Solar Thermal Installer and Consultant Certificate

Description – What can I do with this certificate:

Learn the essentials of residential solar system design, installation, troubleshooting and operation procedures for residential water and pool heating with greater emphasis on water heating. This course includes the theory, design considerations and installation techniques necessary to install and maintain a solar domestic hot water system. Also included are safety considerations, code compliance, system sizing, and understanding solar collector performance.

This certificate involves both classroom instruction and student-interactive exercises. Exercises such as hands-on activities and demonstration laboratories that explain the design, installation, commissioning and trouble-shooting of solar hot water systems and pool heating systems, and that aim at developing the participant's working knowledge of solar thermal systems.

Academic Options: Pursue continuing education

What are the eligibility requirements of this course?

To be eligible for this course, the student should have prior work experience as a plumber, contractor or roofer. Previous academic studies related to this field would also suffice.

For students with no prior experience and knowledge, the Green Building and Design certificate is a mandatory requirement.

This unit will prepare you to apply for the following certification(s).

This program would be specifically developed for a NABCEP certification. North American Board of Certified Engineers Practitioners (NABCEP) Certification establishes consistent standards by which to measure specific, multi-discipline knowledge sets. It provides a way to test a variety of skilled trades' people and other practitioners on the specific and unique knowledge requirements of the PV or solar thermal specialty. This program will train professionals; architects, contractors, plumbers or HVAC engineers in the field of solar thermal consulting and installation. The training would be focused towards the nationally recognized North American Board of Certified Engineers Practitioners.

A certification from the NABCEP (North American Board of Certified Energy Practitioners), as a certified solar thermal installer requires a minimum of 40 hours of cumulative training by an educational body along with 2 years of experience in installing solar hot water systems.

This program has a dual focus:

Focus One: Solar Thermal Consultant

This course is designed for engineers and architects (with more technical knowledge and inclination), the training provided will be in the field of optimum design sizing of solar hot water systems. All the work that is part of the system sale and commissioning process (Sales Application Engineers, Financial Analysts, Site Inspectors, System Designers, Plan Checkers, Outside Sales, Representatives, Sales Managers, etc.) and that is done without the use of tools. NBCEP is planning on introducing a certification for the same.

Focus Two: Solar Thermal Installer

Designed specifically for plumbers, contractors, pipe fitters, this program provides basic training on system design and an extensive training on system installation, system checks and on-site maintenance and troubleshooting. This program would be focused towards the NABCEP certification.

Focus 1: Solar Thermal Consultant

A 19 credit hour training program, it would include workshops from industry partners as well as an applied project of solar hot water installation

Basic Solar Thermal Consultant	CREDIT HOURS
Module 1: Solar Energy Fundamentals	**3**
Module 2: Solar Thermal Fundamentals and Applications	**3**
Module 3: Code Compliance and Tax Credits	**3**
Total	**9**

Advanced Solar Thermal Consultant	CREDIT HOURS
Module 4: Site Analysis and Report	3
Module 5: Residential Sales, Commercial Sales and Marketing	2
Module 6: Computer Aided Modeling	2
Module 7: Workshops	3
Total	**10**

Focus 2: Solar Thermal Installer

This course would be offered for 20 required credit hours, followed by an optional 6 hour applied project option with FAFCO.

Basic Solar Thermal Installer	CREDIT HOURS
Module 1: Solar Energy Fundamentals	3
Module 2: Solar Thermal Fundamentals and Applications	3
Module 3: Code Compliance and Tax Credits	3
Module 5: Professional Conduct	1
Total	**10**

Advanced Solar Thermal Installer	CREDIT HOURS
Module 4: Site Analysis and Report	3
Module 6: System Components and Sizing	3
Module 7: System Installation, Structural Considerations and Troubleshooting	3
Module 8: Collector and System Certification	1
Total	**10**

Elective Courses	CREDIT HOURS
Module 9: Applied Project	6

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Credits:

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Module 1: Solar Energy Fundamentals

Description:

This course introduces the fundamentals of solar energy, solar radiation and measurements. The student will be involved in lab activities using the pathfinder, inclinometer, and radiometers to determine sun angles and radiation intensity.

