGNED A LETTER OF INTENT TO BUILD AN AMORPHOUS PV PLANT IN FRANCE. MODULES PROOUCED HERE WILL BE SOLO IN FRANCE AND IN AFRICA.

RECORD # 146 PV NEWS 5/84,3 PRINCETON NJ
05/01/84 CHRONAR PRINCETON NJ
AN EX SOLAREX EMPLOYEE IS NOW A VP WITH CHRONAR. RON STRATHMA N ALSO JOINS CHRONAR FROM WESTERN REFRIGERATION.

RECORD # 181 SEIR 7/84,212 SOUTH WALES
07/02/84 CHRONAR SOUTH WALES
IS MAKING SHIPMENTS OF PV MANUFACTURING EQUIPMENT TO ITS PROD UCTION FACILITIES IN SOUTH WALES. THE FACILITY WILL BE OPERAT IONAL IN 1985.

RECORO # 213 PVIR 8/84,3
08/01/84 CHRONAR
CHRONAR HAS ANNOUNCED A VERY AGRESSIVE PLANT DEVELOPMENT PROG RAM WITH NINE PV PLANTS UNOER CONSTRUCTION. THE TOTAL PRODUCT ION CAPACITY FOR THESE PLANTS WILL BE 10 MW/YR.

RECORD # 219 SEIR 8/84,260
08/13/84 CHRONAR
RECEIVED $40,000 FROM THE NSF TO STUDY ULTRA HIGH PURITY SI A ND GERMANIUM HYDRIDE .

RECORD # 229 SOLAR AGE 6/84,85
06/01/84 CHRONAR PRINCTON NJ
HAS A $7.2 MILLION VENTURE WITH ALABAMA AND A $10 MILLION VEN TURE WITH FRANCE.

1984 PV EVENTS

RECORD # 258 PVNEWS 10/84,1
10/01/84 CHRONAR PRINCETON NJ
PROVIDED SERI WITH A 6.1% EFFICIENT A-SI MODIULE UNDER THEIR CONTRACT.

RECORD # 275 SEIR 10/84,325
10/15/84 CHRONAR PRINCETON, NJ
VIOLATED SECURITIES ACT IN PREPARING THEIR 1983 FINANCIAL STATEMENT. UNDER QUESTION IS THE WAY INWHICH THEY RECOGNIZED REVENUE FROM CONTRACTS TO FURNISH 2 PRODUCTION FACILITIES.

RECORD # 281 PV INTERN'L 09/84
D9/01/845 CHRONAR PRINCETON, NJ
SHIPPED MANUFACTURING EOUIPMENT TO ITS BRITISH SUBSIDIARY, CHRONAR LTD. PRODUCTION OPF A-SI AT THE 1 MW FACILITY WILL BEG IN IN 1985.

RECORD # 318 PV INTERN'L 10/84,1 ENGLAND
10-01-84 CHRONAR PRINCETON, NJ
SENDING PV MANUFACTURING EQUIPMENT TO ITS NEW BRITISH SUBSIDIARY. THE 1 MW PLANT WILL BE COMPLETED IN EARLY 1985 AND WILL SELL TO EUROPE, GREAT BRITAIN, AND AFRICA.

RECORO # 346 SOLAR AGE 12/84,35
12-01-84 CHRONAR
TRISOLAR CORP.IS IN THE PROCESS OF BEING ACQUIRED BY CHRONAR CORP.

RECORD # 371 PVINTER. 12/84,12
12-01-84 CHRONAR
HAS ACQUIRED TRISOLAR INC. FOR APPROXIMATELY $150,000.

RECORD # 274 SOLAR AGE 10/84,39
10/01/84 CHRONAR CORP.
RECEIVED A $40,000 GRANT FROM THE NSF TO STUDY ULTRA HIGH PURITY SILICON AND GERMANIUM HYDRIDE FEEDSTOCK.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 289 SEIR 10/84,339 PRINCETON,NJ
10/29/84 CHRONAR CORP. PRINCETON, NJ
HAS ANNOUNCED AN AGREEMENT TO ACQUIRE TRISOLAR CORP. THE COM PANY WILL BE RENAMED TO CHRONAR TRISOLARCORP. THEY WILL CONTI NUE TO MARKET PV PUMPING SYSTEMS.

RECORD # 296 SOLAR AGE 10/84,11 PRINCETON,NJ
10/01/84 CHRONAR CORP. PRINCETON, NJ
HAS BEEN AWARDED $40,066 BY NSF TO SPEED DEVELOPMENT OF ULTRA HIGH PURITY SI AND GERMANIUM HYDRIDE FEEDSTOCK GASES FOR ELEC TRONICS MATERIALS.

RECORD # 307 PVIR 11/84,1 PRINCETON NJ
11-01-84 CHRONAR CORP. PRINCETON, NJ
SUIT FILED BY THE SEC WILL NOT HAVE AN EFFECT ON THEIR PLANS TO BUILD 9 PV PRODUCTION FACILITIES. WILL HAVE 1 MW PLANT OPE RATING BY THE END OF THE YEAR.

RECORD # 320 PV INTERN'L 10/84,1
10-01-84 CHRONAR CORP. PRINCETON, NJ
DELAYED FILING ITS MOST RECENT 10 K BECAUSE OF INQUIRY BY SEC INTO ITS ACCOUNTING PRACTICES.

RECORD # 340 PVIR 12/84,1
12-01-84 CHRONAR CORP. PORT JERVIS NY
OPENING ITS PV PRODUCTION FACILITY DEC. 3 1984. THE PLANT WIL L BE CAPABLE OF PRODUCING 1 MW OF PV. THE PLANT WILL COST $6 MILLION.

RECORD # 355 SEIR 12/84,382 PORT JERVIS
12-01-84 CHRONAR CORP. PORT JERVIS, NY
OPENED ITS $ 6MILLION MANUFACTURING FACILITY. THE THREE SHIFT FACILITY IS DESIGNED TO PRODUCE 1 MW A-SI.

RECORD # 196 PV INT'L7/84,20
06/01/84 CHRONAR FRANCE
WILL ESTABLISH A SUBSIDIARY CALLED CHRONAR FRANCE TO MANUFACT URE AND TO MARKET PV MODULES.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 222 SEIR 8/84,256
08/06/84 CITY OF AUSTIN AUSTIN TX
PLANNING TO SEND OUT A PROPOSAL ON A 300 KW CENTRAL STATION P V SYSTEM. THEIR MAIN SOURCE OF POWER IS COAL AND THE CITY IS GROWING RAPIOLY. THEY NEED TO RETIRE SOME PLANTS SOON.

RECORD # 330 PV NEWS 12/84,3 AUSTIN,TX
12-01-84 CITY OF AUSTIN AUSTIN, TX
5 COMPANIES ARE NOW BIDDERS FOR THE 300 KW SYSTEM THEY PLAN T O INSTALL. COMPANIES INCLUDE ACUREX, BDM, FLUOR, HUGHES, AND STONE AND WEBSTER.

RECORD # 170
06/01/84 COLOMBIAN GOVERNMENT
THE GOVERNMENT WILL OFFER LOW INTEREST LOANS TO ALLOW FARMERS TO INSTALL PV SYSTEMS IN THEIR HOMES.

RECORD # 119 PVIR 5/84,5 GREENSBORO
05/01/84 COPLEY ENERGY ALEXANDRIA VA
15.7 KW SYSTEM HAS BEEN OPERATING SUCCESSFULLY FOR THE PAST Y EAR. THE SYSTEM HAS BEEN PROVIOING ELECTRICITY USING SOLAREX PANELS.

RECORD # 183 SEIR 7/84,
07/18/84 OEMOCRATIC PARTY WASHINGTON, DC
WILL SUPPORT RESEARCH ON RENEWABLE ENERGY FORMS AS STATED IN THEIR DRAFT PLATFORM.

RECORD # 224 SEIR 8/84,276
08/27/84 OEPARTMENT OF ENERGY WASHINGTON DC
IS PREPARING A BROCHURE ON PV FOR INTERNATIONAL DISTRIBUTION. THE COVER LETTER IS SIGNED 8Y HODEL.

RECORD # 198 PV INT'L7/84,20
06/01/84 DINH COMPANY
DEVELOPED A HEAT PUMP THAT RUNS OFF OF DC POWER. THE 1 TON UN IT RECEIVES POWER FROM 8 40 WATT PV MODULES.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 12 SEIR 2/84,42 WASH DC
02/06/84 DOE WASHINGTON D.C.
IS ASKING FOR $164 MILLION FOR THE 1985 SOLAR BUDGET. PV BUDG ET WOULD FALL FROM $58 M IN 1983 TO $50 M IN 1984, AND TO $47 M IN 1985. SERI'S BUDGET FOR PV WOULD INCREASE.

RECORD # 231 SOLAR AGE 6/84,97
06/01/84 DONCO OF LACROSSE INC. LACROSSE WI
OFFERS A PV POWERED HEAVY OUTY GATE SYSTEM. THE UNIT USES SOL AREX SX-20 MODULES.

RECORD # 169 WORLD SOLAR MARKET
06/01/84 DOW CHEMICAL BARODA CITY, INDIA
SIGNING AGREEMENT TO BUILD POLYCRYSTALLINE PLANT IN INDIA. WI LL BUILD A 200 T/YEAR PLANT OF POLY.

RECORD # 20 PVIR 2/84,6
02/01/84 ECD
RECEIVED $15 MILLION FROM THE SALE OF 400,000 SHARES OF COMMO N STOCK.

RECORD # 40 PVIN 4/84,5
04/09/84 ECD
RECEIVED $15 MILLION FROM THE SALE OF 400,000 SHARES OF COMMO N STOCK. THIS BRINGS ECD'S TOTAL CASH TO $30 MILLION.

RECORD # 110 PVIN 5/84,3
05/01/84 ECD
CONSTRUCTING A PV PILOT PRODUCTION PLANT THAT WILL PRODUCE 1/ 2 TO 1 MW . COMMERCIAL SIZED PLANT WILL NOT BE OPERATIONAL U NTIL 1986.

RECORD # 147 PV NEWS 5/84,3
05/01/84 ECD
INTRODUCED THEIR PV BEACH BLANKET THATS A A-SI POWER PACK FOR A TRANSISTOR RADIO.

1984 PV EVENTS

RECORD # 277 SEIR 10/84,315
10/08/84 ECD
ECD IS ON SCHEDULE TO HAVE FIRST A-SI PROOUCTION READY IN 4TH QUARTER OF 1984.

RECORD # 339 PVIR 12/84,1
12-01-84 ECD
INTRODUCEO A THINNER, LOWER COST SUBSTRATE FOR ITS A-SI CELLS .

RECORO # 26 WSM 2/84,9
02/01/84 ECO SOHIO
SOVONICS WILL BUILD 2 PV PRODUCTION FACILITIES- MICHGAN FOR C ELL PROO, ANO OHIO FOR MODULE PROD.. PLANTS WILL COST $6 MILL ION AND WILL USE ROLL-TO-ROLL TECHNIOUE.

RECORD # 80 PV NEWS 4/84,4
04/01/84 ENERGY MATERIALS
WILL SPEND ABOUT $1 MILLION ON THEIR HORIZONTAL EDGE-DEFINED GROWTH PROCESS IN 1984.

RECORD # 199 SOLAR AGE 7/84,6
07/01/84 ENERGY SCIENCE COMPANY
IS SELLING PV MOOULES AT $5 PER WATT.

RECORD # 234 WSM 8/84,7
08/01/84 ENERTECH COLOMBIA
IS OFFERING FARMERS A SIMPLE PV ELECTRIC FENCE SYSTEM THAT CA N ALSO SUPPLY RESIOENTIAL POWER. THE SYSTEM CONSISTS OF 2 OR MORE PV PANELS, REGULATOR AND BATTERY.

RECORD # 13 PVNEWS 1/84,8-9 OALLAS, TX
01/01/84 ENTECH OALLAS, TX
HAS STARTED ITS NEW COMPANY AT DALLAS AIRPORT. THE COMPANY HA S 9 PARTIALLY COMPLETED CONTRACTS AND HAS SECURED $450,000 MO RE SINCE STARTING.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 43 SOLAR E&C 4/84,53
04/01/84 ENTECH DFW AIRPORT, TX
PURCHASED COMPANY FROM E-SYSTEMS OF DALLAS.

