Augustyn & Company
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JAMES R. AUGUSTYN, P.E.

Augustyn & Company, Consulting Engineers
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Mr. Augustyn has over 40 years of engineering design, consulting, and project and business management experience in the power and energy industries. He has successfully operated a small solar engineering consultancy since 1989 specializing in various aspects of solar radiation measurement and data quality assessment. He is also the author of *The Solar Cat Book*, a uniquely humorous and well-received treatment of human peculiarities in the quest for solar energy with 50,000 in print.

His professional engineering career has included design and safety analysis of mechanical steam and reactor safety systems in commercial nuclear plants as well as development, design, and performance analysis of a range of solar power and solar thermal energy systems. He has worked extensively in solar energy research and development for government, industry, and commercial organizations in the U.S., Europe, Africa, Asia, and the Middle East. Much of this work has involved assessing the nature and variability of the available solar energy resource both in broad geographical and site specific evaluations for large scale solar power plants.

In recent years, he has focused on hardware and software development as well as installation, O&M, and calibration of a unique solar energy measurement product pioneered by Dr. Edward Kern of Irradiance, Inc., called the Rotating Shadowband Radiometer. This device and its ancillary measurement sub-systems constitute a leading approach to solar energy measurement for large scale solar power developers worldwide. Mr. Augustyn has installed nearly 160 solar measurement stations around the world.

More recently, Mr. Augustyn has developed a readily portable, highly accurate reference irradiance measurement system which can be quickly deployed and used to validate and/or calibrate the irradiance measurement accuracy of installed, operating systems, on-site.

He also developed and patented a unique solar measurement device to accurately determine the instantaneous optimum solar tracker tilt taking in to account varying sky and ground reflections at. a particular site. This device currently forms the irradiance measurement basis of U.S. D.O.E. funded research to develop an improved tracker control algorithm for large single axis tracking solar photovoltaic power plants.

CREDENTIALS

B.S., Illinois Institute of Technology, Mechanical & Aerospace Engineering, 1968
Registered Professional Mechanical Engineer in California, No. 15616.
Fellow of the American Solar Energy Society, elected May 15, 2012

EXPERIENCE

AUGUSTYN & COMPANY, Berkeley, CA. 1988 - ON

- For Terabase LLC, consulting services for development of a comprehensive weather and irradiance measurement package serving large scale solar photovoltaic power plants.

- Independent development and acquisition of U.S. patent for the first device capable of direct detection of the instantaneous tilt angle of the plane receiving the highest plane of array irradiance along a fixed rotational axis.

- Independent development of an automated solar irradiance sensor cleaning system for use with Irradiance RSR2, and thermopile irradiance sensors.

- For EDRI, the IT Electronics Eleventh Design & Research Institute Scientific and Technological Engineering Co. Chengdu, China, consulting services related to developing a solar irradiance measurement program for large scale PV development.

- For SunPower Corporation, development and deployment of a custom project development solar irradiance measurement system.

- For NEXTracker, Inc. Fremont, California, irradiance measurement consulting services.

- Under subcontract with the National Renewable Energy Laboratory, revision and upgrade of the solar energy data processing and quality assessment software known as *"The Data Quality Management System",* originally developed by Augustyn & Company in the 1990's for NREL's support of a network of solar measurement stations run by the Kingdom of Saudi Arabia, and for the U.S. D.O.E.'s Atmospheric Radiation Measurement program.

- For KACARE, the King Abdulla City for Atomic and Renewable Energy, custom production and training in the use of several portable Field Reference Irradiance Measurement Systems to perform field validations of the accuracy of their nation-wide network of broadband irradiance measurement stations.

- For Chevron Technology Ventures, on-site, field validation and recalibration of a solar irradiance measurement station in Kuwait using Augustyn & Company's Field Reference Irradiance Measurement System.

- In partnership with Irradiance, Inc, development, deployment and support of the RSR2 Rotating Shadowband Radiometer Version 2 product line. This work has involved evolving mechanical and logistical product development, software design, development of calibration techniques with the National Renewable Energy Laboratory's Solar Radiation Research Lab, as well as direct field supervision of systems installation and operation. Customers for this product to date include nearly all major players in the concentrating solar power market, including an increasing number of prominent photovoltaic power producers worldwide.