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Explain various aspects of solar radiation, including types of radiation, various sun angles, concept of sun mass and solar constant.
2. Discuss various aspects of Sun's movement and define sun's position using sun chart.
3. Discuss the solar spectrum, short wave and long wave radiations.
4. Define various solar angles, along with measure the same.
5. Discuss the concept of radiometers and radiation measurements as well as perform basic measurements using radiometers like the LiCor 200, Crystalline Silicon reference cells, NIP radiometers.
6. Efficiently use the NREL solar radiation database to perform quick feasibility studies.
7. Define terms such as tilt angles, incidence angle etc.

** This course is required for the Solar Thermal Installers and Consultants.*

Module 1: Solar Energy Fundamentals		
Expected Outcome	Topic	Suggested Activities
1-3	**Solar Radiation-** □ **I**nsolation, Irradiance • Sun angles • Direct, Diffuse, Global Radiation • Clear Sky, Cloudy Sky • Concept of Air Mass • Solar Constant • Convert solar irradiation into other units □ Sun's Movement • Find true solar south from magnetic (compass) south given a declination map • Basic solar movement and the effect of earth tilt • Angular effects on the irradiance of array • Solar position using solar path diagrams • Factors that reduce/enhance solar irradiation • Average solar irradiation on various surfaces □ Solar Radiation Spectrum • Ultravoilet • Visible • Infrared	
4	**Measure Solar Altitude and Azimuth**	
5	**Measure Solar Radiation** • Thermopiles • Radiometers-Pryanmeters, Pyreheliometers	
6	**National Solar Radiation Database** □ NREL Solar Radiation Maps	
2	**Use of Pathfinder and Sun Charts** □ Effect of horizon on solar irradiation (shading)	
7	**Introduction to terms: Tilt Angles, Incidence angles**	

Expected Outcome	Lab
	LAB: □ Use of Inclinometer to determine altitude and azimuth □ Use of radiometers (pyranometer, pyreheliometer) to measure direct, diffuse and global radiation □ Use of Pathfinder for shading analysis.

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

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Module 2: Solar Thermal Fundamentals and Applications

Description:

This course demonstrates the various kinds of collectors and the working principles of the same. It also addresses various applications of solar thermal. The student will be provided extensive knowledge in all applications of solar thermal for residential as well as commercial applications

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the basics of solar thermal.
2. Define the principle of solar thermal and different kinds of systems such as thermosyphon system and forced-circulation system.
3. Discuss principles of vacuum tubes, different types of vacuum tubes and their applications.
4. Define the working principles of the different kinds of collectors and their applications.
5. Discuss the hot water storage options and requirements.
6. Identify the various required controllers in a hot water system.
7. Define a heat transfer fluid and the various different heat transfer fluids used in different solar hot water applications.
8. Enlist the various solar thermal system types for residential applications.
9. Enlist the various solar thermal system types for commercial applications.
10. Discuss the principles, do's and don'ts for design, installation and maintenance of systems.
11. Define the concept of solar district heating and its applications. Case studies would enable students to identify its feasibility.

** This course is required for the Solar Thermal Installers and Consultants.*

Module 2: Solar Energy Fundamentals		
Expected Outcome	Topic	Suggested Activities
1	**Solar Heating Basics**	
2	**Types of Solar Thermal Systems-** A. Active Systems- 1. Active Drainback Indirect System 2. Active Antifreeze Indirect System 3. Direct Active System (Pump) B. Passive Systems 1. Thermosyphon Systems	
3	**Vacuums Tubes** A. Principle 1. Types: Heat Pipe and Open Vacuum Tubes 2. Innovations in Vacuum tube technology	
4	**Solar Collectors: Types** A. Evacuated Tube B. Flat Plate C. Fundamental principles D. Comparison of Technology E. Advantages and Disadvantages	
5	**Solar Hot Water Storage**	
6	**Solar Hot Water Controllers and Circulators**	
7	**Heat Exchangers**	
8	**Solar Thermal: Residential Applications** A. Domestic Hot Water B. Pool Heating C. Radiant and Space Heating	
9	**Solar thermal: Commercial Applications** A. Pool Heating B. Space Heating	
10	**Design Principle of Solar Hot Water Systems** A. Proper Location, Orientation and Tilt of System B. Protection Against Freezing C. Tempering Valve and Bypass Capability D. Periodic Maintenance	

11	**Solar District Heating** A. Principle B. Storage C. Piping D. Heating Cycle E. Collecting Cycle F. Advantages and Disadvantages G. Possibilities	

Expected Outcome	Activities
11	This include a field trips for a demonstration of these technologies, including a trip to the APS STAR test center.