RECORD # 71 PVNEWS 4/84,2
04/01/84 ENTECH CHATTANOOGA, TN
IS BUILDING A 5 KW PROTOTYPE LINEAR FRESNEL LENS AIRCOOLED PV SYSTEM FOR THE TVA.

RECORD # 98 PV INTER 3/84,16
03/D1/84 ENTROPY LTD.
ANNOUNCED THE MERGER OF SOLENERGY AND ENTROPY LTD THROUGH AN EXCHANGE OF SECURITIES. NEW COMPANY WILL BE CALLED SOLENERGY CORP.

RECORD # 279 SEIR 10/84,319
10/08/84 EPRI PALD ALTO, CA
PLAN TO INCREASE RESEARCH OF PV WITH EMPHASIS ON CONCENTRATIN G PV, TANDOM A-SI AND RIBBONS. CONCENTRATORS HAVE THE MOST A PPEAL.

RECORD # 302 PVIR 11/84,1 PALO ALTO, C
11-01-84 EPRI PALO ALTO, CA
IS EXPANDING ITS R&D IN PV SINCE THEY FEEL THAT IT COULD BECO ME A MAJOR POWER PRODUCER. RESEARCH WILL BE CONDUCTED ON THIN FILMS AND CONCENTRATORS.

RECORD # 21 RENEWS 2/84,16
02/01/84 ERICSSON CO. STOCKHOLM, SWEDEN
DEVELOPED A HYBRID PV, DIESEL, WIND SYSTEM FOR POWERING THEIR TELECOMMUNICATIONS EQUIPMENT.

RECORD # 105 WORLD SOLAR 5/84,4 BELGIUM
05/01/84 EUROPEAN COMMISSION BELGIUM
STATES THAT PV CAPACITY COULD BE 200 GWP IN EUROPE IN 2025, R EPRESENTING 10% OF TOTAL ELECTRICITY PRODUCTION.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 150 SEIR 5/84,163 NEW YORK
05/21/84 EXXON NEW YORK, NY
MAY SOON FIND A BUYER FOR ITS DEFUNCT SOLAR POWER CORP. SOLA REX IS ALSO LOOKING AT THE POSSIBILITY OF ACQUIRING SPC.

RECORD # 176 SOLAR AGE 6/84,17
06/01/84 EXXON
IS SELLING OFF SPC INVENTORY AND EQUIPMENT AND CLOSING ITS DO ORS.

RECORD # 266 SEIR 09/84,302
D9/24/84 FLORIDA POWER & LIGHT
HAS DEOICATED ITS FIRST PV GENERATING SYSTEM IN DADE COUNTY. THE PROJECT IS BEING USED AS A PV LEARNING EXPERIENCE. THE 10 KW SYSTEM WILL POWER LIGHTS AND FEED POWER TO THE GRID.

RECORO # 114 SOLAR AGE 5/84,48 BLUFFTON
05/01/84 FRANKLIN ELECTRIC BLUFFTON, IN
DEVELOPED A SOLAR SUBMERSIBLE PUMP.

RECORD # 173 ALTER ENER. 6/84,7
06/01/84 FROST AND SULLIVAN
STATE THAT POLYSILICON FUTURE PRICE AND AVAILABILITY COULD LI MIT THE PROOUCTION OF PV. WACKER IS THE DOMINANT PRODUCER AND REMAINS UNCHALLENGED BY OTHERS.

RECORO # 210 PVIR 8/84,1 JAPAN
08/01/84 FUJI JAPAN
DEVELOPED A MASS PROOUCTIONTECHNIOUE TO PRDDUCE MULTIFORM A-S I CELLS TO FIT WATCHES. CAN PRODUCE THESE CELLS ON 30 MM2 SU BSTRATES.

RECORD # 36 PVIN 4/84,6
04/09/84 FUJI ELECTRIC
ANNOUNCED THAT THE INTERDIGITAL-VERTICAL-ELECTROOE METHOD COU LD INCREASE A-SI PRODUCTION 8Y FOUR TIMES. PROCESS USES THREE SEPARATE A-SI DEPOSITION CHAMBERS.

1984 PV EVENTS

RECORD # 92 WSM 4/84,7
04/01/84 FUJI ELECTRIC TOKYO JAPAN
HAS SIGNED A COOPERATIVE AGREEMENT TO SHARE ITS TECHNOLOGICAL DEVELOPMENTS WITH PHOTOWATT. FUJI IS DEVELOPING A-SI AND PHOTOWATT IS DEVELOPING RIBBON SI.

RECORD # 299 PVIR 11/84,1 JAPAN
11-01-84 FUJI ELECTRIC CO. JAPAN
HAS ATTAINED AN 11.1% CONVERSION EFFCIENCY FOR A-SI CELLS.

RECORD # 278 SEIR 10/84,317
10/08/84 GEORGETOWN UNIVERSITY
PV SYSTEM IS RATED AT 245 KW DC, AND 230 KW AC. SOLAREX PV MODULES ARE USED AS WELL AS GEMINI (WINOWORKS) INVERTER.

RECORD # 91 RENEW 4/84,5
04/01/84 HEBREW UNIVERSITY JERUSALEM
HAS DEVELDPED A METHOD FOR INCORPORATING FLUORESCENT DYES INTO GLASS OURING PROCESSING. PV CELLS ARE MOUNTED ON THE EDGES OF THE GLASS AND RECEIVE CONCENTRATED INSOLATION.

RECORD # 4 PVIR 3/84,5 IRVINE, CA
03/01/84 HELIONETICS
HAS ACQUIRED SOLAR INDUSTRIES, A SOLAR THERMAL MANUFACTURER IN HOPES OF BROADENING ITS ALTERNATIVE ENERGY CAPABILITIES.

RECORD # 85 PVIN 4/84,2
04/01/84 HELIONETICS
STOCK PRICES ARE WEAKENING OUE TO ACQUISITIONS AND THEIR 1983 ACCOUNTING PRACTICES. THEY HAVE BEEN DROPPED FRON THE PV STOCK INDEX SINCE THEIR NO LONGER PRIMARILY A PV COMPANY.

RECORD # 103 PV NEWS 3/83,5
03/01/84 HELIONETICS IRVINE, CA
HELIONETICS HAS WON THE LARGEST POWER CONDITIONING CONTRACT FOR A CENTRAL STATION PV SYSTEM. THEY WILL RECEIVE $2.7 MILLION FOR 7 MW OF EQUIPEMNT FOR USE IN CALIFORNIA.

DATE LISTED 03-08-85

1984 PV EVENTS

RECDRO # 163 PV NEWS 6/84,3 WASH DC
06/01/84 HOUSE APPROPRIATIONS WASHINGTON DC
APPROVED A $57 MILLION BUOGET FOR PV IN FY 1985, $6.6 MILLION ABOVE CURRENT FISCAL YEAR.

RECORD # 294 SOLAR AGE 10/84,11 SAPPORO
10/01/84 HOXAN SAPPORO, JAPAN
PLANS TO BUILO A 9 MW SINGLE CRYSTAL SI PRODUCTION FACILITY.

RECORO # 205 PV NEWS 8/84,3 JAPAN
08/01/84 HOXAN CORP JAPAN
BUILDING 9 MW PV PLANT TO BE COMPLETED IN MARCH 1985. WILL US E BOTH SINGLE SI AND POLY SI TECHNIQUES.

RECORD # 236 PVIR 9/84,1
09/01/84 HOXAN CORP TOKYO JAPAN
IS BUILOING A PLANT IN CHITOSE JAPAN THAT WILL BE A8LE TO PRO DUCE 9 MW PER YEAR. THE PLANT WILL BE COMPLETED IN MARCH 1985 AND WILL PRODUCE BOTH SINGLE AND POLY SI.

RECORD # 161 SEIR 6/84,189 JAPAN
06/11/84 HOXAN CORP. SAPPORO JAPAN
WILL ANNOUNCE A FULLY AUTOMATED MULTI MEGAWATT PRODUCTION ,LI NE SOON. THEY WILL USE SINGLE CRYSTAL SI TECHNOLOGY.

RECORD # 165 PV NEWS 6/84,4 JAPAN
06/01/84 HOXAN CORP. JAPAN
DELIVERED 200 KW OF SINGLE CRYSTAL SI MODULES IN 1983, AND WI LL DELIVER ABOUT 300 KW IN 1984.

RECORD # 178 WSM 7/84,2 SAPPORO
07/01/84 HOXAN CORP. SAPPORO JAPAN
WILL ANNOUNCE A FULLY AUTOMATED PV PRODUCTION LINE IN JUNE.

1984 PV EVENTS

RECORD # 368 PVINTER. 12/84,11
12-01-84 HUGHES AIRCRAFT COMPANYS LONG BEACH, CA
UNDER COTRACT TO NASA HAS DESIGNED AND INSTALLED A VILLAGE PV POWER SYSTEM IN THE VILLAGE OF UTIRIK IN THE MARSHALL ISLANDS.

RECORD # 6 PVIR 3/84,4
03/01/84 IBARAGI ELECTRIC COM.
HAS DEVELOPED A INP SOLAR CELL WITH A REPORTED CELL CONVERSION EFFICIENCY OF 16.5%.THE CELL HAS ALSO DEMONSTRATED HIGH STABILITY.

RECORD # 267 WSM 09/84,5
09/01/84 INDIA GOVERNMENT
THERE WILL BE ND BANS ON THE TRANSFER BY DOW CORNING OF POLY SI TECHNOLOGY TO INDIA.

RECORD # 171 WSM 6/84,7
06/01/84 INDONESIAN GOVERNMENT
WILL BUILD A PV POWER PLANT COSTING $1.1 MILLION WITH THE HELP OF THE JAPANESE.

RECORD # 42 SOLAR 4/84,53
04/01/84 INTEGRATED POWER CORP. GAITHERSBURG,MD
NEW FIRM THAT WILL MANUFACTURE CUSTOM HY8RID ELECTRIC SYSTEMS FOR REMOTE APPLICATIONS. PV WILL BE THE MAIN POWER SOURCE.

RECORD # 59 PV NEWS 3/84,3
03/01/84 INTEGRATED POWER CORP.
NEW FIRM TO DESIGN AND MANUFACTURE SYSTEMS FOR REMOTE APPLICATIONS. MOST SYSTEMS WILL BE SOLD TO THE COMM. INDUSTRYFOR REPEATER STATIONS.

RECORD # 1D1 PV INTER 3/84,17
03/01/84 INTEGRATED POWER CORP. GAITHERSBURG, MD
DESIGNS PV AND HYBRID PV SYSTEMS FOR REMOTE POWER APPLICATIONS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 259 PVNEWS 10/84,1
10/01/84 INTEGRATEO POWER CORP.
HAS CONTRACT WITH THE US NAVY TO MANUFACTURE AND INSTALL 2800 W ELECTRIC POWER SYSTEM AT CHINA LAKE.

RECORD # 315 SE&C 11/84,21
11-01-84 INTEGRATED POWER CORP. GAITHERSBURG, MD
HAS RECEIVED A CONTRACT FROM THE NAVY TO BUILD AND INSTALL A 2.8 KW PV SYSTEM AT CHINA LAKE, CA.

RECORD # 35 PVIN 4/84,2
04/09/84 INTERSOL
STATES THAT THEY CAN INSTALL A 1 MW CENTRAL PV POWER STATION FOR $7.00/WP. THIS COMPARES TO CURRENT COSTS OF $10/WP INSTALLED.

RECORD # 192 PV INT'L7/84,20
06/01/84 INTERSOL POWER CORP.
INTERSOL POWER CORP HAS ENTERED INTO A CONTRACT WITH DOE TO DESIGN GA AS MODULES WITH 18% EFF. THE BASIC COMPONENT IS A SPACE AGE EGG CRATE.

RECORD # 255 PVIR 10/84,2
10/01/84 INTERSOL POWER CORP. LAKEWOOD, CO
COMPLETED ONE OF THE WORLD'S LARGEST PV CONCENTRATOR PUMPING SYSTEMS IN SOUTHERN CALIFORNIA. THE 10 HP SYSTEM PUMPS 425 GPM FROM 38 FT.

