

diy geothermal air conditioning

diy geothermal air conditioning offers an innovative and sustainable approach to home cooling by harnessing the stable temperatures beneath the earth's surface. This method significantly reduces energy consumption compared to traditional air conditioning systems, providing both environmental and financial benefits. By understanding the principles of geothermal technology, homeowners can implement their own systems, reducing reliance on conventional HVAC units. This article explores the basics of diy geothermal air conditioning, including how it works, necessary materials, installation steps, and maintenance tips. Additionally, it addresses common challenges and considerations to help ensure a successful project. Whether upgrading an existing system or building new, a diy geothermal air conditioning setup can improve comfort while promoting energy efficiency. Below is a detailed overview of the key aspects covered in this guide.

- Understanding Geothermal Air Conditioning
- Essential Components for DIY Geothermal Systems
- Step-by-Step Installation Process
- Maintenance and Troubleshooting
- Benefits and Considerations of DIY Geothermal Air Conditioning

Understanding Geothermal Air Conditioning

Geothermal air conditioning utilizes the earth's consistent underground temperature to regulate indoor climate through heat exchange. Unlike traditional air conditioners that rely heavily on electricity, geothermal systems transfer heat between a building and the ground using a looped piping system filled with a heat-conductive fluid. This makes diy geothermal air conditioning an energy-efficient alternative, especially in regions with extreme temperature variations.

How Geothermal Systems Work

At the heart of diy geothermal air conditioning is the heat pump, which circulates fluid through underground pipes called ground loops. During hot seasons, the system extracts heat from the indoor air and transfers it into the cooler ground. In colder months, the process reverses, drawing heat from the earth to warm the building. This continuous exchange leverages the stable subterranean temperature, typically ranging from 50 to 60 degrees Fahrenheit,

to maintain comfortable interior climates year-round.

Types of Ground Loop Configurations

Choosing the right ground loop configuration depends on land availability, soil type, and climate. The three primary types include:

- **Horizontal loops:** Installed in trenches 4 to 6 feet deep, ideal for larger properties with ample yard space.
- **Vertical loops:** Drilled deep into the ground, suitable for smaller plots or rocky terrain.
- **Pond or lake loops:** Submerged in a nearby water source, where available, offering efficient heat transfer.

Essential Components for DIY Geothermal Systems

Building a diy geothermal air conditioning system requires specific materials and equipment to ensure effective operation and longevity. Understanding these components is crucial before beginning installation.

Ground Loop Piping

High-density polyethylene (HDPE) pipes are commonly used for ground loops due to their durability and resistance to corrosion. These pipes circulate a water-antifreeze solution that absorbs and dissipates heat between the earth and the heat pump.

Heat Pump Unit

The geothermal heat pump acts as the system's core, facilitating the heat exchange process. Selecting a unit compatible with the home's size and cooling requirements ensures optimal performance. It includes a compressor, a heat exchanger coil, and a fan to circulate conditioned air indoors.

Distribution System

The distribution system comprises ductwork or radiant floor tubing that delivers cooled or heated air throughout the building. Proper sizing and sealing of ducts are vital to maintain energy efficiency and comfort.

Control Systems and Thermostats

Advanced thermostats and control units allow precise temperature regulation and system monitoring. Integrating programmable or smart thermostats enhances energy savings and user convenience.

Step-by-Step Installation Process

Proper installation is essential for the success of diy geothermal air conditioning systems. The following outlines the general steps involved in setting up a functional geothermal cooling system.

Site Assessment and Planning

Evaluate the property to determine the best ground loop type based on soil conditions, available space, and local regulations. Conduct soil thermal conductivity tests if possible to optimize system design.

Excavation and Loop Installation

Excavate trenches or boreholes according to the chosen ground loop configuration. Carefully lay the HDPE pipes, ensuring proper spacing and avoiding sharp bends that could restrict fluid flow. Connect pipe segments securely using heat fusion or mechanical fittings.

Heat Pump and Distribution Setup

Install the heat pump inside the mechanical room or designated area, connecting it to the ground loop piping and indoor distribution system. Ensure all connections are airtight and insulated to prevent energy loss.

System Charging and Testing

Fill the ground loop with the antifreeze solution and purge air from the system. Perform pressure tests to detect leaks and verify fluid circulation. Finally, test the heat pump and thermostat controls to confirm proper operation.

Insulation and Final Adjustments

Insulate exposed piping to protect against temperature fluctuations and damage. Adjust system settings to match user preferences and seasonal demands for optimal efficiency.

Maintenance and Troubleshooting

Maintaining a diy geothermal air conditioning system is generally less intensive than conventional HVAC units but requires regular attention to ensure longevity and efficiency.

