

## CHAPTER 2

### 1974 to 1984 The Solarex Corporation



Solarex Corporation "PV Breeder" Factory in Frederick, Maryland Completed 1983  
The First 200 kWp Building-Integrated Photovoltaic [BI-PV] Roof

During the 1970's Energy Crisis, everyone began looking for new ways to get where they wanted to go and to light up their lives and TVs without using fossil fuels. The press lauded energy efficiency as the answer in the 1970's just as it was deceptively the focus during Energy Crisis 2000.

In the early 1970's, a physicist by the name of Dr. Lindmayer was working for Comstat a satellite manufacturer that was using photovoltaic energy. He made discoveries that doubled the efficiency of solar cells. This advancement in technology was significant, but Dr. Lindmayer was not compensated for the patent that was owned by the company he worked for. He received minimal recognition and compensation for this important accomplishment. After some consideration of the energy crisis on the horizon, he decided to open his own manufacturing company where he could realize the profits of his work.

With the energy crisis at full tilt, Dr. Lindmayer realized it would be an ideal time to attempt the venture. He had a new and unique idea of using terrestrial photovoltaics to generate electricity for homes and office buildings.

Dr. Lindmayer and his partner Dr. Varadi, who had similar interests, founded the Solarex Corporation ca. 1974. This was the first terrestrial photovoltaics manufacturing company in the world.

## PV Action Begins to Flourish

*The modern solar industry began with the oil embargo of 1973-74 and was strengthened with the second embargo in 1979. The growth of the solar industry during the period of fuel shortages and high prices (1974-1984) soared from 45 solar collector manufacturing firms to 225 firms and from 1.3 million square feet to 17.2 million square feet of production annually. The solar market was helped during this period by government assistance, both Federal and State, mainly in the form of tax credits.<sup>97</sup>*

In 1974, Tyco Laboratories and Mobil Oil Corporation formed Mobil Mobil-Tyco Solar Energy Corporation.

*The origin of RWE SCHOTT Solar dates back to 1974, when Tyco Laboratories and the Mobil Corporation teamed up to begin developing advanced silicon solar cells for utilities, which required substantially tighter specifications and quality standards than other applications at the time. In 1994, ASE GmbH of Germany acquired all of Mobil's solar technology and assets, including its cell and module technology, which became the basis of today's ASE 300 module, the most powerful solar module available today.<sup>98</sup>*

In 1973, Harold Hovel published the first book of PV theory and technology,<sup>99</sup> "Solar Cells," Vol. 11 of Semiconductors and Semimetals, R. Williardson, A. Beer, ed., Academic Press, New York, NY 1975. In 1975, Ishaq Shahryar founded *Solec International*<sup>100</sup> and Exxon started the *Solar Power Corporation*.<sup>101</sup>

## Arco Solar ~ Bill Yerkes

In 1975, Bill Yerkes started *Solar Technology International* that later became *Arco Solar* which he managed until the late 1980s. In 2004, his new company Solaicx<sup>102</sup> built a PV manufacturing facility that promises to produce 8" PV wafers at \$1 watt. In Chapter 21 read the rich spontaneous PV history Bill provided via e-mail to me a few months ago. His fascination with PV is quoted in Dr. John J. Berger's 1998 book *Charging Ahead*<sup>103</sup>:

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<sup>97</sup> Chapter 6, *Solar Industry Profile, Renewable Energy Annual 1996*, April 1997 Energy Information Administration, Office of Coal, Nuclear, Electric and Alternative Fuels, U.S. Dept .of Energy, Washington, DC <http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap06.html>

<sup>98</sup> RWE Schott Solar previously Tyco-Mobil Solar, *ASE Profile*, <http://www.greenstar.org/ASE%20Profile.htm>

<sup>99</sup> Hovel, Harold, *Solar Cells*, Vol. 11 of Semiconductors and Semimetals, R. Williardson, A. Beer, ed., Academic Press, New York, NY 1975.

<sup>100</sup> Solec International, 2001 <http://www.accoair.com/content.asp?category=36>

<sup>101</sup> *The History of PV*, 2003 by Mark Fitzgerald, Science Communications, Inc., [www.pvpower.com/pvhistory.html](http://www.pvpower.com/pvhistory.html)

<sup>102</sup> Solaicx, photovoltaic manufacturing company founded by Bill Yerkes, 2004 <http://solaicx.com/>

<sup>103</sup> John J. Berger, PhD, *Charging Ahead, The Business of Renewable Energy and What It Means for America*, 1998

*“The thing I like about Photovoltaics is that it is so clean you can eat off of it.”*

The Jet Propulsion Laboratory (JPL) instituted *Block I*<sup>104</sup> procurement by the United States government. In January, the United States government initiated a terrestrial PV research and development project assigned to JPL and patterned after the Cherry Hill Conference held in Cherry Hill, New Jersey. Chapter 17 includes excerpts of JPL’s *California State Photovoltaics Consultant Report*, published by the California Energy Commission in 1978. Based upon the interviews of eight PV manufacturers, JPL forecast a price of \$.50 W by 1986. In 1977, the Solar Energy Research Institute<sup>105</sup> (SERI) opened in Golden, CO PV. That year PV production exceeded 500 kW. By 1982, worldwide production exceeded 9.3 MW. In 1991, SERI was renamed the National Renewable Energy Laboratory.