RECORD # 113 SOLAR AGE 5/84,39 CALIFORNIA
05/01/84 IRS CALIFORNIA
STATES THAT ITS ILLEGAL TO CLAIM AN INVESTMENT IN SOMETHING STRICTLY TAKEN FOR TAX BENEFITS BASED ON A LOSS.

RECORD # 215 SOLAR AGE 8/84,57
08/01/84 ISOFOTON
THE ISO-50 IS A NEW MODULE MADE WITH BIFACIAL CAPABILITIES. THE MODULE HAS A POWER RATING OF 45 WATTS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 306 PVIR 11/84,1 JAPAN
11-01-84 JAPAN PV INDUSTRY JAPAN
COST IS THE PRIMARY FACTOR IN LIMITING THE WIDESPREAD USE OF PV SYSTEMS IN JAPAN.

RECORD # 102
05/09/84 JAPAN SOLAR ENERGY JAPAN
DR WATANABE ACCOMPANIED BY DR. INOUE OF KYOCERA, OF SAN DIEGO , AND MR. ALLEN PANTON IN CHARGE OF SOLAR MARKETING AT KYOCER A. THE COMBINED PRODUCTION OF THE AMORPHOUS SILICON AND THE

RECORD # 164 PV NEWS 6/84,3 JAPAN
06/01/84 JAPAN SUNSHINE PROJECT JAPAN
BUDGET FOR 1984 IS $30.54 MILLION, UP FROM $23.5 MILLION IN 1 983.

RECORD # 250 PVIR 10/84,1
10/01/84 JAPANESE PV INDUSTRY JAPAN
IN 1983 THEY PRODUCED 4.5 MW OF PV, OF WHICH 3.0 WAS A-SI, AN D 1.5 WAS OTHER CELL MATERIALS.

RECORD # 309 PVNEWS 11/84,3 JAPAN
11-01-84 JAPANESE PV INDUSTRY JAPAN
SENT REPRESENTATIVES TO 13 DEVELOPING COUNTRIES TO STUDY THE NEED FOR PV. INDIA--200 MILLION PEOPLE W/O ELEC., PAKISTAN-80 ,000 VILLAGES W/O ELEC., TURKEY-37,000 VILLAGES W/O ELEC.

RECORD # 326 PV NEWS 12/84,2 JAPAN
12-01-84 JAPANESE PV INDUSTRY JAPAN
SALES OF PV WILL GROW FROM 4.8 MW TO 8 MW IN 1984. THE PRIMAR Y AREA OF GROWTH HAS BEEN IN THE CONSUMER GOODS MARKET WHICH INCREASED FROM 3.5 TO 5.6 MW.

RECORD # 223 SEIR 8/84,269
08/20/84 JPL CALIFORNIA
LOSS OF FEDERAL SOLAR TAX CREDITS COULD SEVERELY HURT THE PV INDUSTRY. ALTHOUGH PV WOULD CONTINUE TO GROW, THE GROWTH RATE WOULD BE LESS.

1984 PV EVENTS

RECORD # 329 PV NEWS 12/84,3 JAPAN
12-01-84 KANEKA JAPAN
HAS A COMPLETE LINE OF A-SI ON STEEL FOIL CELLS FOR USE IN CO SUMER PRODUCTS. THEY SHIPPED ABOUT 50 KW AND THE CELL WAS USE D ON CASIO CREDIT CAROS.

RECORD # 37 PVIN 4/84,6
04/09/84 KOMATSU
HAS OEVELOPED A NEW A-SI CELL AND OEPOSITION PROCESS THAT INC REASES EFFICIENCY TO 10.7% AND SIMPIFIES PRODUCTION. USES 3 L AYERS OF A-SI, GLASS SUBSTRATE, TRANSPARENT ANO METAL ELECTRO

RECORO # 52 SEIR 3/84,95
03/19/84 KOMATSU JAPAN
ACHIEVED 10.7% EFFCIENCY ON A-SI CELL. THIS CELL WILL BE COMM ERCIALLY AVAILABLE IN A FEW YEARS.

RECORO # 60 PV NEWS 3/84,4
03/01/84 KOMATSU JAPAN
ATTAINED A CONVERSION EFFICIENCY OF 10.7% ON A-SI CELL. THIS WAS POSSIBLE BY USING A NEW TRANSPARENT ELECTROOE THAT INCREA SE LIGHT INCIDENT ON THE CELL.

RECORD # 49 SEIR 4/84,113
04/02/84 KYOCERA
REPRESENT KYOCERA IN THE US FOR PV PUMPING SYSTEMS, TELECOMM, AND SOLAR THERMAL OEVICES.

RECORD # 84 PV NEWS 4/84,7
04/01/84 KYOCERA
MARKETS SOLAR FOR GRID-CONNECTED HOMES, STREET LIGHTING, TELE COMM., WATER HEATING,AND MARINE APPLICATIONS. US OFFICE 8611 BALBOA AVE. SANDIEGO, CA 92123 JOHN KIMBALL, SALES ENGINEER.

RECORD # 96 WSM 4/84,10
04/01/84 KYOCERA
INTENDS TO COMPLETE A 100 KW SOLAR ENERGY CENTER THIS SUMMER. THE $850,000 PROJECT WILL BE THE LARGEST PRIVATELY FINANCED SOLAR PROJECT.

1984 PV EVENTS

RECORD # 127 PV INTER 5/84,19 SAN DIEGO
05/01/84 KYDCERA SAN DIEGO, CA
HAS BEEN DESIGNING PV POWEREO HIGHWAY SIGNS FOR USE ON REMOTE PARTS OF THE CALIFORNIA HIWAY SYSTEM . PRELIMINARY TESTS HAV E BEEN SUCCESSFUL AND MORE PV POWERED SIGNS WILL BE INSTALLED

RECORD # 131 PV INTER 5/84,34 SAN DIEGO
05/01/84 KYOCERA SAN DIEGO, CA
DFFERS A 54,44,AND 22 WATT MODULES MADE FROM POLYCRYSTALLINE SI.

RECORD # 155 PVIR 6/84,4
06/01/84 KYOCERA KYOTO JAPAN
BUILT A $20 MILLION LIMITED PRODUCTION FACILITY IN SAN OIEGO, CA. WILL MANUF. MARINE MODULES, TRAFFIC SIGN ILLUMINATION SY STEMS, WATER PURIFICATION SYSTEMS, AND PARKING LOT LIGHTS.

RECORD # 156 PVIR 6/84,4
06/15/84 KYOCERA KYOTO JAPAN
INTRODUCING ITS FIRST HYBRID POLY MONOCRYSTALLINE SI MODULE. ITS PSA 100H-441 IS A 20 VOLT MOD WITH AN OUTPUT OF 54 WATTS @ 2.7 AMPS.

RECORD # 166 PV NEWS 6/84,5 SAN DIEGO
06/01/84 KYOCERA SAN DIEGO, CA
HAS SOLD SEVERAL MILLION DOLLARS WORTH DF LIGHTS AND SIGNS IN THE US. THEIR SOLAR POWERED LAMP HAS 2 44-WATT MODS. 2 105 A MP HR. BATTERIES, 2 30 W, 12-VOLT, 870 LUMEN LAMPS.

RECORD # 168 PV NEW 6/84
06/01/84 KYOCERA SAN DIEGO, CA
CALIFORNIA HIGHWAY DEPARTMENT HAS PLACED $2 MILLION ORDERS FO R PV-POWERED HIGHWAY SIGNS.

RECORD # 182 PV NEWS 6/84
06/01/84 KYOCERA SAN DIEGO, CA
SOLD SEVERAL MILLION DOLLARS WORTH OF SIGNS TO THE CALIFDRNIA HIGHWAY DEPARTMENT.

1984 PV EVENTS

RECORD # 197 PV INT'L7/84,20
06/01/84 KYOCERA
COMPPLETED A 100 KW SOLAR ENERGY CENTER IN SAKURA CITY. THE P ROJECT COST WAS $850,000 (US).

RECORD # 230 SOLAR AGE 6/84,87
06/01/84 KYOCERA SAN DIEGO CA
OFFERS A 54 WATT PV MODULE THAT OPERATES AT 20 VOLTS. THEY O FFER OTHER POLYCRYSTALLINE PV MODULES INCLUDING A 44,22 AND 1 0 WATT VERSION.

RECORD # 257 PVNEWS 10/84,1
10/01/84 KYOCERA JAPAN
JUST OPENED A PV-POWERED ENGINEERING CENTER AT SAKURA.

RECORD # 261 PVNEWS 10/84,1
10/01/84 KYOCERA JAPAN
INTRODUCED A SOLAR THERMAL WATER HEATER WITH A PV POWERED PUM P.

RECORD # 311 PVNEWS 11/84,3 SAN DIEGO CA
11-01-84 KYOCERA CORP.
SUPPLIED PV-POWERED HIGHWAY SIGNS FOR THE NEW MEXICO HIGHWAY DEPT.

RECORD # 349 WSM 12/84,5 SAN DIEGO CA
12-01-84 KYOCERA INTERNATIONAL SAN DIEGO, CA
COMPLETED THE FIRST PV-POWERED HOME IN PRESCOTT AZ. THE 1.76 KW SYSTM USES 40 KYOCERA MODULES EACH RATED AT 44 W. DIVIDED INTO 12 AND 24 VOLT SYSTEMS.

RECORD # 356 SEIR 12/84,384 SAN OIEGO CA
12-03-84 KYOCERA INTERNATIONAL SAN DIEGO, CA
HAS COMPLETED A PV-POWERED HOME IN PRESCOTT AZ. THE HOUSE USE S 40 KYOCERA 44 W MODULES. HAS BOTH A 12 AND 24 VOLT SYSTEM.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 270 SEIR 09/84,283
09/10/84 LOCKHEED
BUILT THE 102 FT. ARRAY THAT WAS USED ON DISCOVERY.

RECORD # 152 SEIR 5/84,167
05/21/84 LOS ALAMOS NATIONAL LAB LOS ALAMOS NM
DEVELOPED A SUITABLE PLASTIC THAT WILL CONDUCT ELECTRICITY. THE PLASTIC IS POLYACETYLENE THAT IS DOPED WITH CESIUM ELECTRIDE. THIS MAY BE USEFUL FOR PV APPLICATIONS.

RECORD # 214 SOLAR AGE 8/84,14
08/01/84 MARINE CORP
THE MARINES WILL BE TESTING PORTABLE PV GENERATORS THAT POWER RADIOS COMMUNICATIONS EQUIPMENT.

RECORD # 10 PVIN 2/84,2
02/01/84 MARTIN MARIETTA
IS PLANNING TO ESTABLISH AN INTERNATIONAL PV COMPANY THAT WOULD ALLOW THEM TO COMPETE IN THE PV ARENA.

RECORD # 149 PV NEWS 5/84,7 GERMANY
05/01/84 MESSERSCHMITT GERMANY
HAVE EIGHT PROFESSIONAL WORKING ON A-SI RESEARCH ON BOTH GLASS AND METAL SUBSTRATES.

RECORD # 61 PV NEWS 3/84,5
03/01/84 MITI JAPAN
WILL EXTEND PV TECHNOLOGY TO BOTH INDONESIA AND PAKISTAN WITH OUT COMPENSATION. WILL SUPPLY PV SYSTEMS FOR VILLAGE ELECTRIFICATION AND EDUCATIONAL FACILITIES.

RECORD # 185 PVIR 7/84,3 TOKYO
07/01/84 MITI TOKYO JAPAN
MITI HAS SIGNED AN AGREEMENT TO BUILD PV POWER PLANTS IN REMOTE AREAS OF AUSTRALIA AND ON THE GALAPAGOS ISLANDS. THE 50 KW PLANTS WILL BE SUPPLEMENTED BY WIND SYSTEMS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 242 PVNEWS 9/84,2
09/01/84 MITI JAPAN
MITI WILL BUILD PV PLANTS FOR DEVELOPING COUNTRIES, FREE OF C
HARGE.