Routine Inspections

Schedule periodic inspections of the heat pump, ground loop pressure, and fluid levels. Check for signs of leaks, corrosion, or unusual noises that could indicate mechanical issues.

Filter and Duct Cleaning

Keep air filters clean and replace them as recommended to maintain air quality and system efficiency. Inspect and clean ductwork to prevent blockages and improve airflow.

Common Troubleshooting Issues

Typical problems include low fluid pressure, thermostat malfunctions, or compressor faults. Address these promptly by consulting technical manuals or professional support to avoid system damage.

Benefits and Considerations of DIY Geothermal Air Conditioning

Implementing a diy geothermal air conditioning system offers numerous advantages but also requires careful planning and commitment.

Energy Efficiency and Cost Savings

Geothermal systems use less electricity than conventional air conditioners, resulting in lower energy bills. While initial installation costs may be higher, long-term savings and potential tax incentives can offset upfront expenses.

Environmental Impact

Using earth's natural thermal properties reduces greenhouse gas emissions and reliance on fossil fuels, making diy geothermal air conditioning an eco-friendly choice for sustainable living.

Installation Challenges and Permits

DIY installation demands technical knowledge, proper tools, and adherence to local building codes and permits. It is important to assess skills realistically and consider professional consultation if necessary to ensure safety and compliance.

Longevity and Reliability

Geothermal systems typically have longer lifespans than traditional HVAC units, with ground loops lasting over 50 years. Proper maintenance supports system reliability and consistent performance.

Frequently Asked Questions

What is DIY geothermal air conditioning?

DIY geothermal air conditioning involves creating a home cooling system that uses the earth's stable underground temperature to regulate indoor air temperature, typically through a ground loop and heat exchange system, built and installed by homeowners themselves.

How does a DIY geothermal air conditioning system work?

A DIY geothermal air conditioning system works by circulating a fluid through underground pipes where the temperature remains constant, absorbing heat from the home in summer and releasing it into the cooler earth, thereby cooling the indoor air without traditional refrigerants.

What materials are needed for a DIY geothermal air conditioning system?

Materials typically include high-density polyethylene (HDPE) piping for the ground loop, a heat exchanger or geothermal heat pump unit, circulation pumps, thermostats, and insulation materials to properly install and seal the system.

Is it cost-effective to build a DIY geothermal air conditioning system?

Building a DIY geothermal air conditioning system can be cost-effective in the long run due to energy savings and reduced utility bills, although the upfront cost and labor can be significant and require technical knowledge.

What are the main challenges of installing a DIY geothermal air conditioning system?

Challenges include correctly sizing the system, digging and laying the ground loop pipes properly, ensuring leak-free connections, understanding local regulations, and having some plumbing and electrical skills for installation.

Can I use a DIY geothermal system for both heating and cooling?

Yes, most geothermal systems are designed for both heating and cooling by reversing the heat exchange process depending on the season, making them versatile for year-round climate control.

How deep do I need to bury the pipes for a DIY geothermal air conditioning system?

Pipes typically need to be buried 6 to 10 feet underground where the temperature remains relatively constant throughout the year, but depth can vary based on soil type and local climate conditions.

Are there environmental benefits to using DIY geothermal air conditioning?

Yes, geothermal air conditioning reduces reliance on fossil fuels, lowers greenhouse gas emissions, and uses renewable energy from the earth, making it an environmentally friendly cooling solution.

Where can I find reliable DIY guides for geothermal air conditioning installation?

Reliable DIY guides can be found on specialized green energy websites, forums like Reddit's r/Geothermal, YouTube tutorials from professionals, and publications from organizations promoting sustainable energy solutions.

Additional Resources

1. Geothermal Air Conditioning: A Comprehensive Guide to DIY Installation

This book offers step-by-step instructions for designing and installing a geothermal air conditioning system in your home. It covers the basics of geothermal energy, system components, and troubleshooting tips. Perfect for homeowners and DIY enthusiasts looking to reduce energy costs and environmental impact.

2. DIY Geothermal Systems for Home Cooling and Heating

An accessible guide that explains how to build and maintain your own

geothermal system for year-round climate control. The book includes detailed diagrams, material lists, and cost-saving strategies. It's ideal for readers with intermediate DIY skills interested in sustainable living.

3. *Energy-Efficient Geothermal Cooling: Practical DIY Solutions*

Focused on maximizing energy efficiency, this book explores innovative DIY methods to optimize geothermal air conditioning systems. Readers will learn about system design, soil analysis, and advanced techniques to enhance cooling performance. It's a valuable resource for eco-conscious homeowners.

