SELLING SUNSHINE: ASU SOLAR ENERGY RESEARCH, 1951-1980

At a glance, harnessing the power of the Arizona sun would seem to be a natural fit for an aspiring southwestern university. ASU's increasing research capability, the ambitions of Arizona businesses and the Arab oil embargoes of the 1970's might have been a perfect storm for the development of solar technology. But technical challenges, uncertain government support and silos between academic disciplines impeded strategic investment and innovation in a field that sparked the imagination but required robust interdisciplinary research and development. Arizonans would wait decades for ASU to resume its' place as an international leader in alternative energy technology research and development.

Tempe pioneers understood the potential for solar energy in the early 20th century. A water well pump using the Ericsson solar concentrator apparatus was located at Mill Avenue and Broadway in Tempe as early as 1902. Its' concave mirrors were damaged in a hail storm and the apparatus was abandoned in 1915, but the idea of harnessing the power of the sun was established in the memories of Tempe residents.

On July 2nd 1951 J. Robert Burns, director of publicity for the Phoenix Chamber of Commerce wrote President Grady Gammage, asking for his leadership in advancing a solar energy research agenda. Burns initial interest was promoting tourism, but he wrote "my eyes have been opened to the tremendous implications" of solar energy research and industrial development. Burns' curiosity was piqued by the work of Arizona State College (ASC) student Charles Beharka, who under the direction of Dr. Alan T. Wager compiled data indicating that Phoenix receives more solar radiation than "any other station in the Weather Bureau's solar radiation network". President Gammage directed Dr. Wager and several other faculty members to evaluate the opportunity, and on August 6th Gammage forwarded to Burns a report from Dr. Wager recommending a research program focused on measurement of solar radiation.

This modest basic research sparked the imaginations of several Arizona business leaders such that by March 1954 the **Association for Applied Solar Energy (AFASE)** was

founded in Phoenix with a high powered board that included: Henry Sargent (former president of Arizona Public Service) as chairman, Walter Bimson (Valley National Bank), Ray Cowden (rancher), Lewis O. Douglas (Southern Arizona Bank and Trust), L.A. Eastburn (ASC-Flagstaff), Grady Gammage (ASC – Tempe), R. J. Harvill (University of Arizona), G. Robert Herberger, Howard Pyle, M. O. Best and attorney Frank Snell.

On October 29, 1955 the **World Symposium on Applied Solar Energy** opened in Phoenix and Tucson, co-sponsored by the Association for Applied Solar Energy, the Stanford Research Institute and the University of Arizona. 130 delegates from 36 countries attended the conference. Solar engineering exhibits were displayed at the Phoenix Civic Center and in an open lot on Indian School Road in Phoenix, and symposium papers were delivered at the Westward Ho and the University of Arizona.

Gadgets in the Sun

After the World Symposium, ASC considered establishing a solar energy museum comprised of the devices acquired for the solar energy exhibits. Arizona Public Service had the exhibits in storage and they were anxious to see them on public display. The Stanford Research Institute was contacting the exhibit owners in attempts to acquire them for display at a ten acre plot in Scottsdale they offered for this purpose.

In April 1956 ASC made national headlines when they acquired a **Solar Furnace.** Designed to test effects of high temperatures up to 6,000 degrees Fahrenheit on materials used in rockets and guided missiles**,** the device was installed on the roof of the Science Building (now Discovery Hall). Solar furnace research activity was coordinated **by Dr. Duane Brown** of chemistry and **Dr. Clement J. Kevane** of physical sciences. Brown previously attended three summer institutes on high temperature research at the Oak Ridge National Laboratory, while Kevane was formerly a research consultant at the Motorola Research Laboratory in Phoenix. The installation was featured in articles with photographs in *Time* and *Life* magazines. In its' May meeting the Arizona Board of Regents recommended acceptance of an $11,000 **Office of Naval Research** contract for high temperature materials research using the solar furnace. In June of 1957 the **US Army** awarded a $35,532 contract to ASC for additional materials research to be directed by **Dr. Ben Gossick** of Motorola.

John I. Yellott, then secretary-treasurer of AFASE, confirmed in June that ASC could take possession of an Italian built **solar powered water pump.** The pump was installed at ASC

in February 1957. “Tubing, painted black for heat absorption, is filled with liquid sulphur dioxide, which is turned into gas by heat.” The gas pressure was used to pump water.

In July **George Boyd**, assistant director of Special Services for ASC, began contacting owners of the other exhibits to secure them for the planned museum, citing approval of the loan of a SOMOR pump from the manufacturer in Italy. In August Boyd confirmed Bell Telephone Laboratories’ agreement to provide two solar batteries for “permanent demonstration”. He also described efforts to acquire two “solar engines” and a model of a large solar furnace being built for the Air Force.

That day he also wrote the **General Electric Company**, indicating ASC was considering a new course in applied solar energy within our engineering division, we had acquired the solar furnace and we were building “an exhibit of solar devices”. He asked if GE would provide a copy of their recent research study of solar energy applications, and if they would be interested in a discussion regarding research contracts for using the solar furnace. He also asked if GE could suggest “other demonstrations to assist in our teaching program.”