RECORD # 186 PVIR 7/84,3 TOKYO
07/01/84 MITSHUBISHI ELECTRIC TOKYO JAPAN
HAS BEGUN MASS PRODUCTION OF GA AS CELLS WITH CONVERSION EFFI
CIENCIES OF 15.7 TO 19.3%. THESE CELLS WILL BE USED FOR ITS
THIRD COMMUNICATIONS SATELITE LAUNCHED IN 1987.

RECORD # 79 PV NEWS 4/84,3
04/01/84 MOBIL SOLAR
SHIPPED 70 KW IN 1983 AND WILL DOUBLE PRODUCTION IN 1984. BY
THE END OF 1984 THEY WILL HAVE A 1 MW PRODUCTIDN CAPACITY.

RECORD # 208 PVIR 8/84,1 WALTHAM
08/01/84 MOBIL SOLAR ENERGY CORP WALTHAM MA
SMUD HAS AWARDED MOBIL A $245,00D CONTRACT TO SUPPLY 37 KW OF
RIBBON SI MODULES FOR PHASE 2 OF THE 100 MW SYSTEM.

RECORD # 369 PVINTER. 12/84,11
12-01-84 MONEGON
MONEGON'S SUBSIDIARY, FUTURE SYSTEMS HAS ACQUIRED HOLEC'S TWO
MEGAWATT SEMICRYSTALLINE PV PRODUCTION LINE IN HOLLAND.

RECORD # 179 SEIR 7/84,221 CRANSTON RI
07/09/84 MONOSOLAR CRANSTON RI
BP SOLAR AND STANDARD OF OHIO HAVE LICENSED TECHNOLOGY FOR EL
ECTROCHEM. DEPOSITION FROM MONOSOLAR.

RECORD # 351 WSM 12/84,10 AUSTRALIA
12-01-84 MOUNT TOM PRICE MINE AUSTRALIA
PV-POWERED CAMARAS ARE BEING USED TO MONITOR MINING ACTIVITY.

1984 PV EVENTS

RECORD # 333 PV NEWS 12/84,4
12-01-84 N. CAROLINA ALTERNATIVE
HAS INSTALLED A 4 KW PV SYSTEM FOR TESTING. SOLAREX SEMIX PV MODULES WERE USED AND PURCHASED FOR LESS THAN $7/W. TEST RESULTS WILL BE AVAILABLE TO INTERESTED PARTIES.

RECORD # 104 WORLD SOLAR 5/84,2 WASHINGTON
05/01/84 NASA LERC WASHINGTON DC
RANKED 5 PV HYBRID SYSTEMS 1) PV DIESEL, 2) PV HYDRO, 3) PV WIND, 4) PV CLOSED CYCLE VAPOR TURBOGENERATOR, 5) PV FUEL CELL .

RECORD # 350 WSM 12/84,7 CLEVELAND OH
12-01-84 NASA LERC CLEVELAND, OH
DEVELOPED A SOLAR CELL THAT COULD USE READILY AVAILABLE MATERIALS AND HAVE A 50% CONVERSION EFFICIENCY. PATENTS HAVE BEEN AWARDED.

RECORD # 237 PVIR 9/84,1
09/01/84 NATIONAL AUDUBON SOCIETY USA
PROPOSED AN ENERGY PLAN FOR RENEWABLE ENERGY SYSTEMS. THE PLAN IS BASED ON THE FREE MARKET SYSTEM AND WOULD INCREASE THE USE OF RENEWABLES FROM 7% TO 20% OF TOTAL ENERGY.

RECORD # 7 PVIR 3/84,4
03/01/84 NEDO TOKOYO, JAPAN
NEDO IS CHANGING ITS PV POLICY DIRECTION AND WILL SUPPORT BOTH A-SI AND POLYCRYSTALLINE SI DEVELOPMENT AFTER 1985.

RECORD # 109 PVIN 5/84,3
05/01/84 NORTEK
SOLD MONOSOLAR FOR $3 MILLION TO BRITISH PETROLEUM AND SOHIO .

RECORD # 335 PV NEWS 12/84,6 OCEANSIDE CA
12-01-84 OCEANSIDE LIBRARY
INSTALLED 10 KW OF KYOCERA PV MODULES ON THEIR ROOF. THE SYSTEM WILL SUPPLY ABOUT 10% OF THEIR POWER REQUIREMENTS. THE INSTALLATION WAS FINANCED THROUGH THIRD PARTY FINANCING.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 301 PVIR 11/84,1 SAN FRAN.
11-01-84 PACIFIC GAS AND ELECTRIC SAN FRANSISCO, CA
IS ENCOURAGED AT THE RESULTS OF THEIR FIELD TESTING OF PV MOD
ULES AND ARRAYS.

RECORD # 47 SEIR 4/84,110
04/02/84 PAUL MAYCOCK
FORESEES A 5 YEAR BATTLE BETWEEN COMPETING PV TECHNOLOGIES. H
IS FAVORITES ARE CONCENTRATORS AND A-SI.

RECORD # 360 SEIR 12/84,391 OCEANSIDE, C
12-10-84 PHOTOCOMM OCEANSIDE, CA
HAS INSTALLED A 10 KW PV SYSTEM ON ITS LIBRARY. THE PROJECT W
AS ASSISTED BY THIRD PARTY FINANCING. COOPERATIVE EFFORT BETW
EEN THE CITY GOVERNMENT AND PRIVATE INVESTORS.

RECORD # 44 SOLAR E&C 4/84,53
04/01/84 PHOTOELECTRIC INC SAN DIEGO, CA
NEW NAME OF ALPHA ENERGY MAIN PRODUCT IS SI 3000 INVERTER.

RECORD # 252 PVIR 10/84,2
10/01/84 PHOTOTHERM INC. NASHUA, NH
DEVELOPED A NEW PV DEVICE WITH A CONVERSION EFFICIENCY OF 75%
AND A CLAIM THAT IT WILL COST 1/10TH OF TODAYS PV DEVICES.

RECORD # 347 SOLAR AGE 12/84,35 MIAMI, FL
12-01-84 PHOTOVOLTAICS INC. MIAMI, FL
IS GETTING OUT OF THE PV BUSINESS AND WILL DIVERSIFY INTO OUT
DOOR ADVERTIZING.

RECORD # 73 PVIR 4/84,3
04/01/84 PHOTOWATT
DEVELOPED AN AUTONOMOUS PHONE BOOTH USING TWO 38 WP PV POLYCR
YSTALLINE MODULES. THE SYSTEM CAN OPERATE FOR 20 DAYS W/O SU
NLIGHT.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 195 PV INT'L7/84,20
06/01/84 PHOTOWATT
PHOTOWATT AND FUJI ELECTRIC HAVE ESTABLISHED A FIVE YEAR INFO RMATION EXCHANGE AGREEMENT. PHOTOWATT WILL WORK ON RI88ON, AN D FUJI ON A-SI.

RECORD # 337 PVIR 12/84,1
12-01-84 PHOTOWATT INTERNATIONAL
INTRODUCING ITS NEW LINE OF MULTICRYSTALLINE SI CELLS. THE NE W MODULES COME IN 10,20,40 AND 80 WATT. USES POLYX INGOT CAST ING PROCESS.

RECORD # 32 WSM 02/84,2
02/01/84 PRAGMA ITALY
HAS ALREADY SOLD ITS 1984 PRODUCTION OUOTA FOR PV. THEY ARE A LSO WORKING ON A-SI HAVING ALREADY SPENT $30 MILLION ON ITS D EVELOPMENT.

RECORD # 143 SEIR 4/84,129 HONOLULU
04/16/84 PRI ENERGY SYSTEMS HONOLULU HAWAII
HAS BEGUN TO OFFER PV POWERED PUMPS ON ITS RESIDENTIAL SOLAR HOT WATER SYSTEMS. SUCH SYSTEMS HAVE BEEN GATHERING INCREASED POPULARITY OVER THE PAST SEVERAL YEARS.

RECORD # 334 PV NEWS 12/84,4
12-01-84 PULSTAR CORP.
USES A 5 WATT MODULE TO START THE WATER FLOW IN A SOLAR HOT W ATER SYSTEM.WATER PUMPS NOW OUT PERFORMS GRID-DRIVEN SYSTEMS.

RECORD # 221 SEIR 8/84,253
08/06/84 PV ENERGY SYSTEMS
EXTENDING THE SOLAR TAX CREDITS WOULD ALLOW THE PV INDUSTRY T O GROW TWICE AS RAPIDLY AS IT WOULD WITHOUT THE CREDITS. THE US COULD ALSO MAINTAIN ITS LEAD IN THE INDUSTRY.

RECORD # 154 PVIR 6/84,1
06/01/84 PV INDUSTRY
PV MODULE PRODUCTION INCREASED TO 12.6 MW IN 1983 AND WORLD P RODUCTION WAS 21.1 ACCORDING TO EIA REPORT.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 343 SOLAR AGE 12/84,10
12-01-84 QUEENSLAND INSTITUTE AUSTRALIA
DEVELDPED A WATER-FILLED PV CONCENTRATOR THAT COULD CUT THE C OSTS OF PV IN HALF. THE UNIT HAS A V-SHAPED WATER TROUGH AND LIGHT IS REFLECTED INTERNALLY TO THE PV CELLS.

RECORD # 297 WSM 10/84,10 AUSTRALIA
10/01/84 QUEENSLAND INSTITUTE OF AUSTRALIA
DEVELOPED A PV CONCENTRATOR THAT WILL CUT IN HALF THE COSTS O F CONVENTIONAL PV SYSTEMS. THE CONCENTRATOR CONSISTS OF A V-S HAPEO PLASTIC TROUGH FILLED WITH WATER.

RECORD # 332 PV NEWS 12/84,4 JAPAN
12-01-84 RAPSS JAPAN
REACHED AN AGREEMENT WITH AUSTRALIA TOBUILD 5 REMOTE PV SYSTE MS. THE COST PER PROJECT MAY REACH $1 MILLION.

RECORD # 338 PVIR 12/84,1
12-01-84 RIKAGAKU KENKYUJO
DEVELOPED A POLYMER WHICH CAN GENERATE ELECTRICITY AS WELL AS STORES IT. THE POLYMER IS EXPECTED TO BE USEO IN PV CELLS.

RECORD # 9 PVIN 2/84,2
02/01/84 ROCKWELL INTERN'L
PROPOSED THAT THE US BUILD 2 OR THREE COMMERCIAL PV POWER STA TIONS OF 55KW EACH. THE PV CELLS WOULO BE SUBCONTRACTED AND W OULD BE WORTH ABOUT $1-2 8ILLION PER STATION.

RECORD # 212 PVIR 8/84,3
08/01/84 SANDIA
HAS ACHIEVED A CONVERSION EFFICIENCY OF 17% WITH SINGLE SI CE LLS. EACH CELL IS EQUIPT WITH A FRESNEL LENS.

RECORD # 95 WSM 4/84,10
04/01/84 SANYO
A PV POWERED AM RAOIO USING A-SI CELLS WILL BE PLACED ON THE MARKET APRIL 1, 1984. THE AMORTON RADIO WEIGHS 50 g WITH BATT ERIES. PV CAN RECHARGE BATTERIES IN 4 HOURS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD #	121 PVIR 5/84,4	JAPAN
05/01/84	SANYO	JAPAN

WITH THE INCREASE DEMAND FOR THEIR MODULES SANYD WILL SIGNIFI CANTLY EXPAND THEIR PRODUCTION. IN 1981 THEY RPODUCED 1.5 MIL LION MOD. /MONTH AND 8Y THE END OF 1983 4 MILLION/ MONTH.

RECORD #	256 PVNEWS 10/84,1	
10/01/84	SANYO	JAPAN

WILL CONTINUE TO EMPHASIS CONSUMER GOODS. CURRENTLY PRODUCE 3 .3 MW IN 1984 AND WILL EXPAND TO 50 MW IN 1988. CURRENTLY H AVE 5 MW PRODUCTION CAPACITY.

RECORD #	300 PVIR 11/84,1	JAPAN
11-01-84	SANYO ELECTRIC CO.	JAPAN

HAS ATTAINED AN 11.5% CONVERSION EFFCIENCY FOR A-SI CELLS.