- Design, installation, calibration, data collection, processing and reporting services for the following technology providers and developers of large scale solar thermal and photovoltaic power projects worldwide directly related to their purchase and deployment of one or multiple Rotating Shadowband Radiometer systems:

Abengoa Solar, S.A. (Spain)
Acciona Energy S.A.
(Spain)AquaSol AGL Energy Ltd.,
(AUS)
BrightSource Energy (Israel)
Chevron Corporation
Colorado Governor's Energy Office
Dynergy Corporation
Energy Ltd. (AUS)
Entegra Energy ltd. (India)
First Solar Inc.
FPL (NextEra Energy)
Gas Atacama S.A., (Chile)
GWF Energy
LS Power Corporation
Magtel Industries, S.A. (Spain)
Pacific Light & Power
SMUD
Solar Millennuim, A.G. (Germany)
Solar Millennium LLC (USA)
SunPower Corporation
Solaria Corporation
SolarGen LLC
Solar Reserve LLC
Stanwell Corporation (AUS)
Tessera Solar

- For Flabeg Solar International Solar & Meteorological Monitoring Stations Design and fabrication of custom solar radiation and meteorological monitoring stations for remote installation at sites in southern Europe where large scale solar thermal electric generating stations may be built. The first installed system at a site in southern Spain began automated operation in March, 2000. A unique feature of these systems is automated data transmission directly from the monitoring site via email transmission. Data collected at these sites will serve a critical need for on site data used for plant economic feasibility calculations and for design purposes. Flabeg Solar International is the world's largest manufacturer of highly efficient parabolic trough reflectors used in solar electric generating stations such as the KJC SEGS plant (see below)

- For Solar Millennium GmbH Solar and Meteorological Monitoring Stations - Design, fabrication, and installation training for seven environmental monitoring stations similar to those delivered to Flabeg Solar International above.

- Also for Solar Millennium, large scale parabolic trough CSP project development including setup of their U.S. offices in 2005/2006 and production of several competitive offerings for proposed projects in California and the desert southwest of the U.S..

- For Renewable Energy Services Corporation in design assistance in monitoring and reporting on the performance of photovoltaic systems installed at the Natural Energy Laboratory of Hawaii Authority's Kona, Hawaii facility.

- For the City of San Francisco Public Utilities Commission Department of Water and Power: Design, fabrication, installation and operation of an 11 station network of solar and weather monitoring stations located across the city intended to assess the variation of solar irradiance characteristics across different areas of the city. This work supports the City's program to promote the use of rooftop electric power generation for City facilities and the general public.

- For ESKOM Enterprises Pty. Technical Services Division: For the deregulated branch of national electric utility of the Republic of South Africa, design, fabrication, installation and training for a three-site network of solar measurement stations. This work was part of ESKOM's renewable energy research and development effort, part of which is in cooperation with the Development Bank of South Africa.

- For the National Renewable Energy Laboratory (NREL): Development of methods to improve the accuracy of a relatively low cost device used to measure direct beam solar irradiance. The device in question, the rotating shadow band pyranometer, manufactured by Schott Applied Power Corporation, has historically exhibited serious characteristic errors in its direct beam measurements. This project combined hardware and device software modifications and application of exisiting sensor-specific corrections as well as development of new corrections for errors previously ignored. The results of the project are a physically improved model of the instrument, and an algorithm which can be used to correct data collected with the old version of the instrument.

- For Deutsches Zentrum fur Luft-und Raumfahrt / Plataforma Solar de Almeria / Morocco Solar and Meteorological Monitoring Station - Design, fabrication, and installation training for a customized solar and environmental monitoring station commissioned for the Moroccan Government. This station is to provide baseline site data for a planned 30 MW sparabolic trough solar thermal power plant partly funded by the World Bank.