## The University of New South Wales Key Center for Photovoltaic Engineering<sup>106</sup>

In 1975, the University of New South Wales (UNSW) made their first solar cell. Dr. Professor Martin Green has led their tremendous research effort for many years. August 1998, I took the UNSW premier on-line Short Course *Advanced Photovoltaics*. See the lovely certificate from the UNSW Department of Engineering included herein in Chapter 11.

Twenty-five years after their first solar cell was created in 1974, March of 2000, the University of New South Wales announced the first photovoltaic engineering degree programs in the world. They offer five Bachelor dual degrees in Photovoltaic Engineering, a Master’s and PhD. I applaud their success and know these premier offerings of PV Engineering degrees will assure many more PV degree offerings at universities in the United States and around the world within the first decade of the 21<sup>st</sup> Century.

### Title 42, Chapter 71, Subchapter III Solar Photovoltaic Energy

*“To reduce the average cost of installed solar photovoltaic systems to \$1 per peak watt by fiscal year 1988; and (3) to stimulate the purchase by private buyers . . . at least 90 per centum”<sup>107</sup>*

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<http://www.ucpress.edu/books/pages/8296.html>

<sup>104</sup> *Inventors History; Photovoltaics Timeline*, About, A Primedia Company, 2004,

<http://inventors.about.com/library/inventors/blsolar2.htm>

<sup>105</sup> *The Solar Energy Research Institute Facility*, Golden Colorado, Highlighting High Performance, 1977

[www.nrel.gov/buildings/highperformance/pdfs/29390.pdf](http://www.nrel.gov/buildings/highperformance/pdfs/29390.pdf)

<sup>106</sup> Key Center for Photovoltaic Research, University of New South Wales in Sydney, Australia 2004

[www.pv.unsw.edu.au/](http://www.pv.unsw.edu.au/)

<sup>107</sup> Title 42, Chapter 71, Subchapter III Solar Photovoltaic Energy Research, Development and Demonstration, Sec. 5581,(b) (2), US Code Collection, Legal Information Institute, Cornell University, release date 7-24-2003

In 1975, 99.5% of the electricity consumed by Americans was generated by fossil fuel, nuclear and large hydro generation. During the next twenty years, despite numerous advances in renewable energy technology, increased knowledge about and concern about the environment including the birth of Earth Day in 1972, all other technologies increased only 0.1%.

## Dr. Selfridge and Solar Architecture Teaching Assistant 1975

*O. John Selfridge, Ph.D., 1996, - Dr. Selfridge has a master's degree in city planning and a Ph.D. in epidemiology and public health. He has been active in energy and environmental health consulting issues since 1975. He teaches courses related to health and safety concerns of buildings.<sup>108</sup>*

In 1975, I was studying architecture at Kansas State University. I served as an assistant to Dr. Selfridge for his special community education project to teach primary school children about solar energy. Photovoltaics was claimed to cost too much at that time for most homeowners to install. The children cooked chicken and eggs using a hanger and aluminum foil.

In 1976 the IEEE published an historic overview of the electricity industry, *Turning Points In The Electricity Industry*. An important goal of this book is to provide an otherwise inaccessible and unique historic chronicle for consumers to familiarize ourselves with a comprehensive view of the electricity industry. The 1980's and 1990's reveal the forces and patterns of illegal commerce and oppressive litigation that have kept photovoltaics off the market. It further reveals the potential benefits of facilitating industry transformation to distributed self-generation renewable BI-PV through mass consumer intervention in energy agency proceedings.

*Unlike the arrays of solar panels on a hillside that represented the experimental phase of solar cells in the past, the Intercultural Center combines multiple uses by incorporating the solar panels into the structure of the roof. When completed in 1983, the roof will hold 35,000 square feet of solar cells. Each cell consists of two layers of silicon wafers. Photons radiate energy from the sun – striking the layers of silicon excite the electrons of the silicon wafers. These positively and negatively charged particles are then scooped up by a metal collector sandwiched between the wafers as direct electrical current, like that, which comes from batteries. The current then is sent through an inverter, which changes it to AC, or alternating current like that, which comes from a wall socket. Under ideal conditions, the new roof will provide the power to heat and light the six-story building and its auditorium with 300 to 350 kilowatts of power.<sup>109</sup>*