RECORD #	135 SOLAR ENG. 5/84,23	FLORIDA
05/01/84	SE RES EXPERIMENT	CAPE CANAVERAL FL

TESTING 3 PV POWERED HOMES-1) 60 PHOTOWATT MODULES, 2) 70 SOL AREX GEORGETOWN MODS. 3) MOBIL SOLAR MODS.

RECORD #	217 SEIR 8/84,260	
08/13/84	SEIA	

MAY SEEK SOLAR TAX CREDIT EXTENSIONS COVERING ONLY THOSE TECH NOLOGIES REPRESENTED BY THEIR TRADE ASSOCIATION. CREDITS MAY BE DECREASED AT OIFFERENT RATES FOR VARIOUS TECHNOLOGIES.

RECORD #	243 PVNEWS 9/84,2	
09/01/84	SERA	SANTA CLARA CA

HAS DONE RESEARCH ON CONCENTRATOR PV CELLS, LIOUID JUNCTION C ELLS, AND THEIR CONCENTRATOR TECHNOLOGY IS READY FOR THE MARK ETPLACE. THEIR EFFICIENCY IS ABOUT 19% AT 100X CONCENTRATION.

RECORD #	313 SE&C 11/84,21	
11-01-84	SERA	SANTA CLARA, CA

PRODUCED A 1 IN SO. CONCENTRATING SINGLE SI CELL WITH AN EFFI CIENCY OF 19%. CUSTOM MANUFACTURED CELLS ARE NOW AVAILABLE.

1984 PV EVENTS

RECORD # 303 PVIR 11/84,1 SANTA CLARA,
11-01-84 SERA CORP SANTA CLARA, CA
HAS LAUNCHED A CAMPAIGN TO COMMERCIALIZE ITS LIOUID JUUNCTION PV CONCENTRATOR TECHNOLOGY. IT WILL MANUFACTURE CONCENTTRATOR CELLS AND DESIGN PRODUCTION FACILITIES FOR OTHERS.

RECORD # 253 PVIR 10/84,2
10/01/84 SHARP CO. JAPAN
DEVELOPED A NEW SUPER LIGHT WEIGHT SINGLE CRYSTAL PV CELL THAT IS SUPERIOR TO GAAS IN SOME SPACE APPLICATIONS.

RECORD # 25 WSM 2/84,9
02/01/84 SHIKOKU ELEC. SAIJO CITY JAPAN
EXPANDED PV SYSTEM FROM 23 KW IN 1982 TO 200 KW IN 1983. ADDED 5000 PV PANELS. PLANS ARE TO EXPAND TO 1 MW BY 1985.

RECORD # 148 PV NEWS 5/84,4
05/01/84 SIEMENS
INTERATOM NOW HAS FULL PV RESPONSIBILITIES FOR SIEMENS. 1983 SHIPMENTS OF PV WERE 250 KW. AEG TELEFUNKEN HAD SHIPMENTS OF 800 KW IN 1983.

RECORD # 116 SEIR 4/84,132 GERMANY
04/23/84 SIEMENS/INTERATOM GERMANY
WORKING ON SINGLE CRYSTAL SI, POLYCRYSTALLINE RIBBONS AND A-SI.

RECORD # 201 SOLAR AGE 7/84,6
07/01/84 SILICON SENSORS
IS OFFERING A PV POWERED LIGHT SYSTEM THAT FEATURES A 30 WATT PANEL, A RAY-O-VAC FLUORESCENT LANTERN 12 FOOT CABLES.

RECORD # 29 SEIR 3/84,77
03/05/84 SMUD SACREMENTO, CA
SMUD I WILL BE DEDICATED IN JULY. IT WAS COMPLETED ON TIME AND UNDER BUDGET. PHASE II MAY HAVE UP TO 7 PV MANUFACTURERS INVOLVED.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 38 PVIN 4/84,3
04/09/84 SMUD CALIFORNIA
HAS ONLY RECEIVED 1 BID FOR PHASE II OF SMUD. THE BID WAS FRO M SOLAREX. PROBLEM THAT SMUD REQUIRES EACH COMOANY TO DIVULGE CONFIDENTIAL INFORMATION ANO HAVE TOUGH WARRENTEE REQUIREMEN

RECORD # 209 PVIR 8/84,1
08/01/84 SMUD SACREMENTO
SMUD HAS SET A GOAL OF $4/W FOR PHASE 3

RECORO # 363 SEIR 12/84,407
12-24-84 SMUD
RFP FOR UP TO 5 MWP AC OF SMUD MOOULES WILL BE POUT IN MID JA NUARY. TRYING TO BETTER THE $4.75/W BID OF ARCO SOLAR'S.

RECORD # 151 SEIR 5/84,164 WASHINGTON
05/21/84 SOLAR BUDGET WASHINGTON OC
1985 BUDGET FOR PV --$47.5 MILLION REQUESTEO, THE HOUSE OF RE PS APPROVED $57 MILLION.

RECORD # 162 SEIR 6/84,192
06/11/84 SOLAR ELECTRIC ENG. SEBASTOPOL, CA
WILL BUILD A 15 KW PV SYSTEM FOR FARM USE IN WALNUT CREEK, CA BY THE END OF 1984. WILL SUPPLY POWER TO HEATHER FARMS GARDE N ASSOCIATION.

RECORD # 321 PV INTERN'L 10/84,1
10-01-84 SOLAR ELECTRIC ENGINEERIN SEBASTOPOL, CA
PLANS TO BUILD PV GENERATING FACILITY BY THE END OF 1984 IN W ALNUT CREEK. WILL SUPPLY 15 KW OF POWER TO HEATHER FARMS GARD EN ASSOCIATION.

RECORD # 291 SEIR 10/84,337 ST PETERSBUR
10/29/84 SOLAR ELECTRIC SYSTEMS ST PETERSBURG, FL
ANNOUNCED THE AVAILABILITY OF PV CIRCULATION SYSTEM FOR COMME RIAL AND RESIDENTIAL WATER HEATING SYSTEMS.

1984 PV EVENTS

RECORD # 226 SOLAR AGE 9/84,16
09/01/84 SOLAR ENERGY INDUSTRY AS. WASHINGTON DC
HAS BEEN PREPARING FOR THE SECONO ROUND OF TAX CREDIT BATTLE BY ESTABLISHING STATE SEIA CHAPTERS.

RECORD # 123 PV INTER 5/84,16 OAKLANO, CA
05/01/84 SOLAR INITIATIVE OAKLAND, CA
HIREO BY THE HOPLAND INDIANS TO DEVELOP A PV SYSTEM FOR THE HOPLAND RANCHERIA 100 MILES NORTH OF SAN FRANCISCO.

RECORD # 89 RENEW 4/84,1 WASHINGTON
04/01/84 SOLAR LOBBY WASHINGTO DC
MONEY MISMANAGEMENT HAS CAUSED THE SOLAR LOBBY TO BE IN DEBT MORE THAN $250,000. THE LOBBY IS NOW FORCED TO SEVERLY CUT BACK ITS EFFORTS WHILE IT SOLICITS MORE MONEY FROM MEMBERS.

RECORD # 228 SOLAR AGE 6/84,17
06/01/84 SOLAR POWER CORP MASS
IS SELLING OFF ITS INVENTORY AND EQUIPMENT. ABOUT 100 EMPLOYEES WERE RELEASED ALTHOUGH MOST HAO ALREADY FOUNO NEW JOBS.

RECORO # 14 SEIR 1/84,35 WOBURN
01/30/84 SOLAR POWER CORP. WOBURN, MASS
EXXON HAS NARROWED THE NUMBER OF POTENTIAL BUYERS OF SPC TO ONE. NO INDICATION AS TO WHEN NEGOCIATIONS WOULO BE COMPLETED.

RECORD # 23 SEIR 2/84,50
02/13/84 SOLAR POWER CORP.
A.D. LITTLE ANO NORTEK INC. ARE TEAMING UP TO PURCHASE SOLAR POWER CORP. FROM EXXON. OTHER FIRMS INTERESTEO IN SPC ARE BP SOLAR, KYOCERA, AND GE.

RECORD # 45 SEIR 4/84,107
04/02/84 SOLAR POWER CORP.
SPC CLOSED ITS DOORS AFTER FAILING TO COME TO AN ACCORD WITH PROSPECTIVE BUYERS. THE COMPANY IS STILL OPTIMISTIC THAT SOMEONE WILL BUY THE COMPANY. 100 EMPLOYEES WERE LAYED-OFF.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 63 RENEW 3/84,3
03/01/84 SOLAR POWER CORP. FLORIDA
THE 70 KW SYSTEM INSTALLED TWO YEARS AGO HAS BEEN OPERATING W ELL. THE SYSTEM WAS INSTALLED BY SOLAR POWER CORP.

RECORD # 76 SEIR 4/84,117
04/09/84 SOLAR POWER CORP.
STATES THAT THE REASON FOR CLOSING ITS DOORS WAS THAT NORTEK AND ADL COULD NOT ARRANGE A PACKAGE FOR THE PURCHASE OF SPC.

RECORD # 86 PVIN 4/84,3
04/01/84 SOLAR POWER CORP.
SOLAR POWER CLOSED THEIR DOORS SINCE A JOINT VENTURE BETWEEN NORTEK AND ADL FELL THROUGH. NORTEK AND ADL PLANNED TO MAKE A $10 MILLION PUBLIC OFFERING TO BUY SPC.

RECORD # 120 PVIR 5/84,5 WOBURN MA
05/01/84 SOLAR POWER CORP. WOBURN MA
EXXON IS CURRENTLY SELLING THE ASSETS OF SOLAR POWER CORP.

RECORD # 137 SOLAR ENG. 5/84,24
05/01/84 SOLAR POWER CORP.
EXXON SHUTDOWN SPC OPERATIONS AND IS SELLING CAPITAL.

RECORD # 5 PVIR 3/84,5
03/01/84 SOLAREX
WILL PROVIDE PV SYSTEM TO TWO GUYANA HEALTH CARE FACILITIES. INCLUDES A 20.1 KWP AND A 3.5 KWP SYSTEM. BOTH WILL BE COMPL ETED BY MID-1984.

RECORD # 17 PVIR 2/84,3
02/01/84 SOLAREX
COMPLETED THE FIRST NON GRID CONNECTED HOME USING 1.2 KW SOLA REX ARRAY. THE HOUSE WAS DESIGNED BY FRANK B. ARENAS.

1984 PV EVENTS

RECORD # 27 WSM 2/84,9
02/01/84 SOLAREX
HAS 8EEN AWARDED A CONTRACT BY GUYANA HEALTH MINISTREY TO PRO VIDE 2 PV SYSTEMS. THESE ARE 20.1 KW SYSTEM FOR KUMAKA, AND A 3.5 KW SYSTEM FOR SAND CREEK.

RECORD # 54 SEIR 3/84,100
03/26/84 SOLAREX
PURCHASED A 20 ACRE PARCEL IN SAN BERNADINO COUNTY FOR A 1 MW PV PLANT CONNECTED TO SOUTHERN CALIFORNIA EDISON GRID. PLANT WILL HAVE AN INITIAL CAPACITY OF 1 MW.

RECORD # 55 SEIR 4/84,100
03/26/84 SOLAREX
SOLO A-SI PV MODULES TO JAPANESE FIRM FOR USE IN POWER CALCUL ATORS. MODULES WERE MADE USING RCA'S TECHNOLOGY AND ARE THE F IRST TO BE SOLD TO THE JAPANESE BY A US FIRM.

RECORD # 69 PVIR 4/84,1
04/01/84 SOLAREX
SOLAREX WAS THE FIRST US PV MANUFACTURER TO SELL MODULES TO T HE JAPANESE. THE A-SI MODULES WILL BE USED IN CALCULATORS.

RECORD # 70 PVIR 4/84,1
04/01/84 SOLAREX
SERI AWARDED SOLAREX A $4.6 MILLION CONTRACT TO ADVANCE SINGL E JUNCTION THIN FILM A-SI CELLS USING THE GLOW DISCHARGE DEPO SITION TECHNIQUE. $4.6 MILLION WAS ALSO AWARDED TO 3M.