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Module 3: Code Compliance and Tax Credits

Description:

Various applicable codes required during system installation will be demonstrated, market trends in solar thermal application discussed and the U.S., federal and state policy analyzed,

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the applicable ASHRAE codes for solar heating design, installations, operation and maintenance and testing.
2. Discuss the IAPMO codes for plumbing systems, mechanical systems and the ANSI approved USEC.
3. Discuss the United Facilities Criteria which includes planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the Department of Defense Field.
4. Discuss the requirements of the Factory Mutual Engineering approval guides.
5. Define the mandatory requirements and procedures as outlined by the National Fire Protection Association's National Electric Code.
6. Define the performance code and minimum certification standards as outlined by SRCC.
7. Analyze government policies with solar thermal rebates and incentives.
8. Analyze state policies towards solar thermal. (Arizona State)
9. Analyze existing utility rebate programs.
10. Identify the key performance indicators (KPI) for the solar thermal market and analyze the market trends based on the same.

* *This course is required for the Solar Thermal Installers and Consultants.*

Module 3: Code Compliance and Tax Credits		
Expected Outcome	Topic	Suggested Activities
1	**ASHRAE** • ASHRAE 90003 Active Solar Heating Design Manual • ASHRAE 90336 Guidance for Preparing Active Solar Heating Systems Operation and Maintenance Manuals • ASHRAE 90342 Active Solar Heating Systems Installation Manual • ASHRAE 93 Methods of Testing to Determine the Thermal Performance of Solar Collectors	
2	**International Association of Plumbing and Mechanical Officials** • Uniform Plumbing Code (UPC) • Uniform Mechanical Code (UMC) • Uniform Solar Energy Code (2009 USEC was adopted by American National Standards Institute, as the national governing body for the installation, inspection and maintenance of solar energy systems and their component products.)	
3	**Department of Defense** • UFC 3-440-04N Solar Heating of Buildings and Domestic Hot Water	
4	**Factory Mutual Engineering and Research Corp. (FM Global)** • FM P7825 Approval Guide	
5	**Solar Hot Water Controllers and Circulators**	
6	**National Fire Protection Association (NFPA)** • NFPA 70 National Electrical Code	
7	**Performance Code and Minimum Standards-** **Solar Rating and Certification Corporation (SRCC)** • SRCC OG-300-91 Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems	
8	**Federal Tax Incentives for Solar Thermal**	
9	**State Tax Incentives and Production Tax Incentives**	
10	**Utility Rebate Programs**	
	US Market Trends in Solar Thermal • Cost and Market Trend • Key Performance Indicators • Key Influential Factors	

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Module 4: Site Analysis and Report

Description:

This course introduces students to requirements for site analysis, optimum collector orientation, collector sizing as well as performance calculation. Report writing to effectively convey results also comprises of a crucial segment of this course.

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss aspects of site analysis required for a solar hot water system installation.
2. Define optimal orientation of the collector on the basis of location and roof configuration.
3. Discuss the various collector mounting possibilities and the applicable possibilities for different roof configurations.
4. Carry out a shading analysis to determine annual and daily shading of collector and the corresponding affect on collector performance.
5. Analyze existing hot water system in the house to define the system type and fuel used.
6. Carry out a roof analysis to identify possible locations and piping configuration.
7. Identify the most applicable system type on the basis of house location and requirements.
8. Carry out a system sizing as well as cost analysis to determine the same.
9. Create a site report summarizing all the above mentioned aspects to enable the user to make an informed decision.