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Original Source: [Pub. L. 95-590](#), § 2, Nov. 4, 1978, [92 Stat. 2513.](#), <http://www4.law.cornell.edu>

<sup>108</sup> Kansas State University Graduate Certificate Program in Occupational Health Psychology, Support Faculty [http://www.k-state.edu/psych/graduate\\_health.htm](http://www.k-state.edu/psych/graduate_health.htm), 2003 Kansas State University

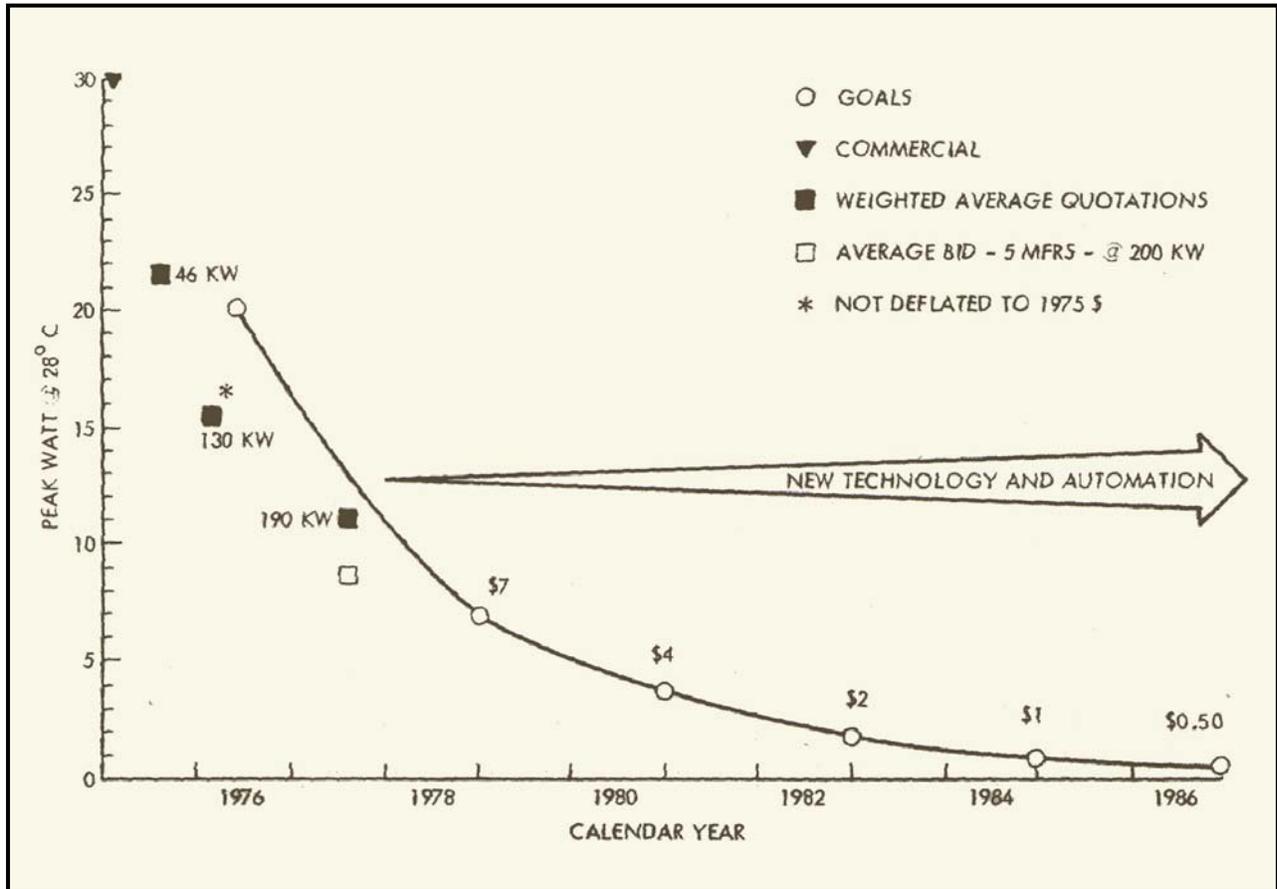
<sup>109</sup> *Anticipating the Future*, Georgetown Magazine, Nov-Dec 1982, page 7

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California State Photovoltaics Consultant Report<sup>110</sup>  
written by the Jet Propulsion Laboratory  
published by the California Energy Commission [CEC] 1978

California Energy Commission No. 5030-188  
LSSA Price Goals/Achievements  
1975 DOLLARS PER PEAK WATT @ 28° C

Arco Solar was the largest  
photovoltaic manufacturing  
company in California in 1978.



