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KEY=SOLAR - PIPER SCHULTZ

SOLAR POWER SATELLITES

A SPACE ENERGY SYSTEM FOR EARTH

John Wiley & Son Limited *Discusses technologies involved in the development of a solar power satellite network, as well as economic and societal issues relevant to the development of solar power satellites both as an alternative energy supply and as a stimulus for the exploration and use of space. Fifty- three contributors cover such topics as wireless power transmission,.*

MICROWAVE POWER TRANSMISSION AS A FUTURE FEASIBILTY OF SOLAR POWER SATELLITE

GRIN Verlag *Research Paper from the year 2013 in the subject Energy Sciences, , language: English, abstract: The search for a new, safe and stable renewable energy source led to the idea of building a power station in space which transmits electricity to Earth. The concept of Solar Power Satellites (SPS) was invented by Glaser in 1968. SPS converts solar energy into microwaves and transmit it to a receiving antenna on Earth for conversion to electric power. The key technology needed to enable the future feasibility of SPS is Microwave Power Transmission. SPS would be a massive structure with an area of about 56 sq. and would, weigh about 30,000 to 50,000 metric ton. Estimated cost is about $74 billion and would take about 30 years for its construction. In order to reduce the projected cost of a SPS suggestions are made to employ extra terrestrialresources for its construction. This reduces the transportation requirements of such a massive structure. However the realization of SPS concept holds great promises for solving energy crisis.*

ENERGY CONVERSION, CONTROL AND TRANSMISSION FOR THE SOLAR POWER SATELLITE

ENERGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

ENERGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES

SOLAR POWER SATELLITE

HEARINGS BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS AND THE SUBCOMMITTEE ON ADVANCED ENERGY TECHNOLOGIES AND ENERGY CONSERVATION RESEARCH, DEVELOPMENT, AND DEMONSTRATION OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S. HOUSE OF REPRESENTATIVES, NINETY-FIFTH CONGRESS, SECOND SESSION, APRIL 12, 13, 14, 1978

SOLAR SATELLITE POWER SYSTEM CONCEPTS

HEARINGS BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS AND THE SUBCOMMITTEE ON ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S. HOUSE OF REPRESENTATIVES, NINETY-FOURTH CONGRESS, SECOND SESSION, FEBRUARY 20, 1976

SATELLITE POWER SYSTEM. CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. VOLUME 4: ENERGY CONVERSION AND POWER MANAGEMENT

Analyses performed for the satellite power system (SPS) reference system concept are presented. The reference concept together with descriptions of energy conversion, power distribution, and power management for solar photovoltaics, solar thermal, and concept comparisons are reviewed. Studies on energy conversion and power management (environmental impacts, annealing, nuclear SPS concept, and thermionic) are also reported.

SATELLITE POWER SYSTEM

CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. ENERGY CONVERSION AND POWER MANAGEMENT

Analyses performed for the satellite power system (SPS) reference system concept are presented. The reference concept together with descriptions of energy conversion, power distribution, and power management for solar photovoltaics, solar thermal, and concept comparisons are reviewed. Studies on energy conversion and power management (environmental impacts, annealing, nuclear SPS concept, and thermionic) are also reported.

SPACE SOLAR POWER SATELLITE TECHNOLOGY DEVELOPMENT AT THE GLENN RESEARCH CENTER

AN OVERVIEW

TECHNOLOGY FOR LARGE SPACE SYSTEMS

A SPECIAL BIBLIOGRAPHY WITH INDEXES

LIBRARY OF CONGRESS SUBJECT HEADINGS

SOLAR POWER SATELLITE SYSTEM DEFINITION STUDY. PART 1 AND PART 2, VOLUME 1

EXECUTIVE SUMMARY

Createspace Independent Publishing Platform *The Solar Power Satellite principle is illustrated and it shows that in a geostationary orbit 36,000 km above the earth's equator, each SPS is in sunlight 99% of the time and in continuous line of sight contact with its ground receiving station. Electrical power produced on the satellite by photovoltaic or heat engine conversion of sunlight is then converted to radio frequency energy at high efficiency, and formed into a focused beam precisely aimed at the SP ground stations. The ground station receiving antenna reconverts the energy into electricity for distribution. Unspecified Center NASA-CR-151665, D180-22876-1-PT-1-VOL-1, D180-22876-1-PT-2-VOL-1 NAS9-15196*

STATUS OF FEDERAL ENERGY CONSERVATION PROGRAMS

HEARING BEFORE THE SUBCOMMITTEE ON ENERGY CONSERVATION AND REGULATION OF THE COMMITTEE ON ENERGY AND NATURAL RESOURCES, UNITED STATES SENATE, NINETY-FIFTH CONGRESS, FIRST SESSION ....