- For Pacific Gas and Electric Company (PG&E): operating the Solar Insolation Monitoring Program, a 15 station monitoring network designed to accumulate data on the solar radiation resource within PG&E's service territory for purposes of solar power plant siting and load management program planning.

- For the State of Hawaii Department of Business, Economic Development, & Tourism's Energy Division, support the solar resource assessment aspect of a comprehensive renewable energy resource assessment study. This work included monitoring network design, installation, and operation.

- For the California Construction Authority: Design, procurement, fabrication, programming and installation of equipment and software to monitor and display the real time electric output of 80 commercial scale PV systems located at six county and state fairground sites throughout the state. This project employed innovative, low cost kwh meters and wireless data loggers with data collection and dissemination via internet. It also involved numerous extensions and enhancements to ACI's DQMS database software to provide timely and pertinent data products to system operators and supervisors.

- For U.S. Borax, Boron Operations: Extensive upgrade and expansion of a network of environmental monitoring stations located throughout the world's second largest borate mining operation. This works also includes evaluation and redesign of remotely controlled dewatering systems

- For the U.S.D.O.E. Battelle/PNNL/NREL/ARM DQMS Revision Project This project will result in an extensively revised version of DQMS to meet certain crritical needs of D.O.E.'s Atmospheric Radiation Measurement Program - ARM. DQMS Version 3 adds many new tests and features to DQMS, allowing more effective quality tracking and control of the ARM SIRS data flow.

- For PowerLight Corporation PV Installation Monitoring System Design, development, installation, and support for a custom application of DQMS and additional software to provide PowerLight and its customers with performance data measured at each of their commercial photovoltaic system installations. This provides PowerLight with rapid feedback on system performance and detailed data for R&D purposes. This system incorporates automated comparison of measured to simulated system performance, as well as automated generation of Web graphics and reports for controlled distribution via

the Internet. It also provides an automated web and LAN based summary of performance data updated daily, for all PowerLight systems for internal company purposes.

- Also for PowerLight Corporation Mauna Lani Hotel Photovoltaics Monitoring System Design and fabrication of a custom Data Acquisition System for a 75 kilowatt photovoltaic system providing power to a famous Hawaiian resort. Design and fabrication of a second, similar Data Acquisition System for a second, 110 kilowatt photovoltaic system installed at the same site.

- For U.S. Borax Boron Operations Environmental Monitoring System Custom application of DQMS and telecommunications hardware to allow automated, real time display and capture of environmental parameters measured at the world's largest borate mining facility.

- For the Kramer Junction Company (KJC), operators of the world's largest solar thermal electric generating plant located near Barstow, California, adaptation and modification of DQMS to include a greatly enhanced on-screen graphic data display, including real time, scrolling data plots.

- Also for KJC, redesign and rewriting of their plant performance computer model used to optimize supplemental natural gas use.

- Also for NREL: identifying, assessing the quality of, and obtaining the highest quality solar radiation data sets from as many U.S. locations as possible. This work involved coordinating the activities of two subcontractors and in-house staff in compiling a database of information concerning over 1,400 locations in the U.S. which have collected at least one year of solar radiation data at an hourly or shorter time interval. Data sets which were judged to be the highest quality were obtained, and detailed quality assessment was performed and the data sets were delivered to NREL for use in a variety of research and development projects.

- For Campbell Scientific, Inc. translation of the telecom elements of an integrated Windows based data logger communications software package (originally developed by Campbell) into a stand-alone program which is capable of interfacing between Campbell Scientific's data loggers, and data processing software developed by others.

- For the City of Pasadena Department of Water and Power: design, installation, operation and data analysis for a solar data acquisition system.

- For the Electric Power Research Institute (EPRI), research and writing a utility guide to solar resource monitoring, summarizing the collective experience of utilities in the field of solar resource measurement, with particular attention to costs and application of newly developed equipment and data handling techniques.

- Also for PG&E: solar resource, transformer load, and substation equipment performance monitoring and data analysis at PG&E's Kerman, California substation as part of the preliminary design and evaluation phase of a project to install a 500 kilowatt photovoltaic distributed power generation unit.