Arco Solar was one of the eight manufacturing companies interviewed by the Jet Propulsion Laboratory [JPL] in 1978 for the *California State Photovoltaics Consultant Report* published by the CEC. The report indicates photovoltaics was market ready and affordable to a portion of the energy marketplace at that time. Arco Solar was selling PV for \$9 to \$11 a watt. The graph on page D-4 of the report shown herein forecast photovoltaics would be fifty cents a watt by 1986. JPL calculates deep space travel and is highly respected for their analytic opinions. *Not even rocket scientists could*

<sup>110</sup> *California State Photovoltaic Consultant Report*, written by the Jet Propulsion Laboratory and published by the California Energy Commission (CEC) Doc. # 5030-188, 1978, page D-4 [Available free at CEC]

*convince energy agencies that PV is and was affordable and market ready not only in 1996, but also in 1978!*<sup>111</sup> Energy agency staff and energy cartel associates claim JPL was in error. See Chapter 17 for information about conflicting CEC documents and the story of how I discovered the JPL report.

In 1978, Arco Solar was one of the largest photovoltaic manufacturers in the world. At that time, they were selling wholesale PV modules at a price of \$9 to \$11 watt to a \$15 watt market. Their claim to fame, among other things, was the installation of the first Megawatt peak field array in Hesperia, California. This was completed in 1988 ten years after Bill Yerkes partnered with Atlantic Richfield to form Arco Solar. Some sources insist controversy existed in the relationship between Arco and Bill Yerkes, however, Arco Solar led by Bill Yerkes was a strong leader in the PV industry for 15 years. Read his version of PV history in Chapter 21 and about his company Solaicx formed in 2004 to produce 8" solar wafers.<sup>112</sup>

*Protecting Solar Access: A Guidebook for California Communities*  
written by Martin Jaffe, Senior Research Associate  
and American Planning Association  
published by CEC 1978

In 1978, the California Assembly passed two bills to assist homeowners and local government officials in the new task of protecting solar access using conventional land use controls to assure space heating, cooling and domestic hot water heaters for new residential developments.

The first bill is the Solar Shade Control Act [CH. 1366, 1978 Cal. Stats.] sponsored by Assemblyman Imbrecht. This law allows communities to control the planting of trees and the construction of new development to minimize conflicts with solar access. The second law is the California Solar Rights Act of 1978 [CH. 1154, 1978 Cal. Stats.] This law sponsored by Assemblyman Levine establishes standards for solar easements and allows local governments to require such easements as a condition of approval of subdivision maps and sets forth design requirements for planning new subdivisions under the Subdivision Map Act to assure existing or future uses of solar and natural heating and cooling strategies. The Solar Rights Act prohibits communities from adopting local ordinances that unreasonably restrict the use of solar energy and amends the state tax laws to better allow the use of tax credits for solar energy systems and solar easements.

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<sup>111</sup> *Energy Technology Status Report*, written and published by the California Energy Commission 1996

<sup>112</sup> Bill Yerkes Pioneer of Photovoltaic Manufacturing, Solaicx, 2004 <http://solaicx.com/>

*The Solar Rights Act also prohibits communities from adopting local ordinances that unreasonably restrict the use of solar energy and amends the state tax laws to better allow the use of tax credits for solar energy systems and solar easements.<sup>113</sup>*

## Real Goods, Inc. Ukiah, California founded in the 1970's

John Schaffer founded Real Goods, Inc. in Ukiah, California during the 1970's. [www.realgoods.com](http://www.realgoods.com) I was always very impressed with them and ordered solar safari hats for dinner guests in 1995. But, as my formal involvement and analysis of the industry evolved, they presented challenges for the Solar Development Cooperative. See Section III to see the significance of their using our domain name, which started February 2000 during the DG Rulemaking. [www.solardevelopment.com](http://www.solardevelopment.com) The Solar Development Cooperative is not associated with Real Goods, Inc. in any way.

## Steven Strong, AIA Cambridge and the Solar Design Associates

In the 1970's, amid the energy crisis of that era, a young architect student from Cambridge, Massachusetts named Steven Strong worked in the oil fields of Alaska to make money to pay for his college expenses. When he returned he was convinced that the world needed to develop renewable energy and reduce the need to deploy fossil fuels. Upon completion of his studies, Mr. Strong founded Solar Design Associates. Over the next decade, he installed several historic BI-PV projects on homes and businesses. The Carlyle House and the Impact 2000 Home are two of the most well known examples of his work. For more information about these important projects visit the SDA website at [www.solardesign.com](http://www.solardesign.com).

## Bob Danielson at Active Solar in Huntington Beach, California<sup>114</sup>

In 1976, Bob Danielson<sup>115</sup> founded Active Solar in Huntington Beach, California. He is a great resource on the history of the photovoltaic industry. I interviewed him for an IN FOCUS News Special Edition on Energy Crisis 2000, which I wrote and produced Fall 2001 while taking a course on news reporting at Golden West College. Bob is a graduate of the GWC.