SPACE FOR MANKIND'S BENEFIT

Proceedings of conference on benefits of space exploration conducted at Huntsville, Alabama Nov. 1971.

SOLAR POWER SATELLITE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM ACT OF 1978

HEARING BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT OF THE COMMITTEE ON ENERGY AND NATURAL RESOURCES, UNITED STATES SENATE, NINETY-FIFTH CONGRESS, SECOND SESSION, ON S. 2860 ... H.R. 12505 ... AUGUST 14, 1978

SOLAR CELL ARRAY DESIGN HANDBOOK

THE PRINCIPLES AND TECHNOLOGY OF PHOTOVOLTAIC ENERGY CONVERSION

Springer Science & Business Media

SIGNAL AND INFORMATION PROCESSING, NETWORKING AND COMPUTERS

PROCEEDINGS OF THE 7TH INTERNATIONAL CONFERENCE ON SIGNAL AND INFORMATION PROCESSING, NETWORKING AND COMPUTERS (ICSINC)

Springer Nature *This book collects selected papers from the 7th Conference on Signal and Information Processing, Networking and Computers held in Rizhao, China, on September, 2020. The 7th International Conference on Signal and Information Processing, Networking and Computers (ICSINC) was held in Rizhao, China, on September, 2020.*

ARMY LOGISTICIAN

The official magazine of United States Army logistics.

ENERGY RESEARCH ABSTRACTS

APR. 2 AND 4, 1974

ENERGY

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in Scientific and technical aerospace reports (STAR) and International aerospace abstracts (IAA).

SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS

NASA AUTHORIZATION FOR FISCAL YEAR 1975

HEARINGS, NINETY-THIRD CONGRESS, SECOND SESSION, ON S. 2955 ..

FEL OPTIONS FOR POWER BEAMING

The demand for the output power of communication satellites has been increasing exponentially. The satellite power is generated from solar panels which collect the sunlight and convert it to electrical power. The power per satellite is limited due to the limit in the practical size of the solar panel. One way to meet the power demand is to employ multiple satellites (up to 10) per the internationally agreed-upon ślot̀in the geosynchronous earth orbit (GEO). However, this approach is very expensive due to the high cost of sending a satellite into a GEO orbit. An alternative approach is power beaming, i.e., to illuminate the solar panels with high power, highly-directed laser beams from earth. The power beaming generates more power per satellite for the same area of the solar panel. The minimum optical beam power, interesting for power beaming application, is P{sub L} = 200kW. The wavelength is chosen to be? = 0.84?m, so that it is within one of the transmission windows of the air, and at the same time near the peak of the photo-voltaic conversion efficiency of Si, which is the commonly used material for the solar panels. Free electron lasers (FELs) are well suited for the power beaming application because they can provide high power with coherent wavefront, but without high energy density in media. In this article the authors discuss some principal issues, such as the choice of accelerator and electron gun, the choice of beam parameters, radiation hazards, technological availability, and overall efficiency and reliability of the installation. They also attempt to highlight the compromise between the cost of the primary installation, the operation cost, and the choice of technology, and its maturity. They then present several schemes for the accelerator-FEL systems based on RF accelerators. The initial electron beam accelerator up to the energy of a few MeV is more or less common for all these schemes.

SOLAR POWER SATELLITES

THE EMERGING ENERGY OPTION

John Wiley & Sons Incorporated

PROCEEDINGS OF THE ... INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE

1978 NASA AUTHORIZATION

HEARINGS BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S. HOUSE OF REPRESENTATIVES, NINETY-FOURTH CONGRESS, SECOND SESSION, ON H.R. 2221 ...