RECORD # 77 SEIR 4/84,117
04/09/84 SOLAREX
WAS AWARDED $4.8 MILLION TO STUDY HIGH EFFICIENCY, SINGLE JUN CTION MONOLITHIC A-SI CELLS FA8RICATED USING GLOW-DISCHARGE D EPOSITION.

RECORD # 83 PV NEWS 4/84,7
04/01/84 SOLAREX
SHIPPED 20-30 KW OF A-SI CELLS TO JAPAN. THE FIRST US A-SI SH IPMENT OF THIS TYPE.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 125 PV INTER 5/84,17
05/01/84 SOLAREX
HAS BECOME THE FIRST US COMMERCIAL PRODUCER OF A-SI MODULES. THEY ARE USING THE RCA TECHNOLOGY. SEMIX WILL REMAIN THE MAIN STAY OF SOLAREX'S MODULES.

RECORD # 136 SOLAR ENG. 5/84,24
05/01/84 SOLAREX GEORGETOWN
300 KWP INSTALLATION USED TO POWER LIGHTS AND IS CONNECTED TO THE UTILITY GRID SYSTEM. USES SEMICRYSTALLINE PV CELLS.

RECORD # 145 SEIR 5/84,153 ROCKVILLE MD
05/07/84 SOLAREX
SUIT BEING FILED BY FORMER SOLAREX STOCKHOLDERS CLAIMING THAT THEY DID NOT RECEIVE A FAIR PRICE FROM ST'D OF INDIANA ON THEIR SHARES OF SOLAREX STOCK.

RECORD # 153 SEIR 5/84,169 ROCKVILLE
05/21/84 SOLAREX ROCKVILLE MD
HAS BEEN PROMOTED TO SENIOR VP IN CHARGE OF OPERATIONS. FORMERLY HEADED SEMIX.

RECORD # 276 SEIR 10/84,329
10/15/84 SOLAREX
INTIODUCING A NEW PRODUCTION LINE AND GUARENTEE THAT THE OUTPUT WILL BE AT LEAST AT THE STATED LEVEL. THIS IS IN CONTRAST TO THE NOMINAL POWER LEVELS NORMALLY STATED.

RECORD # 282 PV INTERN'L 09/84 YAKIMA, WA
09/01/84 SOLAREX
SUPPLIED PV MODULES FOR A 2.1 KW HYBRID PV SYSTEM USED BY THE ARMY. THE POWER IS FOR COMMUNICATIONS EQUIPMENT AND CONSISTS OF 56 MODULES. CLOSED CYCLE VAPOR TURBINE IS THE BACKUP.

RECORD # 319 PV INTERN'L 10/84,1
10-01-84 SOLAREX
MANUFACTURED A 2.1 KW HYBRID PV SYSTEM FOR YAKIMA FIRING RANGE. PROVIDES POWER FOR COMMUNICATIONS EQUIPMENT AND BATTERY CHARGING. LARGEST PV SYSTEM IN THE NORTHWEST.

1984 PV EVENTS

RECORD # 362 SEIR 12/84,405
12-24-84 SOLAREX
SELLING THEIR MARTINSBURG SILICON PURIFICATION PLANT BECAUSE OF THE SLOW GROWTH IN PV AND TECH. PROBLEMS. NO FIRM OFFERS HAVE BEEN RECEIVED TO DATE.

RECORD # 206 PV NEWS 8/84,4 ROCKVILLE
D8/01/84 SOLAREX CORP ROCKVILLE, MD
REDUCED THEIR STAFF BY 70 PEOPLE INCLUDING MANAGERS OF RESEARCH, ENGINEERING, AND MANUFACTURING.

RECORD # 194 PV INT'L7/84,20
06/01/84 SOLAREX CORP.
ANNOUNCED THAT THE FINAL MODULES WERE SHIPPED FOR A LARGE GEORGETOWN UNIVERSITY PROJECT.

RECORD # 218 SEIR 8/84,260
08/13/84 SOLAREX CORP.
REDUCED THEIR STAFF BY 70 PEOPLE-MAINLY MANAGEMENT. THE COMPANY STILL HAS OVER 500 EMPLOYEES AND VERY STRONG CUSTOMERS.

RECORD # 235 PVIR 9/84,1
09/01/84 SOLAREX CORP. ROCKVILLE MD
HAS COMPLETED AN AMBITIOUS PROGRAM TO COMMERCIALIZE THEIR A-SI CELLS. THEY ESTABLISHED THEIR THIN FILM DIVISION IN NEWTON, PA. AND ARE THE FIRST US FIRM TO MANFACTURE AND SELL A-SI.

RECORD # 260 PVNEWS 10/84,1
10/01/84 SOLAREX CORP.
CAPTURED $1.44 MILLION CONTRACT WITH EGYPT FOR REMOTE TELECOM SITES AND MILITARY BACKPACKS.

RECORD # 265 SEIR 09/84,302
09/24/84 SOLAREX CORP.
AWARED $1.44 MILLION FROM EGYPT TO FOR REMOTE TELECOMMUNICATIONS EQUIPMENT AND MILITARY BACKPACKS.

1984 PV EVENTS

RECORD # 310 PVNEWS 11/84,3
11-01-84 SOLAREX CORP.
INTRODUCING A NEW LINE THAT WILL HAVE A MINIMUM WATTAGE GUARE NTEE. 3 MODULES INCLUDE THE SX 38, SX 42, AND THE SX 146.

RECORD # 314 SE&C 11/84,21
11-01-84 SOLAREX CORP. ROCKVILLE, MD
RECEIVED A $1.44 MILLION CONTRACT FROM SIGNAL CORP IN EGYPT F OR PV TO POWER REMOTE TELECOMMUNICATIONS EQUIPMENT. WILL COMP LETE THE CONTRACT IN AUGUST 1985.

RECORD # 342 PVIR 12/84,1
12-01-84 SOLAREX CORP. ROCKVILLE MD
IS INTRODUCING A NEW PRODUCT LINE THAT CARRIES A MINIMUM WATT AGE GUARENTEE. MODULES INCLUDE THE 38,42 AND 46 WATT.

RECORD # 188 SEIR 6/84,196 ROCKVILLE
06/18/84 SOLAREX CORP.. ROCKVILLE, MD
HAS ACQUIRED THE LIONS SHARE OF SPC ASSETS. SOLAREX BOUGHT SP C'S RAW MATERIALS FOR CELL MANUFACTURING AND SOME CZ WAFERS.

RECORD # 180 SEIR 7/84,224 GENEVA
07/09/84 SOLAREX SA GENEVA SWITZERLAND
HAS COMPLETED 4 PV HOMES IN BAVARIA WEST GERMANY. 2 WILL BE I NDEPENDENT OF THE UTILITY AND 2 WILL BE PARTIALLY INDEPENDENT .

RECORD # 130 PV INTER 5/84,34
05/01/84 SOLEC INT'L
HAS DESIGNED A GEO SPACE WAVE TELEMETRY SYSTEM USING PV POWER WITH AMF.

RECORD # 167 PV NEWS 6/84,5
06/01/84 SOLEC INTERNATIONAL
THE LUMISOL (TM) LIGHT HAS 1200 LUMENS OUTPUT 105 AMP HR. AND SOLEC PV MODULES.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 240 PVIR 9/84,1
09/01/84 SOLEC INTERNATIONAL HAWTHORNE CA
INTRODUCES THE CLS-1010 DESIGNED FOR MAXIMUM LIGHT WITH LOW P
OWER CONSUMPTION.

RECORD # 317 PV INTERN'L 10/84,1
10-01-84 SOLECTRIC
SALE OF SOLECTRIC COMMON STOCK WAS COMPLETED IN A "2.75 MILLI
ON TRANSACTION. ALPHA SOLARCO OWNS 62% OF SOLECTRIC AND SOLEC
TRIC PURCHASED ALPHA PATENTS FOR $1,000,000.

RECORD # 200 SOLAR AGE 7/84,6
07/01/84 SOLECTRIC CORP
IS A SUBSIDIARY OF ALPHA SOLARCO AND IS DFFERING 13 MILLION S
HARES OF STOCK AT $.25 PER SHARE.SOLECTRIC EXPECTS TO DEVELOP
A PV BUSINESS.

RECORD # 238 PVIR 9/84,1
09/01/84 SOLENERGY CHATTANOOGA TN
INSTALLED A 4.3 KW SYSTEM ON A GRID CONNECTED HOUSE FOR THE T
VA. THE SYSTEM RUNS 24 HRS. PER DAY AND EXCESS ENERGY IS FED
BACK INTO THE GRID.

RECORD # 262 PVNEWS 10/84,1
10/01/84 SOLENERGY MASS
HAS A CONTRACT TO MANUFACTURE AND INSTALL PV SYSTEMS ON 5 SEP
ARATE ISLANDS.

RECORD # 293 SOLAR AGE 10/84,11 HARBOR ISLAN
10/01/84 SOLENERGY WOBURN, MA
INSTALLED 34 WATT MODULES IN HARBOR ISLAND STATE PARK FOR POR
TABLE RADIOS AND LIGHTS.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 354 WSM 12/84,10 CHINA
12-01-84 SOLENERGY
SIGNED AN AGREEMENT TO MAKE AND MARKET PV CELLS WORLOWIDE.

RECORD # 359 SEIR 12/84,389
12-10-84 SOLENERGY
HAS SIGNED AN AGREEMENT WITH CHINA TO BUILD A MANUFACTURING P LANT IN CHINA. SOLENERGY WILL MANUFACTURE CELLS USING MATERIL SUPPLIED BY THE CHINA FACILITY.

RECORD # 305 PVIR 11/84,1 WOBURN
11-01-84 SOLENERGY CORP. WOBURN, MA
HAS MERGED WITH ENTROPY LTD OF BOULDER COLORADO.

RECORD # 159 SEIR 6/84,187
D6/11/84 SOUTHERN CALIFORNIA EDISO
IS EVALUATING THREE MAJOR SOLAR TECHNOLOGIES TO MONITOR THEIR OUTPUT FOR A TWO WEEK PERIOD DURING THE SUMMER SOLSTICE.

RECORD # 88 PVIN 4/84,7
04/01/84 SOVOLCO
DEVELOPING CUINSE2 CELL FOR CENTRAL STATION APPLICATIONS. PLA N TO OPEN PILOT PLANT IN 1985.

RECORD # 247 PVIR 10/84,1
10/01/84 SOVOLCO SEATTLE, WA
READING BATES HAS PULLED OUT OF THE SOVOLCO JOINT VENTURE. H OWEVER, SOVOLCO IS CONTINUING WITH THE CUINSE2 CELL USING BOE ING FUNDS.

RECORD # 41 SOLAR E&C 4/84,15
04/01/84 SOVONICS
ECD WILL ENTER A-SI MARKET BY THE END OF 1984. CELL ASSEMBLY PLANT WILL BE BUILT IN TROY MI, AND A PANEL FACTORY IN WARREN SVILLE OH. MODULES WILL BE 1 FT WIDE IN VARYING LENGHTS.

1984 PV EVENTS

RECORD # 50 SEIR 4/84,113
04/02/84 SOVONICS CLEVELAND, OH
MOVED FROM SPC TO SOVONICS TO REPRESENT THEIR WORLDWIDE SALES . THEY WILL MASS PRODUCE PV PRODUCTS BY LATE 1984.

RECORD # 126 PV INTER 5/84,18
05/01/84 SOVONICS
IS CURRENTLY CONSTRUCTING 2 PV PLANTS THAT WILL BE COMPLETED IN OCTOBER 1984. THE COST OF THESE PLANTS IS ESTIMATED TO BE $6 MILLION.

RECORD # 202 SE&C 7/84,9
D7/01/84 SOVONICS
DEDICATED ITS NEW PRODUCTION FACILITY IN TROY MI ON MAY 31, 1984.

RECORD # 353 WSM 12/84,10 CHINA
12-01-84 SOVONICS
SIGNED AN AGREEMENT TO ESTABLISH A JOINT VENTURE TO MANUFACTURE AND MARKET A-SI CELLS AND MODULES.