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<sup>113</sup> *Protecting Solar Access: A Guidebook for California Communities*, written by Martin Jaffe, Senior Research Associate and the American Planning Association 1313 East 60<sup>th</sup> Street, Chicago, Illinois 60637 and published by the California Energy Commission (CEC) Document Number: 500-80-013; pg ii 1978 [Available free from CEC]

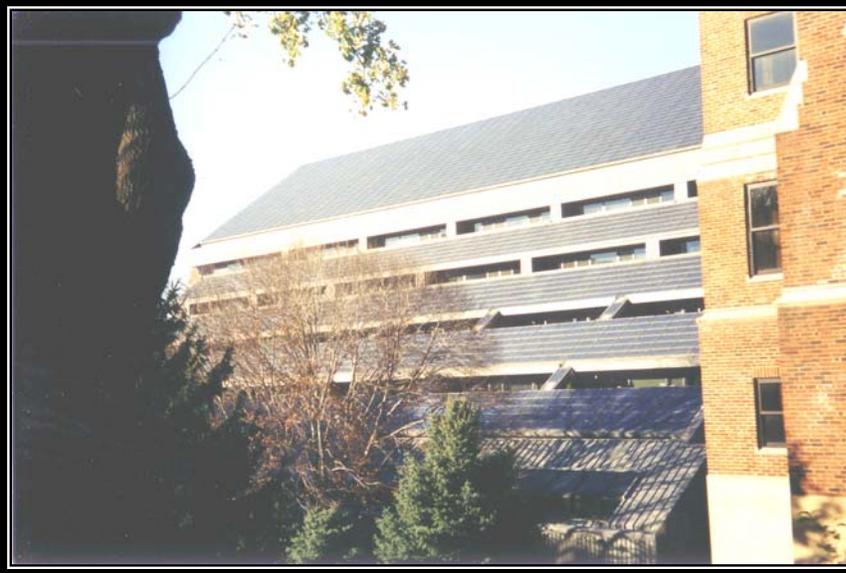
<sup>114</sup> Southern California Directory, Renewable Energy and Energy Efficiency, Building Concerns, Regional Resource Directory, <http://www.buildingconcerns.com/socal/renew.htm>

<sup>115</sup> *Bob Danielson, Active Solar*, Building Concern, Southern California Resource Directory, 2004 <http://www.buildingconcerns.com/socal/renew.htm>

## Mother Earth News

*Mother Earth News* is an excellent magazine that has served as a guide for harmonious existence with nature since it was founded in 1970's. It was one of the few magazines that featured articles on the three types of solar energy<sup>116</sup> at that time and they continue to do so, today. <http://welcome.motherearthnews.com>

Some solar energy experts carelessly install photovoltaics on a roof without employing quality design and construction techniques. They do not appropriately integrate PV systems *architecturally* into homes and office buildings. In a remote-site setting that may be acceptable, but if you're going to make solar electricity by integrating solar systems in a building, why not make it beautiful. A certification program for architects and contractors is needed to assure *building-integrated photovoltaics* (BI-PV) are



well designed and soundly integrated into the building envelope.

By 1980, the first Wang computers were tested in the marketplace. By 1986, the personal computer (PC) was a flourishing market. The computer electronics board is made of *computer-grade silicon* that is

900% more expensive to produce for manufacturing than *photovoltaic-grade silicon*. By 1990, nearly every office and school had computers and most individuals owned at least one. Laptop computer technology had begun to evolve into the market. Silicon makes up of 27% of the earth's crust and the process of refinement is well-known and traditionally rather simple. Considering, the inception of a trillion-dollar computer silicon semiconductor industry and the trillion-dollar celestial or satellite photovoltaic industry coupled with the JPL report indicating PV would be fifty cents a watt by 1986, how is it that the alleged price of PV in 2004 was \$5 to \$10 watt?

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<sup>116</sup> *Solar On A Shoestring*, Mother Earth News, Jan/Feb 1980, Volume #61, <http://www.motherearthnews.com/index.php?page=arc&id=2104>

## URBAN BUILDING-INTEGRATED PHOTOVOLTAICS 1984



*Pretty Polly*

Georgetown University Intercultural Center  
30,000 SF BI-PV Poly-Crystalline Silicon Semiconductor  
Generates Average of One Megawatt Hour Daily