4. *The Homeowner's Guide to DIY Geothermal Air Conditioning*

Tailored specifically for homeowners, this guide breaks down complex geothermal concepts into easy-to-understand language. It provides practical advice on site evaluation, system sizing, installation, and maintenance. The book also features case studies of successful DIY projects.

5. *Geothermal Heat Pumps: DIY Installation and Maintenance*

This book dives into the technical aspects of geothermal heat pumps used in air conditioning systems. It includes comprehensive tutorials on selecting equipment, drilling loops, and maintaining system efficiency. Suitable for readers with a technical background or a strong interest in renewable energy.

6. *Building Your Own Geothermal AC System: A Step-by-Step DIY Manual*

A hands-on manual that guides readers through every phase of building a geothermal air conditioning system from scratch. It emphasizes practical tips, safety considerations, and cost management. The book is designed to empower DIYers to create effective and reliable cooling solutions.

7. *Sustainable Cooling with DIY Geothermal Technology*

Highlighting the environmental benefits, this book discusses how to implement geothermal cooling systems using DIY methods. It addresses common challenges, regulatory considerations, and integration with existing HVAC systems. Ideal for readers passionate about sustainability and green technology.

8. *Geothermal Air Conditioning for Beginners: DIY Edition*

Perfect for beginners, this book simplifies the concepts behind geothermal air conditioning and offers easy-to-follow projects. It covers fundamental principles, necessary tools, and troubleshooting common issues. A great starting point for anyone new to geothermal technology.

9. *The Complete DIY Guide to Geothermal Climate Control*

This comprehensive guide covers both heating and cooling aspects of geothermal systems with a strong focus on air conditioning. It includes detailed plans, cost analysis, and energy savings projections. Suitable for DIY enthusiasts aiming for a full understanding of geothermal climate control solutions.

Diy Geothermal Air Conditioning

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diy geothermal air conditioning: DIY: How to Make Cheap Air Conditioning Earth Tubes

Sharon Buydens, 2016-01-04 Earth tubes (earthtubes, or earth-air tubes) are underground tubes that use geothermal energy to cool or heat temper the air for your home. It works like cheap air conditioning because you can build it yourself for several hundred dollars and it is FREE to run (no electricity needed). Being completely passive, this is a sustainable technology based on designs that are 3,000 years old and still used today around the world to cool homes. TABLE OF CONTENTS (chapters, sections, page numbers): Introduction 15; Who Invented Air Conditioning? 15; How Earth Tubes Work Like an Air Conditioner 18; The Cost of Earth Tubes vs Air Conditioning 19; Background and History of Earth Tubes 23; How I Learned About Earth Tubes 23; Qanats - 3,000 Year Old Earth Tubes 24; Effective Use of Earthtubes 34; How Earthtubes Work 34; Convection Brings Cooler Air Inside the House 36; Evaporation and Condensation 38; Best Material for Earthtubes 41; Interior Thermal Mass Enhances Earthtubes 43; How Many Earthtubes Do I Need? 48; Making the Earthtubes 55; Parts Needed to Make One Earthtube: 57; Tools Needed 57; Earth Tube Checklist 59; Trenches 63; Possible Limitations to Digging Trenches 66; Placement of Trenches 68; Laying the Earthtubes 73; Dealing with Elbows 74; Earthtubes - Outside and Inside 80; OUTSIDE: Protecting Earth Tubes 80; INSIDE: Floor Registers and Side Vents 84; How to Make Earth Tubes Work 93; Ready Your Earth Tubes for Use 93; Treating Earth Tubes Problems with Ozone 94; Summer Use (Air Conditioning) 97; Slow vs Forced Air Flow 103; Weatherizing for Fall/Winter 105; Winter Use (Heat Tempering) 108; A Lesson on Air Quality 114; Adding Earthtubes to an Existing House 121; If you have a Large Front or Backyard 121; Attaching Earth Tubes from Outside 125; Supplemental Uses and Related Ideas 130; Using Earthtubes for a Pantry/Storm Shelter 131; Spiral Earth Tubes for Tight Spaces 133; Spiral Tube Water Catchment 134; Earth Bermes & Earth Sheltered Homes 135; Cave houses & Rock Homes 138; Roofs of Earth, Water, & Air 141; Key Principles on Energy Efficiency 143; Trees and Shrubs 146; Chimneys for Ventilation Draw 147; Solar Chimneys 149; Cooling Tower 153; Earth Lodge & Weathervane Venting 155; Other Designs 161; Bill Traub Witnessed These Earth Tubes 161; Indoor Air Quality 165; Example of Bad Air Quality from Earth Tubes 174; Calculations for Earth Tubes 179; Q&A for the Tubes 180; On the Subject of Earth Tubes 180; Olan Volan's Earth Tube Calculations 181; Tube Diameter 181; Tube Depth 181; Distance Between Tubes 181; Simple Math Calculations 182; Air Transfer 183; Pressure Differences 184; Some Notes on the Calculations of Tubes 184; Earth Tubes Q&A 186;