FEASIBILITY STUDY OF A SATELLITE SOLAR POWER STATION

WIRELESS AND SATELLITE SYSTEMS

11TH EAI INTERNATIONAL CONFERENCE, WISATS 2020, NANJING, CHINA, SEPTEMBER 17-18, 2020, PROCEEDINGS, PART II

Springer Nature *This two-volume set LNICST 357-358 constitutes the post-conference proceedings of the 11th EAI International Conference on Wireless and Satellite Services, WiSATS 2020, held in Nanjing, China, in September 2020. The 91 full papers and workshop papers were carefully reviewed and selected from 200 submissions. Part I - LNICST 357 - details original research and results of wireless and satellite technology for a smarter global communication architecture. The theme of WISATS 2020 is “Intelligent Wireless and Satellite Communications for Beyond 5G”. Part II – LNICST 358 - presents 6 workshop papers: High Speed Space Communication and Space Information Networks (HSSCSIN); Integrated Space and Onboard Networks (ISON); Intelligent Satellite Operations, Managements, and Applications (ISOMA); Intelligent Satellites in Future Space Networked System (ISFSNS); Satellite Communications, Networking and Applications (SCNA); Satellite Internet of Things; Trusted Data Sharing, Secure Communication (SIOTTDSSC).*

SOLAR POWER SATELLITE SYSTEM SIZING TRADEOFFS

SOLAR ENERGY UPDATE

SATELLITE SOLAR POWER STATION

SOLAR PHOTOVOLTAIC ARRAY REPORT

1975 NASA AUTHORIZATION, HEARINGS BEFORE....

A SELECTED LISTING OF NASA SCIENTIFIC AND TECHNICAL REPORTS FOR ...

FINAL REPORT OF THE ERDA TASK GROUP ON SATELLITE POWER STATIONS

NATIONAL SOLAR ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM--DEFINITION REPORT. SOLAR ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION ACT OF 1974. OVERSIGHT HEARINGS

HEARINGS BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S. HOUSE OF REPRESENTATIVES, NINETY-FOURTH

CONGRESS, FIRST SESSION, JULY 16, 1975

AUTOMATIC SOLAR TRACKING SUN TRACKING SATELLITE TRACKING RASTREADOR SOLAR SEGUIMENTO SOLAR SEGUIDOR SOLAR AUTOMÁTICO DE SEGUIMIENTO SOLAR

SOLAR TRACKING, INSEGUIMENTO SOLARE, SOL TRACKING, SOL DE SEGUIMIENTO : HIGH PRECISION SOLAR POSITION ALGORITHMS, PROGRAMS, SOFTWARE AND SOURCE-CODE FOR COMPUTING THE SOLAR VECTOR, SOLAR COORDINATES & SUN ANGLES IN MICROPROCESSOR, PLC, ARDUINO, PIC AND PC-BASED SUN TRACKING DEVICES OR DYNAMIC SUN FOLLOWING HARDWARE