- For the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), development and writing of the WYEC2 User's Manual and Toolkit; a project involving development of computer software tools for manipulation of solar,

illuminance, and weather data as input to building energy analysis computer programs. The WYEC2 (Weather Year for Energy Calculations) weather file format was developed by ASHRAE as a significant improvement over previous formats in the use of advanced techniques for modeling characteristics of solar radiation and illuminance.

- For the American Solar Energy Society: technical chairman of the 1994 Passive Solar Energy Conference

- For the California Energy Commission (CEC): revision of climate zone definitions and revision of the 16 associated hourly weather data sets which form the basis for the state's Building Energy Efficiency Standards.

- For the National Renewable Energy Laboratory - Solar Industrial Process Heating Prefeasibility Program: development of site specific solar and weather data files upon which analysis of projects proposed for funding by the U.S. DOE and others will be based.

- For San Diego Gas and Electric Company: operation of a 5 station monitoring network in support of the Atmospheric Data Assessment Project which supports other work in the area of dynamic rating of high voltage transmission lines.

- Also for PG&E: assessment of the worldwide status of the solar electric conversion (photovoltaic) industry as the "Advanced Photovoltaic Technology Scoping Study".

- Also for EPRI location and assessment of ground station solar radiation data in the southwestern U.S. as part of an effort to develop a method to correlate such data to satellite derived data.

- Individual solar and building energy analyses involving computer modeling, on site system performance monitoring and data analysis of solar and building energy systems. Forensic consulting work and associated expert witness testimony on building energy management and solar heating systems. Calibration of solar radiation measurement instrumentation for utilities and government agencies. Participation in environmental air quality monitoring programs both in instrument calibration and data acquisition and analysis.

BERKELEY SOLAR GROUP, Berkeley, CA. Vice President 1976-1988

Directed engineering projects and managed software marketing, sales, and customer support for a firm specializing in solar heating system and building energy related research, software development, and performance monitoring.

- For Bank of America: technical and financial evaluation of individual solar, alternative energy and cogeneration projects; program development of the bank's Solar Loan Program which later led to detailed evaluation of residential solar pool and water heating systems and energy conservation products from over 100 manufacturers marketing within California.

- For Pacific Gas & Electric Company (PG&E) and San Diego Gas and Electric Company (SDG&E): design, installation, and operation, of automated, data acquisition networks at sites throughout each utility's service territory in support of each utility's solar research and development efforts

- For the Electric Power Research Institute (EPRI): supervised completion of research and writing of the "Monitoring Methodology Handbook for Residential HVAC Systems".

- Designed and supervised construction of over 50 residential and commercial solar, HVAC, and alternative energy projects. Consulted on the design of numerous additional solar water heating systems, and participated in the development of state and national standards for testing and evaluation of solar water heating systems.

- Provided expert witness testimony at hearings and legal proceedings.

- Directed research and writing projects for Sunset Magazine, DOE, EPRI, CEC, ORTHO Books, ABAG, and others on solar and renewable energy related topics.

BECHTEL POWER CORPORATION, San Francisco, CA. Mechanical Engineer1968-74

Responsible for design, analysis, field inspection, quality assurance, and subcontract management activities for mechanical and safety related systems of commercial nuclear power plants, of both boiling and pressurized water designs.
For the Arkansas ANO Unit 2 Plant: wrote the Containment Systems section of the Final Safety Analysis Report; performed the post-accident containment pressure-temperature analysis; formulated and coordinated design changes to reactor core and containment cooling systems.

- For the Trojan Nuclear Plant: system design, equipment sizing and specification for balance of plant steam and auxiliary systems. Maintenance and update of all piping and instruments diagrams for all steam and feed water systems through design, construction and start-up phases including coordination of design changes with electrical, instrumentation, nuclear, and civil engineering groups, as well as with site construction and start-up groups.

- For the Monticello Nuclear Plant: supervised a team of engineers making design changes to containment systems during commercial operation; conducted an extensive on-site quality assurance audit of as-built containment and emergency core cooling systems; sized pumps, flow control devices and other mechanical system design.