RECORD # 358 SEIR 12/84,385
12-03-84 SOVONICS
HAS SIGNED AN AGREEMENT WITH CHINA AND SOHIO TO MANUFACTURE AND MARKET PV IN CHINA.

RECORD # 284 SEIR 11/84,347 CHINA
11-05-84 SOVONICS SOLAR TECHNOLOGY
HAS SIGNED A MEMORANDUM OF UNDERSTANDING GRANTING CHINA FIRST PRIORITY IN CREATING A JOINT VENTURE TO MANUFACTURE AND MARKET A-SI CELLS IN CHINA.

RECORD # 129 PV INTER 5/84,34
05/01/84 SPECIALTY CONCEPTS
IS REPLACING THE PHOTOWATT PCU WITH THE SCI CHARGER. NEW MODEL NUMBER IS SCI1-12-BF3L.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 158 PVIR 6/84,6
06/15/84 SPECTRO LABS SYLMAR, CA
HUGH'S AIRCRAFT GA AS PV TECH HAS BEEN TRANSFERED TO SPECTRO LABS AS THE FIRST STEP IN COMMERCIALIZING THE TECHNOLOGY. THE FIRST GA AS CELLS ARE EXPECTED BY MID 1985.

RECORD # 3 PVIR 3/84,5 BEDFORD, MA
03/01/84 SPIRE
HAS BEEN ELECTED TO NEW POSITION FROM COMBUSTION ENGINEERING INC.

RECORD # 15 SEIR 1/84,37 BEDFORD, MAS
01/30/84 SPIRE
$3 MILLION WAS AWARDED BY SERI TO SPIRE TO STUDY MULTIJUNCTIO N A-SI. THEY HOPE TO ACHIEVE 18% EFFICIENCY BY 1988. POLAROID HAS ALSO CONTRIBUTED TO THE RESEARCH.

RECORD # 22 SEIR 2/84,63
02/20/84 SPIRE
ACHIEVED 18% CONVERSION EFFICIENCY WITH CRYSTALLINE SI CELL, THE HIGHEST ACHIEVED TO DATA.

RECORD # 99 PV INTER 3/84,16
03/01/84 SPIRE
RECEIVE $3 MILLION FROM SERI TO STUDY A-SI MULTIJUNCTION CELL S.

RECORD # 106 PVIN 5/84,1
05/01/84 SPIRE
WAS THE TOP PRICE PERFORMER IN 1984 FOLLOWED BY CHRONAR AND S OLAR ELECTRIC ENGINEERING

RECORD # 272 SOLAR AGE 10/84,13
10/01/84 SPIRE
CONCERNED THAT THE US PV INDUSTRY IS NOT PLACING ENOUGH MONEY INTO CRYSTALLINE SI PRODUCTION AND EMPHASIZING A-SI. JAPAN C ONTINUES TO INVEST IN CRYSTALLINE PRODUCTION FACILITIES.

1984 PV EVENTS

RECORO # 273 SOLAR AGE 10,84,39
10/01/84 SPIRE
HAS SHOWN AN INCREASE IN OF 58% FOR THE PAST SIX MONTHS.

RECORO # 263 PVNEWS 10/84,1
10/01/84 SPIRE CORP MASS
RECEIVED CONTRACT WITH SERI TO STUDY GAAS MULTI BANDGAP CELLS . CONTRACT IS WORTH $841,000.

RECORD # 175 SEIR 6/84,184
06/01/84 SPIRE CORP. BEOFORD, MA
HAS RECEIVED NEW ORDERS WORTH $500,000 FOR THEIR MANUFACTURIN G EQUIPMENT.

RECORD # 285 SEIR 11/84,351 BEDFORD,MA
11-05-84 SPIRE CORP.
REACHED AN AGREEMENT WITH SOLARPAC ENERGY SYSTEMS FOR THE SAL E OF COMPLETE SPIRE TURNKEY PV PRODUCTION SYSTEMS . SOLARPAC IS A CANADIAN FIRM.

RECORD # 295 SOLAR AGE 10/84,11 BEOFORD, MA
10/01/84 SPIRE CORP. BEDFORO, MA
HAS SHOWN A 58% INCREASE IN SALES FOR THE PAST SIX MONTHS. MA NY MARKETS ARE EXPANDING FOR THEIR PRODUCTION LINES IN PARTIC ULAR ARE THE INTERNATIONAL MARKETS.

RECORD # 316 SE&C 11/84,21 BEDFORD, MA
11-01-84 SPIRE CORP. BEDFORD, MA
GRANTED A TWO YEAR CONTRACT WITH SERI TO CONTINUE RESEARCH ON GA AS MULTIBAND CELLS.

RECORD # 328 PV NEWS 12/84,4 BEDFORD, MA
12-01-84 SPIRE CORP. BEDFORD, MA
NOW HAS MANUFACTURING EOUIPMENT LOCATED IN 16 COUNTRIES. CANA DA IS PURCHASING A LINE BY SOLAR PAC ENERGY SYSTEMS-A 1 MW PR ODUCTION LINE.

1984 PV EVENTS

RECORD # 352 WSM 12/84,10 CHINA
12-01-84 SPIRE CORP. BEDFORD MA
SIGNED 20 YEAR, $4 MILLION AGREEMENT WITH CHINA TO SELL 1 MW PV MANUFACTURING EQUIPMENT.

RECORD # 357 SEIR 12/84,385 BEDFORD, MA
12-03-84 SPIRE CORP. BEOFORO, MA
A $4 MILLION AGREEMENT HAS BEEN SIGNED WITH CHINA TO SUPPLY P V PRODUCTION EQUIPMENT. THE AGREEMENT ALSO INVOLVES ELECTRONI C SPACE SYSTEMS CORP.

RECORD # 81 PV NEWS 4/84,4
04/01/84 SPIRE/ARCO
SELECTED BY JPL TO OEVELOP ULTRAVIOLET LASER PROCESS FOR PV J UNCTION FORMATION AND ANNEALING. SPIRE WILL RECEIVE $350,000, AND ARCO WILL RECEIVE $500,000.

RECORD # 364 PVINTER. 12/84,11
12-01-84 SPIRE/JPL 8EDFORO MA
RECEIVED A $250,000 COMPETITIVE PROCUREMENT FROM JPL TO ADAPT PULSED EXCIMER LASER PROCESSING TO FABRICATE COST EFFECTIVE PV CELLS. RESEARCH AIM IS TO PRODUCE A 16% EFFICIENT CELL.

RECORD # 64 RENEW 3/84,18
03/01/84 SPIRE/POLAROID
SPIRE AND POLAROID ARE JOINT PARTNERS IN A $3 MILLION COST SH ARING CONTACT WITH SERI. THE OBJECTIVE IS TO OEVELOP 18% EFF. ADVANCED MULTI JUNCTION A-SI CELL BY 1988.

RECORO # 365 PVINTER. 12/84,11
12-01-84 SPIRE/SOLARPAC SALE BEDFORD MA
SIGNED AN AGREEMENT WITH SOLARPAC OF CANADA TO SALE OF COMPLE TE SPIRE TURNKEY PRODUCTION LINE.

RECORD # 366 PVINTER. 12/84,11
12-01-84 STATE FO NEW MEXICO
IS OFFERING $50,000 TO $250,000 SEEO CAPITAL TO ENERGY ENTREP ENEURS TO ATTRACT THEM TO THE STATE. THE STATE RECEIVES A ROY ALTY OF 2% OF GROSS SALES FOR THE FIRST 8 YEARS.

1984 PV EVENTS

RECORD # 24 SEIR 2/84,52
D2/13/84 STATE OF MASS.
HAS PLANS TO MAKE MASS THE NATION'S LEADER IN PHDTOVDLTAICS. PLANS INCLUDE BUILDING LARGE PV DEMOS., EXPORT TRADING CO., F IELD TESTING, CENTER OF EXCELLENCE,& PARTNERSHIPS.

RECORD # 68 SOLAR AGE 4/84,14
04/01/84 STRATEGIES UNLIM
ESTIMATE THAT 1983 PV SHIPMENT IN THE US WERE 15.3 MW. ARCO AND UEC REPRESENTED 5 MW.

RECORD # 241 PVIR 9/84,1
09/01/84 SUMAMP SCOTTSDALE AZ
HAS AN ELECTRONIC BOAT KIT FOR FISHERMAN THAT INCLUDES AN 16- 2000 35 WATT MODULE, DEEP CYCLE BATTERY, VOLTAGE REGULATOR.

RECORD # 144 SEIR 4/84,145 JAPAN
04/30/84 SUMITDMO CHEMICAL CORP. JAPAN
HAS DEVELOPED A PRDCESS FOR RECOVERING GALLIUM FROM BAUXITE. GA IS REFINED TO 5N PURITY.

RECORD # 111 PVIN 5/84,4 JAPAN
05/01/84 SUNSHINE PROJECT JAPAN
INCREASED PV FUNDING FRDM $23.54 MILLION IN 1983 TO $30.54 MI LLION IN 1984.

RECORD # 100 PV INTER 32/84,17
D3/01/84 SUNWATT PHILIPPINES
HAS SIGNED AN AGREEMENT WITH PILIPINAS SUNPOWER INDUSTRIES AN D DEVELOPMENT CORP TO ESTABLISH THE PV INDUSTRY IN THE PHILIP PINES.

RECDRD # 324 PV INTERN'L 10/84,1
10-01-84 SUNWATT CORP. ENGLISH, IN
IS NOW OFFERING A SMALL BATTERY CHARGER FOR $24.00. CAN CHARG E EITHER AA ,C OR D BATTERIES.

1984 PV EVENTS

RECORD # 254 PVIR 10/84,2
10/01/84 TAKENAKA ENGINEERING JAPAN
DEVELOPED A NEW WIRELESS SURVEILLENCE SYSTEM POWERED BY PV. THE SYSTEM USES 4.5 W PV ARRAY FOR POWER.

RECORD # 19 PVIR 2/84,5
02/01/84 TDK TOKYO, JAPAN
DEVELOPED 1 CM2 A-SI CELL WITH 10.5% CONVERSION EFFICIENCY. THEY WILL PRODUCE A 10 CM2 CELL WITH 10% EFF. IN 1984.

RECORD # 53 SEIR 3/84,95
03/19/84 TDK JAPAN
HAS ACHIEVED 10.5% EFFICENCY ON A 1 CM SQ. CELL. THEY HOPE TO INCREASE THE CELL SIZE TO 10 CM SQ. WITH MINIMAL EFF. LOSS.

RECORD # 94 WSM 4/84,9
04/01/84 TDK
HAS DEVELOPED A 1 CM SQ. A-SI CELL WITH AN EFFICIENCY OF 10.5 % CLAIMED TO BE ONE OF THE HIGHEST IN THE WORLD. THEY HOPE TO DEVELOP A 10 CM SQ. CELL BY THE SUMMER OF 1984.

RECORD # 108 PVIN 5/84,2 TEXAS
05/01/84 TEXAS INSTRUMENTS TEXAS
IS WORKING ON SPJERICAL PV CELLS. THEY ARE TRYING TO IMPROVE THEIR EFFICIENCIES BY MAKING THE CELLS ROUND.

RECORD # 248 PVIR 10/84,1
10/01/84 TEXAS INSTRUMENTS
CONTINUING ITS PV RESEARCH EFFORTS ON THE SPERICAL CELL WITHOUT BUILT IN STORAGE.

RECORD # 207 PV NEWS 8/84,4
08/01/84 TOSHIBA JAPAN
SMUD WILL BE PURCHASING THEIR POWER CONDITIONING EQUIPMENT FROM TOSHIBA OF JAPAN.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 74 PVIR 4/84,3
04/01/84 TRIANGLE RESEARCH INSTITU
RECEIVED $100,365 FROM SERI TO STUDY CASCADE PV CELLS.

RECORD # 8 PVIR 3/84,6
03/01/84 TRISOLAR CORP.
GOING PUBLIC WITH AN OFFERING OF 500,000 SHARES AT $5.00/UNIT
.

RECORD # 18 PVIR 2/84,3 BEDFORD, MAS
02/01/84 TRISOLAR CORP. BEDFORD, MASS
HAS BUILT 7 TRAILER MOUNTED SOLAR CELL POWER SYSTEMS FOR THE ARMY. EACH ARRAY HAS 1 TO 4 KWP AND USE ARCO M51 MODULES.