Gerro Prinsloo *Automatic Solar Tracking Sun Tracking : This book details Automatic Solar-Tracking, Sun-Tracking-Systems, Solar-Trackers and Sun Tracker Systems. An intelligent automatic solar tracker is a device that orients a payload toward the sun. Such programmable computer based solar tracking device includes principles of solar tracking, solar tracking systems, as well as microcontroller, microprocessor and/or PC based solar tracking control to orientate solar reflectors, solar lenses, photovoltaic panels or other optical configurations towards the sun. Motorized space frames and kinematic systems ensure motion dynamics and employ drive technology and gearing principles to steer optical configurations such as mangin, parabolic, conic, or cassegrain solar energy collectors to face the sun and follow the sun movement contour continuously (seguimiento solar y automatización, automatización seguidor solar, tracking solar e automação, automação seguidor solar, inseguimento solare, inseguitore solare, energia termica, sole seguito, posizionatore motorizzato) In harnessing power from the sun through a solar tracker or practical solar tracking system, renewable energy control automation systems require automatic solar tracking software and solar position algorithms to accomplish dynamic motion control with control automation architecture, circuit boards and hardware. On-axis sun tracking system such as the altitude-azimuth dual axis or multi-axis solar tracker systems use a sun tracking algorithm or ray tracing sensors or software to ensure the sun's passage through the sky is traced with high precision in automated solar tracker applications, right through summer solstice, solar equinox and winter solstice. A high precision sun position calculator or sun position algorithm is this an important step in the design and construction of an automatic solar tracking system. The content of the book is also applicable to communication antenna satellite tracking and moon tracking algorithm source code for which links to free download links are provided. From sun tracing software perspective, the sonnet Tracing The Sun has a literal meaning. Within the context of sun track and trace, this book explains that the sun's daily path across the sky is directed by relatively simple principles, and if grasped/understood, then it is relatively easy to trace the sun with sun following software. Sun position computer software for tracing the sun are available as open source code, sources that is listed in this book. The book also describes the use of satellite tracking software and mechanisms in solar tracking applications. Ironically there was even a system called sun chaser, said to have been a solar positioner system known for chasing the sun throughout the day. Using solar equations in an electronic circuit for automatic solar tracking is quite simple, even if you are a novice, but mathematical solar equations are over complicated by academic experts and professors in text-books, journal articles and internet websites. In terms of solar hobbies, scholars, students and Hobbyist's looking at solar tracking electronics or PC programs for solar tracking are usually overcome by the sheer volume of scientific material and internet resources, which leaves many developers in frustration when search for simple experimental solar tracking source-code for their on-axis sun-tracking systems. This booklet will simplify the search for the mystical sun tracking formulas for your sun tracker innovation and help you develop your own autonomous solar tracking controller. By directing the solar collector directly into the sun, a solar harvesting means or device can harness sunlight or thermal heat. This is achieved with the help of sun angle formulas, solar angle formulas or solar tracking procedures for the calculation of sun's position in the sky. Automatic sun tracking system software includes algorithms for solar altitude azimuth angle calculations required in following the sun across the sky. In using the longitude, latitude GPS coordinates of the solar tracker location, these sun tracking software tools supports precision solar tracking by determining the solar altitude-azimuth coordinates for the sun trajectory in altitude-azimuth tracking at the tracker location, using certain sun angle formulas in sun vector calculations. Instead of follow the sun software, a sun tracking sensor such as a sun sensor or webcam or video camera with vision based sun following image processing software can also be used to determine the position of the sun optically. Such optical feedback devices are often used in solar panel tracking systems and dish tracking systems. Dynamic sun tracing is also used in solar surveying, DNI analyser and sun surveying systems that build solar infographics maps with solar radiance, irradiance and DNI models for GIS (geographical information system). In this way geospatial methods on solar/environment interaction makes use use of geospatial technologies (GIS, Remote Sensing, and Cartography). Climatic data and weather station or weather center data, as well as queries from sky servers and solar resource database systems (i.e. on DB2, Sybase, Oracle, SQL, MySQL) may also be associated with solar GIS maps. In such solar resource modelling systems, a pyranometer or solarimeter is normally used in addition to measure direct and indirect, scattered, dispersed, reflective radiation for a particular geographical location. Sunlight analysis is important in flash photography where photographic lighting are important for photographers. GIS systems are used by architects who add sun shadow applets to study architectural shading or sun shadow analysis, solar flux calculations, optical modelling or to perform weather modelling. Such systems often employ a computer operated telescope type mechanism with ray tracing program software as a solar navigator or sun tracer that determines the solar position and intensity. The purpose of this booklet is to assist developers to track and trace suitable source-code and solar tracking algorithms for their application, whether a hobbyist, scientist, technician or engineer. Many open-source sun following and tracking algorithms and source-code for solar tracking programs and modules are freely available to download on the internet today. Certain proprietary solar tracker kits and solar tracking controllers include a software development kit SDK for its application programming interface API attributes (Pebble). Widget libraries, widget toolkits, GUI toolkit and UX libraries with graphical control elements are also available to construct the graphical user interface (GUI) for your solar tracking or solar power monitoring program. The solar library used by solar position calculators, solar simulation software and solar contour calculators include machine program code for the solar hardware controller which are software programmed into Micro-controllers, Programmable Logic Controllers PLC, programmable gate arrays, Arduino processor or PIC processor. PC based solar tracking is also high in demand using C++, Visual Basic VB, as well as MS Windows, Linux and Apple Mac based operating systems for sun path tables on Matlab, Excel.*