Living With the Sun

On August 13th 1956 Boyd wrote to President Gammage “I would like to see a demonstration house built on the campus, air conditioned and heated with solar energy and some of the appliances run with silicon converters.” One year later an **International Solar House Competition** sponsored by AFASE presented submitted designs at the Phoenix Public Library. The design judges included Pietro Belluschi (dean of architecture at of MIT), Carlos Contreras of Mexico, Thomas Creighton, editor *Progressive Architecture* magazine, **James Elmore**, associate professor of architecture at ASC, and famed architect Nathaniel Owings.

In December 1957 AFASE began construction of a **solar house** in Paradise Valley from the winning design of undergraduate architecture student Peter R. Lee of the University of Minnesota. The home would be built by the **Phoenix Association of Home Builders**, and it demonstrated a combination of radiant and convection cooling and heating. The home featured movable louvers over the north and south patios and an insulated underground tank for hot water storage. Instrumentation acquired with a grant from the John B. Pierce Foundation of Connecticut was designed to measure the solar

radiation falling on the house and the amount of heat acquired by the louvers/solar collectors. Swimming pool water was to be used as a means of pre-cooling air ported to traditional Carrier air conditioning units during the summer.

The solar demonstration house was opened for public tours in April of 1958. An *Arizona Republic* editorial the following month expressed the concerns of neighbors regarding issues with traffic, parking and the 85 cent admission fee being collected from tour attendees. “Large crowds gathered at the house directed by an almost county-wide system of signs…and the collection of signs in the vicinity of the solar house gave the residential area something of the ‘Coney Island’ appearance, as charged by the neighbors.” The county adjustment board nullified the admission fee, eliminated the adjacent parking lot and directed that signs must be removed.

The home was apparently acquired by **G. Robert and Katherine K. Herberger** after construction, since in December 1959 they offered to donate the home to the Arizona State University Foundation “for the purpose of establishing a house for the President, Dr. Grady Gammage...and for the furtherance of the study of solar energy.“

Meanwhile the Pierce Foundation began inquiries regarding the status of the instrumentation they funded for solar energy research, which had not been installed. That winter **Professor George Sutton** of engineering agreed to move into the home in order to work on the instrumentation and the house systems. His August 1960 report to founding Dean of Engineering Lee P. Thompson described the status of the solar house:

“The most prominent difficulties have been with the control system, which has been ravaged by removal of some components, and faulty wiring...” Six of the louvers needed replacement or extensive repair and their actuating controls were missing. He specified $2,760 in needed repairs. Ultimately Sutton recommended repair or sale of the property. A formal appraisal of the house completed in 1965 indicated the property originally valued at $80,000 had a fair market value between $18,000 and $20,000. The house was apparently sold thereafter.

George Boyd’s 1956 vision for a solar demonstration house located on the ASU campus finally came to fruition on May 4th, 1980 when construction began on a **solar demonstration house** at the northwest corner of University Drive and Rural Road. The project was directed by Dean **Hugh Burgess** of the College of Architecture. The two story residence comprised three bedrooms, two baths and over 2,000 square feet, but it was also limited to passive solar technology.

Later that year ASU architecture graduate **Jim Hoffman** offered tours of his **solar "dream house"** at 1422 S. Roosevelt in Tempe. The house plans won the 1978 Passive Solar Demonstration Design competition hosted by the US Housing and Urban Development and Energy departments.

Shining the Light of Knowledge

The **Association for Applied Solar Energy** (AFASE) was engaged in acquiring research publications and global literature about solar energy research and development since its' founding in 1954. As early as January 1956 President Gammage inquired with ASC Librarian Harold Batchelor whether the Matthews Library was acquiring solar energy publications. At about the same time a library of about 2,000 titles originally collected by the Stanford Research Institute was moved to the AFASE offices in Phoenix. In December of 1959 AFASE announced it had reached agreement to become an affiliate of Arizona State University, and in 1960 ASU subsequently assigned a full time professional librarian to work in acquiring, cataloging and providing access to library materials. The agreement noted that the solar energy collection would revert to ASU should AFASE become defunct. In 1963 AFASE was reorganized into the Solar Energy Society and they established their official headquarters at ASU. The organization was renamed the International Solar Energy Society and relocated to Australia in 1970.

The **Solar Energy Collection** officially became part of the ASU Libraries in 1972. The collection moved to the new Noble Science and Engineering Library in the 1980's, and specialized indexes of the literature were made available through the ASU Libraries catalog. The Libraries began collecting archival collections of key solar energy researchers such as **John I. Yellott** and **Maria Telkes**, and those collections along with the existing publications were made a part of the Architecture and Environmental Design Library Special Collections in the early 1990s.

Meanwhile ASU's research agenda was advancing in response to opportunities created by the Arab nation oil embargoes of the 1970's. Many will remember the long lines of cars waiting for gasoline and high costs for residential heating oil that occurred as a result of the embargoes. Concern for access to foreign oil eventually caused the federal government to accelerate appropriations in alternative fuels research. Because of ASU's visibility and experience in solar energy research we were positioned to attract investments.