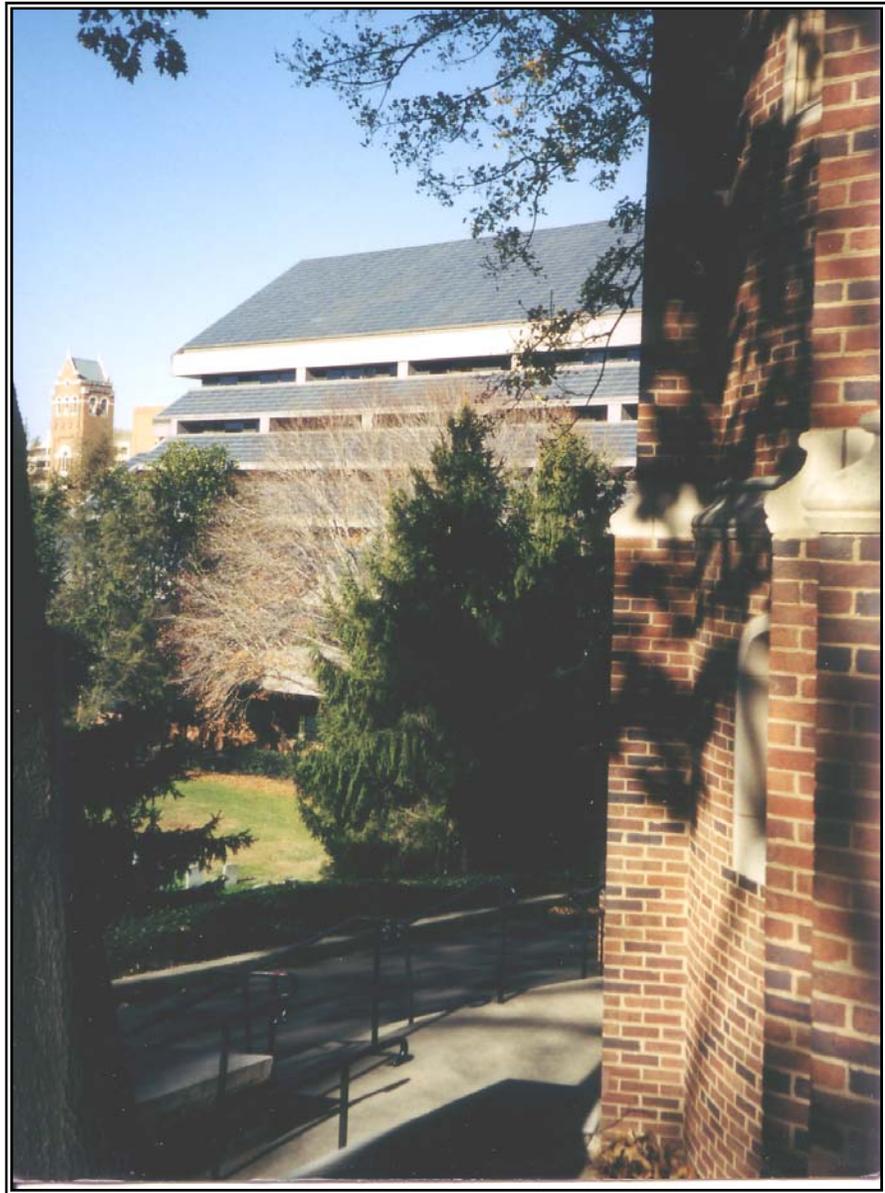
In 1984, the Solarex Corporation completed their first commercial *building-integrated photovoltaic* (BI-PV) system located in a dense urban environment with the installation of the 30,000 SF BI-PV roof on the Intercultural Center at Georgetown University. The importance of this event cannot be emphasized enough. Georgetown University is a Jesuit institution founded in 1789. It houses the oldest Foreign Service Training Center in the United States. The solar electric roof on the Intercultural Center reflects their stated goals to improve foreign policy, communications and expand environmental technologies. The commercial industry will be instrumental in bringing quality products and design to residential photovoltaic consumers.

*Founded in 1789, the same year the U.S. Constitution took effect, Georgetown University is the nation's oldest Catholic and Jesuit university. Today, Georgetown is a major international research university that embodies its founding principles in the diversity of our students, faculty, and staff, our commitment to justice and the common good, our intellectual openness, and our international character.<sup>117</sup>*

<sup>117</sup> Georgetown University, *official website*, 2004, <http://www.georgetown.edu/home/about.html>

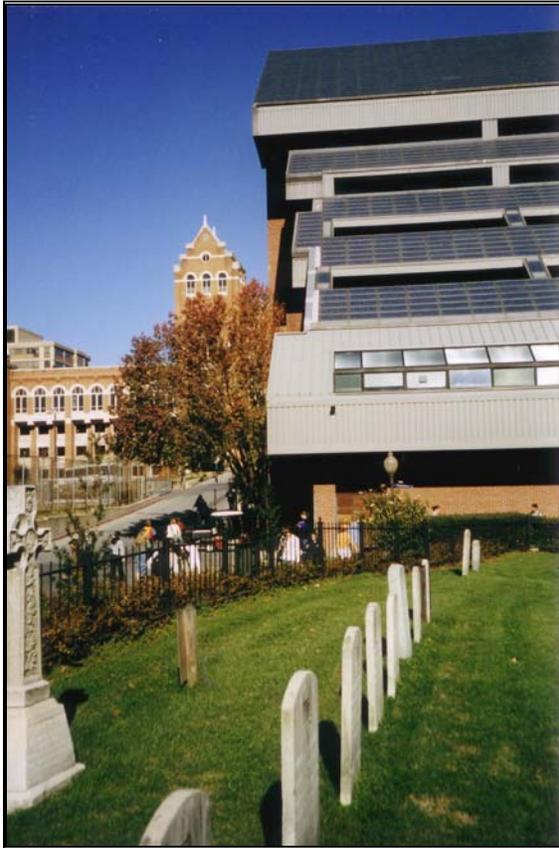
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One thing to remember is that this was the first of its kind. The metal around the PV has degraded a little, but the panels work fine. Titanium frames would be less apt to degrade so quickly and would also be lighter. There is a need to have access to the photovoltaic roof for cleaning once or twice a year. I have often wondered if one could install a water sprinkler system that could be used to wash the modules automatically for a brief period once or twice a month. It could also serve as a safety feature in case of fire.