Some books and internet webpages use other terms, such as: sun angle calculator, sun position calculator or solar angle calculator. As said, such software code calculate the solar azimuth angle, solar altitude angle, solar elevation angle or the solar Zenith angle (Zenith solar angle is simply referenced from vertical plane, the mirror of the elevation angle measured from the horizontal or ground plane level). Similar software code is also used in solar calculator apps or the solar power calculator apps for IOS and Android smartphone devices. Most of these smartphone solar mobile apps show the sun path and sun-angles for any location and date over a 24 hour period. Some smartphones include augmented reality features in which you can physically see and look at the solar path through your cell phone camera or mobile phone camera at your phone's specific GPS location. In the computer programming and digital signal processing (DSP) environment, (free/open source) program code are available for VB, .Net, Delphi, Python, C, C+, C++, PHP, Swift, ADM, F, Flash, Basic, QBasic, GBasic, KBasic, SIMPL language, Squirrel, Solaris, Assembly language on operating systems such as MS Windows, Apple Mac, DOS or Linux OS. Software algorithms predicting position of the sun in the sky are commonly available as graphical programming platforms such as Matlab (Mathworks), Simulink models, Java applets, TRNSYS simulations, Scada system apps, Labview module, Beckhoff TwinCAT (Visual Studio), Siemens SPA, mobile and iphone apps, Android or iOS tablet apps, and so forth. At the same time, PLC software code for a range of sun tracking automation technology can follow the profile of sun in sky for Siemens, HP, Panasonic, ABB, Allan Bradley, OMRON, SEW, Festo, Beckhoff, Rockwell, Schneider, Endress Hauser, Fudji electric. Honeywell, Fuchs, Yokonawa, or Muthibishi platforms. Sun path projection software are also available for a range of modular IPC embedded PC motherboards, Industrial PC, PLC (Programmable Logic Controller) and PAC (Programmable Automation Controller) such as the Siemens S7-1200 or Siemens Logo, Beckhoff IPC or CX series, OMRON PLC, Ercam PLC, AC500plc ABB, National Instruments NI PXI or NI cRIO, PIC processor, Intel 8051/8085, IBM (Cell, Power, Brain or Truenorth series), FPGA (Xilinx Altera Nios), Intel, Xeon, Atmel megaAVR, MPU, Maple, Teensy, MSP, XMOS, Xbee, ARM, Raspberry Pi, Eagle, Arduino or Arduino AtMega microcontroller, with servo motor, stepper motor, direct current DC pulse width modulation PWM (current driver) or alternating current AC SPS or IPC variable frequency drives VFD motor drives (also termed adjustable-frequency drive, variable-speed drive, AC drive, micro drive or inverter drive) for electrical, mechatronic, pneumatic, or hydraulic solar tracking actuators. The above motion control and robot control systems include analogue or digital interfacing ports on the processors to allow for tracker angle orientation feedback control through one or a combination of angle sensor or angle encoder, shaft encoder, precision encoder, optical encoder, magnetic encoder, direction encoder, rotational encoder, chip encoder, tilt sensor, inclination sensor, or pitch sensor. Note that the tracker's elevation or zenith axis angle may measured using an altitude angle-, declination angle-, inclination angle-, pitch angle-, or vertical angle-, zenith angle-sensor or inclinometer. Similarly the tracker's azimuth axis angle be measured with a azimuth angle-, horizontal angle-, or roll angle-sensor. Chip integrated accelerometer magnetometer gyroscope type angle sensors can also be used to calculate displacement. Other options include the use of thermal imaging systems such as a Fluke thermal imager, or robotic or vision based solar tracker systems that employ face tracking, head tracking, hand tracking, eye tracking and car tracking principles in solar tracking. With unattended decentralised rural, island, isolated, or autonomous off-grid power installations, remote control, monitoring, data acquisition, digital datalogging and online measurement and verification equipment becomes crucial. It assists the operator with supervisory control to monitor the efficiency of remote renewable energy resources and systems and provide valuable web-based feedback in terms of CO2 and clean development mechanism (CDM) reporting. A power quality analyser for diagnostics through internet, WiFi and cellular mobile links is most valuable in frontline troubleshooting and predictive maintenance, where quick diagnostic analysis is required to detect and prevent power quality issues. Solar tracker applications cover a wide spectrum of solar applications and solar assisted application, including concentrated solar power generation, solar desalination, solar water purification, solar steam generation, solar electricity generation, solar industrial process heat, solar thermal heat storage, solar food dryers, solar water pumping, hydrogen production from methane or producing hydrogen and oxygen from water (HHO) through electrolysis. Many patented or non-patented solar apparatus include tracking in solar apparatus for solar electric generator, solar desalinator, solar steam engine, solar ice maker, solar water purifier, solar cooling, solar refrigeration, USB solar charger, solar phone charging, portable solar charging tracker, solar coffee brewing, solar cooking or solar dying means. Your project may be the next breakthrough or patent, but your invention is held back by frustration in search for the sun tracker you require for your solar powered appliance, solar generator, solar tracker robot, solar freezer, solar cooker, solar drier, solar pump, solar freezer, or solar dryer project. Whether your solar electronic circuit diagram include a simplified solar controller design in a solar electricity project, solar power kit, solar hobby kit, solar steam generator, solar hot water system, solar ice maker, solar desalinator, hobbyist solar panels, hobby robot, or if you are developing professional or hobby electronics for a solar utility or micro scale solar powerplant for your own solar farm or solar farming, this publication may help accelerate the development of your solar tracking innovation. Lately, solar polygeneration, solar trigeneration (solar triple generation), and solar quad generation (adding delivery of steam, liquid/gaseous fuel, or capture food-grade CO$_2$) systems have need for automatic solar tracking. These systems are known for significant efficiency increases in energy yield as a result of the integration and re-use of waste or residual heat and are suitable for compact packaged micro solar powerplants that could be manufactured and transported in kit-form and operate on a plug-and play basis. Typical hybrid solar power systems include compact or packaged solar micro combined heat and power (CHP or mCHP) or solar micro combined, cooling, heating and power (CCHP, CHPC, mCCHP, or mCHPC) systems used in distributed power generation. These systems are often combined in concentrated solar CSP and CPV smart microgrid configurations for off-grid rural, island or isolated microgrid, minigrid and distributed power renewable energy systems. Solar tracking algorithms are also used in modelling of trigeneration systems using Matlab Simulink (Modelica or TRNSYS) platform as well as in automation and control of renewable energy systems through intelligent parsing, multi-objective, adaptive learning control and control optimization strategies. Solar tracking algorithms also find application in developing solar models for country or location specific solar studies, for example in terms of measuring or analysis of the fluctuations of the solar radiation (i.e. direct and diffuse radiation) in a particular area. Solar DNI, solar irradiance and atmospheric information and models can thus be integrated into a solar map, solar atlas or geographical information systems (GIS). Such models allows for defining local parameters for specific regions that may be valuable in terms of the evaluation of different solar in photovoltaic of CSP systems on simulation and synthesis platforms such as Matlab and Simulink or in linear or multi-objective optimization algorithm platforms such as COMPOSE, EnergyPLAN or DER-CAM. A dual-axis solar tracker and single-axis solar tracker may use a sun tracker program or sun tracker algorithm to position a solar dish, solar panel array, heliostat array, PV panel, solar antenna or infrared solar nantenna. A self-tracking solar concentrator performs