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diy geothermal air conditioning: HVAC: Updated Guide to Heating, Ventilation and Air Conditioning (Your Essential Guide to HVAC Installation, Maintenance, and Troubleshooting) Mark Moro, 101-01-01 This comprehensive guide is your key to becoming a self-sufficient homeowner or kick-starting your career as an HVAC technician. Whether you're eager to handle home maintenance independently or curious about the HVAC industry, this book is your ultimate resource. Dive into a wealth of knowledge with easy-to-understand instructions, pictures, diagrams, and practical advice. Learn the ins and outs of HVAC systems, from theoretical concepts to hands-on installation, troubleshooting, and maintenance. Discover energy-saving strategies to enhance efficiency and sustainability, ensuring your home remains comfortable and eco-friendly year-round, freeing you from expensive professional services! In The HVAC Entrepreneur's

Handbook, you'll learn how to: · Build a solid business plan for your HVAC startup · Set achievable targets in business growth and expansion · Meet legal requirements, including permits, registrations, and certifications · Secure startup capital and effectively manage your finances This book arms you with the essential tools and knowledge you need to get your heating, ventilation, or air conditioning system up and running with minimal hassle or stress. Are you ready to begin designing an HVAC system for your home or business? Then scroll up and order your copy today!

diy geothermal air conditioning: Small Geothermal Energy Systems and Geothermal Heat Pumps Department of Energy (DOE), Energy Efficiency and Renewable Energy Office, Geothermal Technologies Program, U. S. Government, 2017-04-12 This comprehensive compilation of DOE documents provides unique and practical information about geothermal heat pumps, including small geothermal systems and DIY systems. Contents: Chapter 1: Small Geothermal Systems: A Guide For The Do-It-Yourselfer * Chapter 2: Using The Earth To Heat and Cool Buildings * Chapter 3: An Information Survival Kit For The Prospective Geothermal Heat Pump Owner * Chapter 4: Success Stories of the Geothermal Energy Program * Chapter 5: Ground-Source Heat Pumps: Overview of Market Status, Barriers to Adoption, and Options for Overcoming Barriers A heat pump-like an air conditioner or refrigerator-moves heat from one place to another. In the summer, a geothermal heat pump (GHP) operating in a cooling mode lowers indoor temperatures by transferring heat from inside a building to the ground outside or below it. Unlike an air conditioner, though, a heat pump's process can be reversed. In the winter, a GHP extracts heat from the ground and transfers it inside. Also, the GHP can use waste heat from summer air-conditioning to provide virtually free hot-water heating. The energy value of the heat moved is typically more than three times the electricity used in the transfer process. GHPs are efficient and require no backup heat because the earth stays at a relatively moderate temperature throughout the year. A GHP system has three major components: a ground loop (buried piping system), the heat pump itself (inside the house), and a heating and cooling distribution system. There are two main types of GHP systems. The earth-coupled (or closed-loop) GHP uses sealed horizontal or vertical pipes as heat exchangers through which water, or water and antifreeze, transfer heat to or from the ground. The second type, the water-source (or open-loop) GHP, pumps water from a well or other source to the heat exchanger, then back to the source. Because of their versatility, earth-coupled systems dominate the GHP market. Typical loop installations for the earth-coupled systems are expected to work for 50 years. More than 400,000 GHPs are operating in homes, schools, and commercial buildings in the United States. They are adaptable to virtually any kind of building; the Federal government has installed nearly 10,000 GHPs. Geothermal resources are available across the United States at varying depths, providing a ubiquitous buried treasure of domestic renewable energy. Enormous amounts of hydrothermal geothermal energy is available in the western United States, but theoretically, geothermal sources are available across the United States. The key to being able to use geothermal energy is to find a way to enhance geothermal systems lacking key natural characteristics. Natural geothermal systems depend on three factors to produce energy: heat, water, and permeability. While heat is present virtually everywhere at depth, water and permeability are less abundant. Geothermal technology is an attractive renewable resource because it can provide a constant source of renewable baseload electricity. While the sun and wind offer a large potential source of renewable energy that varies over time, geothermal technology is uninterruptible and can provide a stable baseload form of energy while diversifying the nation's renewable portfolio. Geothermal energy has low environmental risk and impact. When used with a closed-loop binary power plant, geothermal systems emit zero greenhouse gas emissions and have a near zero environmental risk or impact.