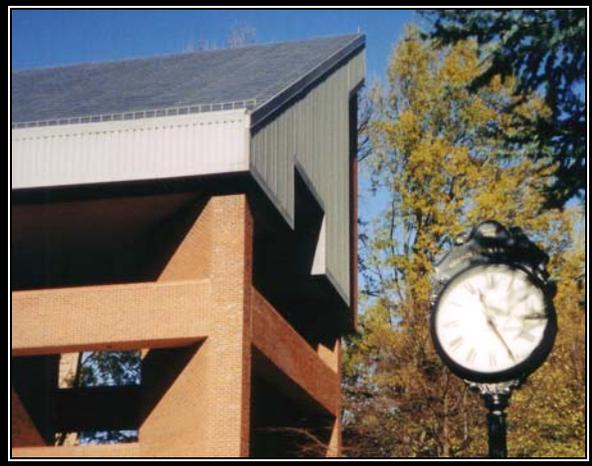


A reliable source shared with me that the Georgetown University solar array only produced at 5% of total expected output for nearly six months. It is said that one day a janitor stopped and chatted with several Ph.D. electrical engineers studying the inverter boxes for the system trying to figure out what might be the problem. The janitor noticed that several wires appeared to be connected wrong. They switched the wires and it has run at 95% efficiency for the last twenty years. It is a turning point in BI-PV history with the first large building-integrated project in a dense urban environment. Most of the people who work in the building daily are not aware the roof generates electricity and has since the BI-PV solar array was completed in 1984. That is over \$1 million of pollution-free, noise-free fuel-free electricity.

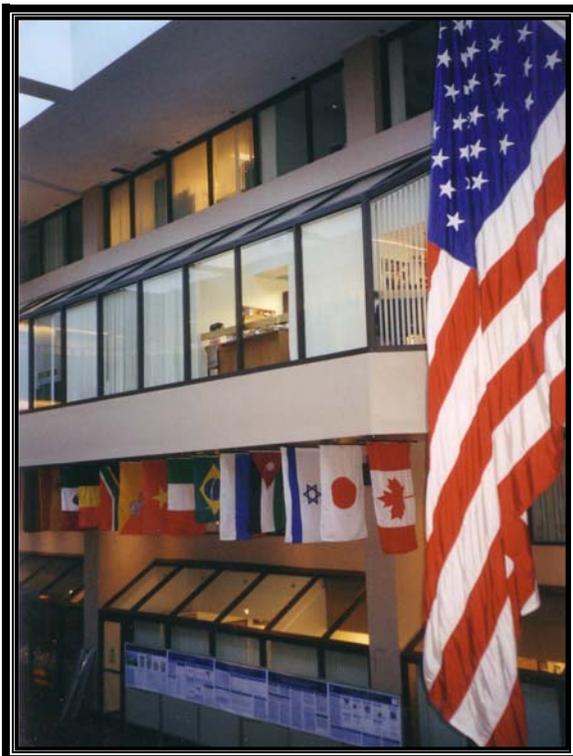
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*Intercultural education, a new idea, was a response to several pressing issues of the seventies, both at Georgetown and in the rest of the country. A growing conviction that international education should become more interdisciplinary had combined with the interest in expanding the traditional, politically oriented curriculum that had grown up in the late 1960s and early 1970s.*