In 1974 the **National Science Foundation** (NSF) awarded $204,200 for ASU to study the use of solar concentrators and photovoltaic solar cells for direct conversion of sunlight to electricity. **Dr. Charles Backus** was principal investigator of that project, at that time the largest award ASU had received from NSF. Also in 1974, TRW Systems Inc. received $485,652 from NSF to investigate uses of solar energy for heating and cooling**. John I. Yellot**, visiting professor of architecture and **Dr. Byard D. Wood**, assistant professor of engineering lead a team of twelve ASU faculty who worked with fourteen TRW industrial engineers on the project.

In December of 1974 glass manufacturer Guardian Industries Corporation awarded ASU and the John Z. DeLorean Corporation a contract to create a computer simulation model to test a DeLorean design for a **solar energy electrical power generating system**. In this design air heated between a sheet of glass and a sunlight absorbing collector plate flowed upward into a turbine engine used to generate electricity. The system would have required twenty acres of collectors to generate one megawatt. A **solar energy research "platform"** was installed on the roof of the Engineering Sciences Center F-Wing in February 1977. The platform included a solar energy heated air collection system, a solar water heating device, and fixed mirror solar concentrator, a parabolic reflector, and an instrument to measure performance of flat plate solar collectors.

ASU's knowledge and experience in practical applications of solar energy enabled us to offer related coursework. In the spring of 1972 the College of Architecture offered courses that focused on specifications for solar energy design. In the fall of 1974, ASU's College of Architecture was the first program in the country to offer a Masters degree that focused on solar applications. In January 1975 ASU presented the nation's first short course in practical uses of solar energy, **Solar Utilization Now**. 100 students registered for the five day course and another 30 were turned away for lack of seats in the class. The course was taught by ASU architecture professor **Jeffrey Cook** and Dr. Byard Wood, now associate professor of mechanical engineering. Professor Cook designed and built his own celebrated solar home in Scottsdale. ASU offered a **"Solar Teach-In"** on May 3rd 1978 on the grounds of Gammage Auditorium as part of the Arizona Sun Week proclaimed by Governor Bruce Babbitt. The Arizona celebration was part of the national initiative endorsed by President Gerald Ford.

State, National and International Leadership

ASU faculty members were invited to share their knowledge with legislators, scientific organizations and communities across the globe. An exhibit of solar building designs and

the related testimony of John Yellott informed creation of the federal Solar Heating and Cooling Act of 1974. That year Dr. Backus received support from the United Nations for a sabbatical project that allowed him to travel to solar energy sites around the world. He made at least two presentations on every continent except Antarctica for a variety of audiences from small local community groups to large international technical organizations. Dr. Backus also taught a three week course on the use of photovoltaic technology in solar energy in Triessa, Italy.

On December 31, 1974 President Carter established the **Energy Research and Development Administration** (ERDA) with an expanded research mission including programs for nuclear, solar and geothermal power, fossil fuels, and energy conservation. In March of 1975, Dr. Backus of ASU testified before a US Senate subcommittee that the proposed $75 million budget for the ERDA represented about half of the funding needed by American scientists. Backus led ASU's efforts to submit a proposal to establish an ERDA sponsored solar research program in Arizona, but the award was instead offered to the Solar Energy Research Institute in Golden, Colorado.

In June 1975 Dr. Backus and **Charles M. Woolfe** (dean of the College of Liberal Arts) were appointed by Governor Raul Castro to the **Arizona Solar Energy Research Commission**. Later that summer ASU created the interdisciplinary **Committee on Solar Energy**, where sixteen faculty and administrators coordinated university research efforts. In their November 1976 meeting, the Arizona Board of Regents approved $576,049 for two solar energy research projects funded by the **Arizona Solar Energy Research Commission**. The projects studied the extent of solar energy radiation and resources in the metropolitan Phoenix area and the Four Corners region.

Winter Solstice

As the urgency of the Arab oil embargoes began to decline in the 1980's, federal investment in solar energy research under President Ronald Reagan declined as well. ASU's efforts in passive solar housing design began to diminish, while basic and applied research in photovoltaic and energy conversion technology continued. At ASU this moment represented a transition from rather than an integration of design and engineering innovations related to solar energy. Much of ASU's leadership in solar energy research faded from visibility after Colorado landed the Solar Energy Research Institute and Dr. Backus was assigned leadership roles at the new ASU East campus and the East Valley Partnership.

Although the work of ASU's solar energy research engineers did not result in huge commercial applications for solar power, they were leading thinkers and developers in the understanding of solar energy and photovoltaic technology. ASU's photovoltaic specialists usually had more papers presented at professional conferences in the 1970's than any other organization. ASU would not resume a place of leadership in alternative energy research until the arrival of President Michael Crow, the establishment of our School of Sustainability, the first comprehensive degree-granting program of its kind in the United States, and the founding of our Global Institute of Sustainability.

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