automatic solar tracking by computing the solar vector. Solar position algorithms (TwinCAT, SPA, or PSA Algorithms) use an astronomical algorithm to calculate the position of the sun. It uses astronomical software algorithms and equations for solar tracking in the calculation of sun's position in the sky for each location on the earth at any time of day. Like an optical solar telescope, the solar position algorithm pin-points the solar reflector at the sun and locks onto the sun's position to track the sun across the sky as the sun progresses throughout the day. Optical sensors such as photodiodes, light-dependant-resistors (LDR) or photoresistors are used as optical accuracy feedback devices. Lately we also included a section in the book (with links to microprocessor code) on how the PixArt Wii infrared camera in the Wii remote or Wiimote may be used in infrared solar tracking applications. In order to harvest free energy from the sun, some automatic solar positioning systems use an optical means to direct the solar tracking device. These solar tracking strategies use optical tracking techniques, such as a sun sensor means, to direct sun rays onto a silicon or CMOS substrate to determine the X and Y coordinates of the sun's position. In a solar mems sun-sensor device, incident sunlight enters the sun sensor through a small pin-hole in a mask plate where light is exposed to a silicon substrate. In a web-camera or camera image processing sun tracking and sun following means, object tracking software performs multi object tracking or moving object tracking methods. In an solar object tracking technique, image processing software performs mathematical processing to box the outline of the apparent solar disc or sun blob within the captured image frame, while sun-localization is performed with an edge detection algorithm to determine the solar vector coordinates. An automated positioning system help maximize the yields of solar power plants through solar tracking control to harness sun's energy. In such renewable energy systems, the solar panel positioning system uses a sun tracking techniques and a solar angle calculator in positioning PV panels in photovoltaic systems and concentrated photovoltaic CPV systems. Automatic on-axis solar tracking in a PV solar tracking system can be dual-axis sun tracking or single-axis sun solar tracking. It is known that a motorized positioning system in a photovoltaic panel tracker increase energy yield and ensures increased power output, even in a single axis solar tracking configuration. Other applications such as robotic solar tracker or robotic solar tracking system uses robotica with artificial intelligence in the control optimization of energy yield in solar harvesting through a robotic tracking system. Automatic positioning systems in solar tracking designs are also used in other free energy generators, such as concentrated solar thermal power CSP and dish Stirling systems. The sun tracking device in a solar collector in a solar concentrator or solar collector Such a performs on-axis solar tracking, a dual axis solar tracker assists to harness energy from the sun through an optical solar collector, which can be a parabolic mirror, parabolic reflector, Fresnel lens or mirror array/matrix. A parabolic dish or reflector is dynamically steered using a transmission system or solar tracking slew drive mean. In steering the dish to face the sun, the power dish actuator and actuation means in a parabolic dish system optically focusses the sun's energy on the focal point of a parabolic dish or solar concentrating means. A Stirling engine, solar heat pipe, thermosyphin, solar phase change material PCM receiver, or a fibre optic sunlight receiver means is located at the focal point of the solar concentrator. The dish Stirling engine configuration is referred to as a dish Stirling system or Stirling power generation system. Hybrid solar power systems (used in combination with biogas, biofuel, petrol, ethanol, diesel, natural gas or PNG) use a combination of power sources to harness and store solar energy in a storage medium. Any multitude of energy sources can be combined through the use of controllers and the energy stored in batteries, phase change material, thermal heat storage, and in cogeneration form converted to the required power using thermodynamic cycles (organic Rankin, Brayton cycle, micro turbine, Stirling) with an inverter and charge controller.