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creating an attractive and effective website using today's top web-based tools. This book helps you launch or improve your website designed to boost your entrepreneurial endeavors, small business, or personal passion. With this easy-to-follow Dummies guide, you can skip learning the complicated coding that runs a site and focus on the parts that attract visitors (and search engines). Grab this book and get expert insight on how to craft a usable design, create site content, improve site findability, and convert browsers into buyers. Discover how to select hosting services, email providers, and beginner-friendly website creators Build your own website without needing to learn any code Learn how to create an attractive design, develop content, and present it all in a way that will appeal to your target audience Improve your site's search engine findability and resonate with your target customer This Dummies guide is an excellent choice for non-designers who want to create a website without hiring someone to do it for them. Learn the ropes, follow the best practices, and launch your site!

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diy geothermal air conditioning: The Solar Garden Greenhouse Ronald Jenkins, 2024-12-05 The Solar Garden Greenhouse is a description of my journey to research, plan, and build a greenhouse that would work well in Northern Idaho, where we have short summers and hard winters. I explored and researched earth sheltering, insulated foundations, rainwater harvest solutions, and geothermal principles that would allow a successful greenhouse not requiring a high carbon footprint. I developed automated heating and cooling systems that would not require a daily presence (such as by manually opening doors, windows, and/or turning on fans). The book provides a discussion of these considerations and includes a pictorial description of the construction of the greenhouse and assorted systems, as well as a description of how they worked out once built. My hope is to inspire others to continue this journey of finding means and methods to build effective greenhouses without a large carbon footprint and perhaps find further improvements to the solutions I describe. This process has been a labor of love and successful beyond what I could have hoped for.

diy geothermal air conditioning: Advances in Energy, Environment and Chemical Engineering Volume 1 Ahmad Zuhairi Abdullah, Azlin Fazlina Osman, 2022-12-21 Advances in Energy, Environment and Chemical Engineering collects papers resulting from the conference on Energy, Environment and Chemical Engineering (AEECE 2022), Dali, China, 24-26 June, 2022. The primary goal is to promote research and developmental activities in energy technology, environment engineering and chemical engineering. Moreover, it aims to promote scientific information interchange between scholars from the top universities, business associations, research centers and high-tech enterprises working all around the world. The conference conducts in-depth exchanges and discussions on relevant topics such as energy engineering, environment technology and advanced chemical technology, aiming to provide an academic and technical communication platform for scholars and engineers engaged in scientific research and engineering practice in the field of saving technologies, environmental chemistry, clean production and so on. By sharing the research status of scientific research achievements and cutting-edge technologies, it helps scholars and engineers all over the world comprehend the academic development trend and broaden research ideas. So as to strengthen international academic research, academic topics exchange and discussion, and promote the industrialization cooperation of academic achievements.

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impact of human activity on planet Earth. Dedicated to converging science and technology in a way that ensures a sustainable future, this book outlines the basics of renewable energy and focuses on current and developing policies that support the shift to renewable energy. New in the third edition, the book addresses bioenergy, energy balance, biodiesel, and photovoltaic applications, and includes an all-new chapter addressing climate change. Revised throughout and includes an all-new chapter on climate change. Includes color images throughout for this new edition. Adds revised end-of-chapter problems, and a solutions manual and PowerPoint slides for instructors. Includes several appendices: mathematics, exponential growth, lifetime of finite resource, order of magnitude estimates, and conversions.

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diy geothermal air conditioning: *Practical Solar Tracking Automatic Solar Tracking Sun Tracking Автоматическое удержание Солнечная слежения ВС* Gerro Prinsloo, Robert Dobson, 2015-11-01 This book details Practical Solar Energy Harvesting, Automatic Solar-Tracking, Sun-Tracking-Systems, Solar-Trackers and Sun Tracker Systems using motorized automatic positioning concepts and control principles. 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. In general, the book may benefit solar research and solar energy applications in countries such as Africa, Mediterranean, Italy, Spain, Greece, USA, Mexico, South America, Brazilia, Argentina, Chili, India, Malaysia, Middle East, UAE, Russia, Japan and China. This book on practical automatic Solar-Tracking Sun-Tracking is in .PDF format and can easily be converted to the .EPUB .MOBI .AZW .ePub .FB2 .LIT .LRF .MOBI .PDB .PDF .TCR formats for smartphones and Kindle by using the ebook.online-convert.com facility. 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. 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. 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. 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, X MOS, 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 be 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 may be measured with an 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 drying 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 CO₂) 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

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