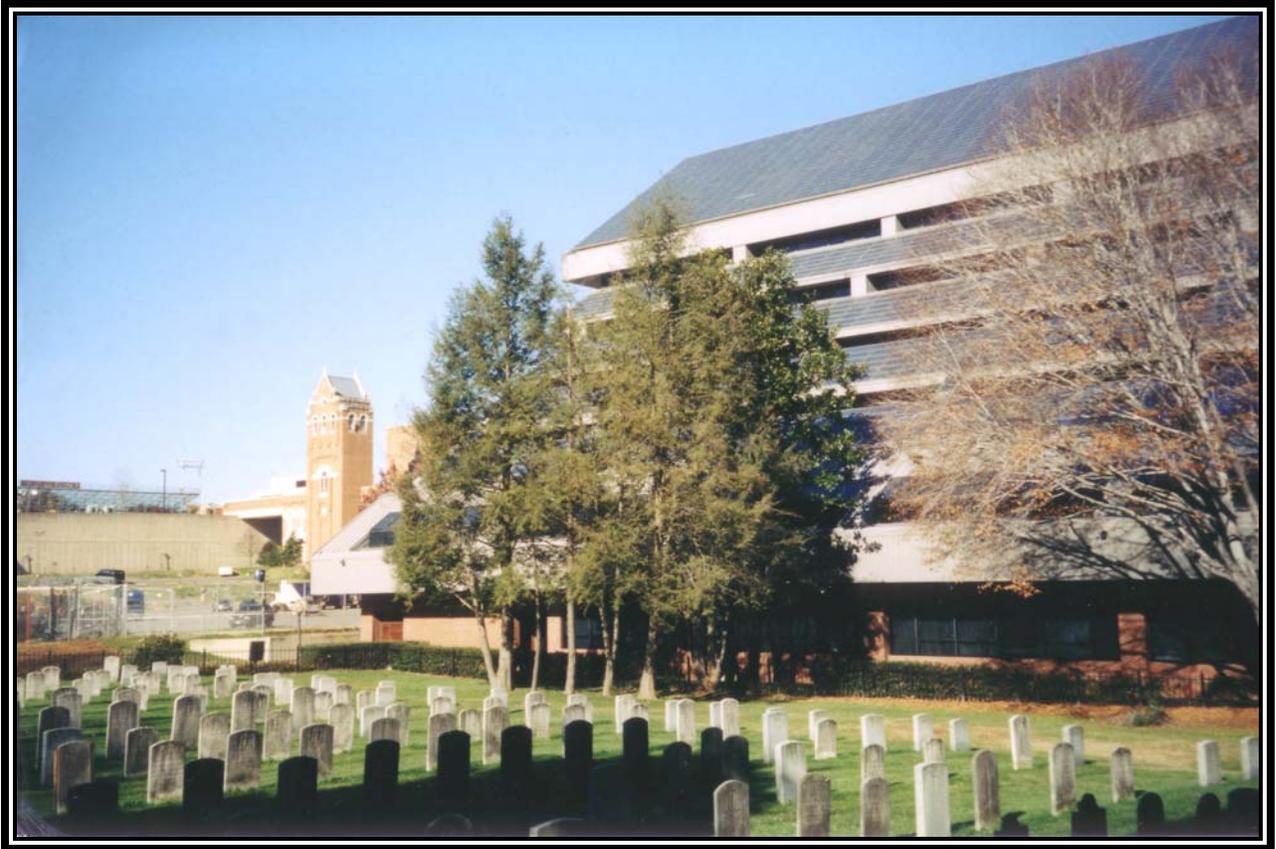


Outside Georgetown, then as well as on campus there was a conviction that traditional international affairs schooling no longer offered sufficient preparation for the modern world.



*At a time when the resurgent forces of nationalism and of ethnic and linguistic consciousness so directly affect global realities the United States requires far more reliable capacities to communicate with its allies, analyze the behavior of potential adversaries, and earn the trust and sympathies of the uncommitted. Yet, there is a widening gap between these needs and the American competence to understand and deal successfully with other peoples in a world of flux. ... In 1976, Congress authorized the commissioner of education to make grants to institutions of higher learning, "for construction of facilities of model intercultural programs designed to integrate the academic requirements of substantive knowledge and language facility." Federal funding followed in 1978.<sup>117</sup>*

<sup>117</sup> *Georgetown Magazine*, Nov-Dec 1982, pgs 7-10



30,000 SF BI-PV Solar Array Georgetown University Intercultural Center

These trees did not exist when the Intercultural Center was built. This photograph was taken in 2004. The trees shade the solar array blocking the sunlight skewing the data of this taxpayer-funded demonstration project. The primary challenge the roof has had is that access for trouble-shooting and cleaning were not designed effectively into the array.

This historic building is a stepping-stone into the 21<sup>st</sup> Century. As consumers actively evolve and adapt commerce toward new renewable technologies allowing more humane autonomous avenues for electricity generation it will of course translate to less blight on the horizon, more efficiency, less pollution and increased national sovereignty in a new world of autonomous *personal generators* [PG].

Gosh, that sounds wonderful. Why do so few people know about this tremendous breakthrough in modern electricity technology and commerce? Many utility engineers, energy agency staff and photovoltaic engineers were not aware of this historic BI-PV demonstration. Why don't we use more solar BI-PV to meet peak air conditioning demand for electricity to reduce dependency on remote-site fossil fuels, blackouts and extorted pricing?