PUBLICATIONS

"A Thermal and Economic Performance Comparison of State of the Art Passive and Active Solar Heating Systems with Similar Methods as Commonly Employed by Cats" J.. Raymond (Jim) Augustyn. Proceedings of the 4th National Passive Solar Conference, 1979-10-03, Kansas City, Missouri, U.S.A.

"The Solar Cat Book", Jim Augustyn, published by Ten Speed Press, Berkeley, CA 1979 ISBN 0-89815-018-3

"Pacific Gas & Electric Company's Solar Insolation Monitoring Program 5.633 Years and Counting", Robert J. Nelson James R. Augustyn Christina Jennings, Proceedings of the 1990 Annual Conference of the American Solar Energy Society, Austin, Texas, U.S.A. 1990-03-19

"Revision of the California Building Energy Efficiency Standarda Climate Zone Definitions" James R. Augustyn, Robert J. Nelson, 15th National Passice Solar Conference Proceedings, American Solar Energy Society, Austin, Texas, U.S.A. 1990-03-19

"A Solar Data Verification System" James R. Augustyn, Robert J. Nelson, Proceedings of the 1993 Annual Conference of the American Solar Energy Society, Washington, D.C., U.S.A. 1993-04-25

"Solar Resource Measurement: Utility Program Implementation and Costs", James R. Augustyn, Robert J. Nelson, John E. Bigger, Proceedings of the 1994 Annual Conference of the American Solar Energy Society, San Jose, California, U.S.A. 1994-06-27

"Solar Resource Assessment in Hawaii", Robert J. Nelson, James R. Augustyn Karen Conover, Proceedings of the 1994 Annual Conference of the American Solar Energy Society, San Jose, California, U.S.A. 1994-06-27

"Radiometer Calibration Drift", Robert J. Nelson, James R. Augustyn, Christina Jennings, Proceedings of the 1994 Annual Conference of the American Solar Energy Society, San Jose, California, U.S.A. 1994-06-27

"Characterization of the Effect of Cloud Transients on Direct Normal Insolation at Carrisa Plaina", James R. Augustyn, Robert J. Nelson, Melissa M. Reading, Proceedings of the 1994 Annual Conference of the American Solar Energy Society, San Jose, California, U.S.A. 1994-06-27

"Survey and Quality Assessment of Solar Radiation Data Sources in the United States", James R. Augustyn, Eugene Maxwell, Proceedings of the 1997 Annual Conference of the American Solar Energy Society, Washington D.C., U.S.A. 1997-04-25

"Improving the Accuracy of Low Cost Measurement of Direct Normal Solar Irradiance" James Augustyn, Taylor Geer, e.t. al. Proceedings of the 2002 Annual Conference of the American Solar Energy Society, Reno, Nevada, U.S.A. 2002-06-15

"Solar Resource Assessment in the Foggiest City on Earth**",** Jim Augustyn, Taylor Geer, Fred Schwartz, Deirdre Appel, Proceedings of the 2003 Annual Conference of the American Solar Energy Society, Austin, Texas, U.S.A. 2003-06-21

"The Return of the Solar Cat Book", Jim Augustyn, published by Patty Paw Press, Berkeley, California, U.S.A., 2004 ISBN 0972994904

"Update of Algorithm to Correct Direct Normal Irradiance Measurement Made with a Rotating Shadow Band Pyranometer", Jim Augustyn, Taylor Geer, Ed Kern, Ruel Little, Tom Stoffel, Frank Vignola, Rich Kessler, Bill Boyson, Proceedings of the 2004 Annual Conference of the American Solar Energy Society, Proceedings of the 33rd Annual Conference of the American Solar Energy Society, Portland, Oregon, U.S.A. 2004-07-09

"Reducing Irradiance Measurement Uncertainty of Operating Measurement Stations Through Field Test and Parametric Correction Function Derivation", Jim Augustyn, Misha Yerlick, Proceedings of the 2014 Annual Conference of the American Solar Energy Society, San Francisco, CA, U.S.A. 2014-06-06

MEMBERSHIPS

American Society of Mechanical Engineers
International Solar Energy Society