HEARINGS, REPORTS AND PRINTS OF THE SENATE SELECT COMMITTEE ON SMALL BUSINESS

LOW-COST SOLAR ELECTRIC POWER

Springer *This book describes recent breakthroughs that promise major cost reductions in solar energy production in a clear and highly accessible manner. The author addresses the three key areas that have commonly resulted in criticism of solar energy in the past: cost, availability, and variability. Coverage includes cutting-edge information on recently developed 40□ efficient solar cells, which can produce double the power of currently available commercial cells. The discussion also highlights the potentially transformative emergence of opportunities for integration of solar energy storage and natural gas combined heat and power systems. Solar energy production in the evening hours is also given fresh consideration via the convergence of low cost access to space and the growing number of large terrestrial solar electric power fields around the world. Dr. Fraas has been active in the development of Solar Cells and Solar Electric Power Systems for space and terrestrial applications since 1975. His research team at Boeing demonstrated the first GaAs/GaSb tandem concentrator solar cell in 1989 with a world record energy conversion efficiency of 35□, garnering awards from Boeing and NASA. He has over 30 years of experience at Hughes Research Labs, Chevron Research Co, and the Boeing High Technology Center working with advanced semiconductor devices. In a pioneering paper, he proposed the InGaP/GaInAs/Ge triple junction solar cell predicting a cell terrestrial conversion efficiency of 40□ at 300 suns concentration. Having become today's predominant cell for space satellites, that cell is now entering high volume production for terrestrial Concentrated Photovoltaic (CPV) systems. Since joining JX Crystals, Dr. Fraas has pioneered the development of various thermophotovoltaic (TPV) systems based on the new GaSb infrared sensitive PV cell. Dr. Fraas holds degrees from Caltech (B.Sc. Physics), Harvard (M. A. Applied Physics), and USC (Ph.D. EE).*