RECORD # 187 PVIR 7/84,3 BEOFORD
07/01/84 TRISOLAR CORP. BEDFORD MA
PROPOSED A PUBLIC OFFERING OF STOCK IN CANADA.

RECORD # 345 SOLAR AGE 12/84,35
12-01-84 TRISOLAR CORP.
IS IN THE PROCESS F BEING ACQUIRED BY CHRONAR CORP.

RECORD # 290 SEIR 10/84,339
10/29/84 TRW
SPACE SOLAR CELLS COULD BECOME MUCH LESS EXPENSIVE AND MUCH L IGHTER DUE TO THE RESEARCH BEING CONDUCTED BY TRW. USE CASSEG RAINIAN CONCENTRATOR AND GA AS MATERIAL.

RECORD # 341 PVIR 12/84,1
12-01-84 TRW INC. REDONDO BEACH, CA
IS INTRODUCING A NEW PV ARRAY THAT WILL REDUCE THE LIFE CYCLE COST OF SPACE PV BY 30%. USE A MINATURE CASSEGRAINIAN CONCEN TRATOR.

1984 PV EVENTS

RECORD # 65 PV NEWS 2/84,3
02/01/84 UEC
UEC SOLD 5.5 MW OF PV IN 1983 WITH 4.5 MW GOING TO ITS THIRD PARTY FINANCED BARSTOW AND BORREGO SPRINGS INSTALLATIONS.

RECORD # 172 RENEWS 6/84,28 FOSTER CITY
06/01/84 UEC FOSTER CITY, CA
SOLD 4.5-5.5 MW OF PV IN 1983 AND IS EXPECTED TO SELL 8.5-9 MW IN 1984. THE MAJORITY OF THESE SALES WERE THROUGH THIRD PARTY FINANCING ARRANGEMENTS.

RECORD # 269 SEIR 09/84,292
09/17/84 UEC
ERNEST LAMPERT SAYS THAT SOLAR TAX CREDITS SHOULD BE EXTENDED AND SHOULD BE LIMITED TO THE PURCHASE OF DOMESTICALLY PRODUCED SOLAR EQUIPMENT.

RECORD # 327
12-01-84 UEC
WILL PRODUCE ABOUT 5 MW OF 100X FRESNEL LENS CONCENTRATORS THIS YEAR. NOW HAVE 2 AXIS TRACKING SYSTEM. 250KW SYSTEM IN BARSTOW IS USED TO PRODUCE ALCOHOL IN A STILL.

RECORD # 308 PVIR 11/84,1 NORTHBROOK
11-01-84 UNDERWRITERS LABORATORIES NORTHBROOK, IL
IS REQUESTING COMMENTS ON ITS PROPOSED FIRST EDITION OF PV STANDARDS.

RECORD # 286 SEIR 11/84,352 NORTHBROOK
11-05-84 UNDERWRITERS LABORATORY
HAS ISSUED ITS FIRST DRAFT OF A PROPOSED STANDARD FOR FLAT PLATE PV MODULES, INCLUDING CONSTRUCTION, PERFORMANCE TESTING, RATINGS AND MARKETING.

RECORD # 48 SEIR 4/84,112
04/02/84 UNISEARCH
IS LOOKING FOR LICENSEES IN THE US TO SELL ITS PV ARRAY WITH SHUNTING DIODE.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 93 WSM 4/84,8
04/01/84 UNISEARCH LTD. SYDNEY AUSTRALIA
OFFERING A PV ARRAY WITH A BUILT IN SHUNTING DIODE FOR LICENS ING IN THE US. THE DEVICE WAS DEVELOPED AT THE UNIVERSITY OF NEW SOUTH WALES. THIS UNIVERSITY HAS OVER 124 PATENTS.

RECORD # 220 SEIR 8/84,251
08/06/84 UNIVERSITY OF MARYLAND
EXTENDING THE STATE SOLAR TAX CREDITS CAN BE EXPENSIVE. IT C OSTS ARIZONA $13.1 MILLION, WISCONSIN $2.9 MILLION AND MICHIG AN $1.2 MILLION. MOST IS MADE UP BY THE STATES.

RECORD # 268 WSM 09/84,5
09/01/84 UNIVERSITY OF SOUTH WALES
FILED A PATENT APPLICATION FOR LASER-GROOVED SOLAR CELLS.

RECORD # 51 SEIR 3/84,90
03/19/84 US CONGRESS
WILL EXTEND SOLAR BUSINESS TAX CREDIT UNTIL 1988, AND THE RES IDENTIAL SOLAR TAX CREDIT THROUGH 1987. HOWEVER THEY ARE CUTT ING THE ENERGY CONSERVATION TAX CREDITS.

RECORD # 66 WORLD SOLAR 3/84,1
03/01/84 US CONGRESS WASHINGTON DC
CONGRESS EXTENDED THE RESIDENTIAL SOLAR TAX CREDITS THROUGH 1 987 AND THE BUSINESS SOLAR TAX CREDIT THROUGH 1988.

RECORD # 160 SEIR 6/84,188 WASH D.C.
06/11/84 US CONGRESS
HELPING TO PROMOTE OVERSEAS SALES WITH PROMOTIONAL INFORMATIO N DEVELOPED BY STRATEGIES UNLIMITED AND JPL.

RECORD # 174 SEIR 6/84,179 WASH DC
06/04/84 US CONGRESS WASHINGTON DC
SOLAR LOBBY IS VERY PESSIMISTIC OVER THE FUTURE OF SOLAR TAX CREDITS BEING EXTEND
SPIRE CORP.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 34 PVIN 4/84,2
04/09/84 US DEP'T OF ENERGY WASHINGTON DC
DOE OFFICAL SAYS THAT EXTENDING THE TAX CREDIT BEYOND 1985 MAY BE HAMPERED BY THE SOLAR INDUSTY'S DISUNITY AND INABILITY TO PRESENT A UNIFIED PACKAGE TO CONGRESS.

RECORD # 78 PV NEWS 4/84,1
04/01/84 US PV INDUSTRY
SENATE FINANCE COMMITTEE WILL EXTEND THE SOLAR TAX CREDITS TO 1988 FOR BUSINESSES AND TO 1987 FOR RESIDENTIAL.

RECORD # 112 SOLAR AGE 5/84,39 USA
05/01/84 US PV INDUSTRY USA
SENATE FINANCE COMMITTEE VOTED TO EXTEND THE RESIDENTIAL AND BUSINESS SOLAR TAX CREDITS. RES. EXTENDED FOR 2 YEARS BUT CONSERVATION TAX CREDIT WAS CUT ONE YEAR.

RECORD # 140 SEIR 4/84,123 USA
04/16/84 US PV INDUSTRY USA
EXTENSION OF THE SOLAR TAX CREDITS IS LIKELY SINCE SENATE COMMITTEE HAS VOTED TO EXTEND THEM.

RECORD # 141 SEIR 4/84,123 USA
04/16/84 US PV INDUSTRY USA
COOPERATION SEEN BETWEEN INTERNATIONAL PV FIRMS. PHOTOWATT FRANCE IS WORKING WITH FUJI ELECTRIC AND CHRONAR WITH THE FRENCH TO SHARE PV TECHNICAL INFORMATION.

RECORD # 203 PV NEWS 8/84,1 USA
08/01/84 US PV INDUSTRY USA
THE US CAN SURVIVE THE TAX CREDIT FAILURE BY REDUCING MODULES COSTS TO $3 PER WATT, CONVINCE CONGRESS TO BUILD TWO SMUD, PASS LEG. TO GET DOD TO USE PV, REDIRECT NUC. FUNDS TO PV.

RECORD # 348 WSM 12/84,1
12-01-84 US PV INDUSTRY
MAY HAVE TO FACE LIFE WITHOUT THE AID OF SOLAR TAX CREDITS. THE REGAN TAX PLAN CALLS FOR ELIMINATING THE TAX CREDIT AS WELL AS ACRS FORMS OF DEPRECIATION.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 361 SEIR 12/84,403
12-24-84 US PV INDUSTRY
SOLAR FIRMS ARE TRYING TO DIVERSIFY THEIR BUSINESS LINES SINC E THE SOLAR TAX CREDITS WILL BE ELIMINATED IN 1 YEAR.

RECORD # 177 WSM 7/84,1 WASH DC
07/01/84 US SENATE WASHINGTON DC
HAS NOT CONVINCED THE HOUSE OF THE BENEFITS OF EXTENDING THE SOLAR TAX CREDITS BEYOND 1985.

RECORD # 115 SEIR 4/84,132 PALO ALTO CA
04/23/84 VARIAN PALO ALTO CA
HAS ANNOUNCED A FIVE YEAR PLAN TO BECOME A MAJOR PRODUCER OF PV USING GALLIUM ARSENIDE. THEY PLAN TO BE IN THE MARKET BY 1 989.

RECORD # 157 PVIR 6/84,5
06/15/84 VARIAN ASSOCIATES PALO ALTO, CA
HAS LAUNCHED A PROGRAM TO BECOME A MAJOR PRODUCER OF GA AS PV CELLS AND OTHER SEMI CONDUCTOR DEVICES. $16 MILLION WILL BE SPENT ON THEIR SOLID STATE MICROWAVE DIVISION IN SANTA CLARA.

RECORD # 246 PVIR 10/84,1
10/01/84 VARIAN ASSOCIATES
HAVE DEVELOPED ALGAAS CELLS WITH ONE SUN EFFICIENCIES OF OVER 19%.

RECORD # 33 WSM 02/84,5
02/01/84 VENTURE TECHNOLOGY UK
VENTURE TECHNOLOGY IS LEAVING THE PV BUSINESS. ABINGDON IS TA KING OVER THEIR PORTION OF THE PV BUSINESS.

RECORD # 283 SEIR 11/84,347 VIRGINIA
11-05-84 VIRGINIA ELECTRIC
HAS ANNOUNCED PLANS TO BUILD A 50 KWE PV FACILITY.

DATE LISTED 03-08-85

1984 PV EVENTS

RECORD # 225 SOLAR AGE 9/84,11
09/01/84 WEST GERMANY RES. WEST GERMANY
TWO RESIDENTIAL OFF-GRID PV SYSTEMS WERE INSTALLED WITHOUT TH E AID OF TAX CREDITS OR OTHER GOVERNMENT ASSISTANCE.

RECORD # 264 SEIR 10/84,1
10/01/84 WESTINGHOUSE CORP.
RECEIVED A $498,000 COONTRACT FROM EPRI TO STUOY DENORITIC WE B.

RECORD # 344 SOLAR AGE 12/84,11 PITTSBURGH
12-01-84 WESTINGHOUSE CORP. PITTSBURGH, PA
GETTING CLOSE TO THEIR GOALS OF LOW COST, HIGH EFFICIENCY CEL LS. THEY PLAN TO MAKE CELLS 16% EFF. AND COST<$1/W.

RECORO # 370 PVINTER. 12/84,12
12-01-84 WINDWORKS
HAS CHANGEO ITS NAME TO OMNION POWER ENGINEERING.

RECORD # 331 PV NEWS 12/84,4
12-01-84 WINDWORKS-OMNION
HAS CHANGED ITS NAME TO OMNION TO BETTER REFLECT ITS BUSINESS LINE. THEY MAKE INVERTERS FOR PV, WIND AND HYDRO.

RECORD # 56 PV NEWS 3/84,1
03/01/84 WORLD PV INDUSTRY
WORLD PV PRODUCTION WILL REACH 30 MW IN 1984. THE US SHARE WI LL BE 18 MW, WITH MAJOR GROWTH IN CONCENTRATORS AND ONLY SLIG HT GROWTH IN A-SI. CONCENTRATOR SHIPMENTS US 10 MW IN 1984.

RECORD # 67 WORLD SOLAR 3/84,3
03/01/84 WORLD WATCH INSTITUTE
WORLD WATCH PREDICTS THAT PV PRODUCTION WILL GROW TO 200 MW B Y 1990, AND TO 1000 MW BY THE YEAR 2000.

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