* *This course is required for the Solar Consultants and Advanced Solar Thermal Installers.*

Module 4: Site Analysis and Report		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Site Analysis** Objectives and Overview of Procedure Involved	Site Selection
2	**Orientation** **A.** Determining Optimal Orientation	System Orientation
3	**Collector Mounting** A. Flush Mount B. Tilt Mount **C.** Ground Mount	
4	**Shading Analysis** A. Annual Shading B. Daily Shading **C.** Tools for Shading Analysis: Pathfinder	Tilt Angle
5	**Existing Hot Water Systems** A. Define Aspects of Existing Systems B. Tank/Tankless **C.** Fuel Type	Identify Plumbing Requirements
6	**Roof Analysis** A. Collector Placement **B.** Piping Possibilities- Shaft/ Exterior Wall	
7	**System Types** A. Evacuated Tube **B.** Flat Plate	System Selection
8	**System Sizing and Costing**	
9	**Report writing**	Prepare a Site Report

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

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Module 5: Residential Sales, Commercial Sales and Marketing

Description:

Techniques for sales and marketing for residential and commercial applications for all system types in solar thermal would be demonstrated and students would be trained to be effective salesmen.

Certification(s): Solar Thermal Consultants

Prerequisite: None

Required Materials: None

Credit Hours: 2

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss aspects of lead generation and closing.
2. Carry out deeper financial analysis of customer ROI.
3. Carry out basic customer qualification procedures.
4. Execute system estimates, give quotes for projects and close deals.
5. Effectively take advantage of federal and state incentives for solar thermal.
6. Discuss several effective solar business models
7. Define strategies to approach local markets.
8. Enlist web marketing tactics for effective sales.
9. Discuss tactics to attract customers through home shows etc.
10. Explain various incentives and rebates; financing options, service plans etc.
11. Discuss various commercial applications of solar thermal.
12. Elaborate on the procedures involved in commercial sales and bidding process.
13. Identify potential opportunities through federal listings.
14. Perform sizing and design of systems at a commercial scale.
15. Proficiently bid and execute sales for commercial projects.

Module 5: Residential Sales, Commercial Sales and Marketing		
Expected Outcome	Topic	Suggested Activities/Lab
1 - 5	**Sales: General** A. Calculating ROI & Energy Savings B. Customer Qualification & Sales Tracking C. Quotes, Estimating, & Deal Closing D. Using State & Federal Incentives	
6-10	**Residential Sales** A. The successful solar business model B. Approaching Local Market C. Web marketing tactics: Get your business on the internet D. The power of the home show and how to execute it E. Incentives, financing options, service plans, and insurance	
11-15	**Commercial Sales and Marketing** A. Introduction To Commercial Solar Thermal Systems & Installations B. The commercial solar thermal sales and bidding process. C. Finding Projects: Federal Listings D. Commercial Solar Thermal Sizing & Design E. Winning Commercial Solar Thermal Bids F. Case Studies in Solar Success	

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Module 6: Computer Aided Modeling

Description:

Students will be introduced to the software RetScreen® for solar hot water feasibility studies, and simple and equity payback.

Certification(s): Solar Thermal Consultants
Prerequisite: None
Required Materials: None
Credit Hours: 2

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Perform basic calculations such as unit conversions to metric and U.S. Units
2. Perform recourse assessment based on use of tracking system, tilt angle, slope and azimuth.
3. Define data to be input for collectors, aperture area, miscellaneous losses, etc.
4. Define values for balance of systems including storage capacity, heat exchanger, pump power etc.
5. Define emissions in comparison to a standard electric hot water heater.
6. Carry out financial analysis on basis of incentives and grants, costs and savings to define simple payback and equity payback.

Module 6: Computer Aided Modeling – Using RetScreen®		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Basics** A. Metric Units and U.S. Units	
2	**Resource Assessment** A. Tracking System	
3	**Solar Water Heater** A. Collectors B. Aperture Area C. Miscellaneous Losses	
4	**Balance of Systems and Miscellaneous** A. Storage B. Storage Capacity C. Heat Exchanger D. Pump Power E. Miscellaneous Losses	
5	**Emission Analysis**	
6	**Financial Analysis**	

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

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Module 7: Workshops

Description:

Workshops organized by our industry partners will demonstrate the different kinds of systems, applications and sales tactics.

Certification(s): Solar Thermal Consultant

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the cutting edge technology prevalent in the market at present.
2. Discus the latest technological innovations in solar thermal systems and components.
3. Identify factors which help in system component selection.
4. Identify job potentials in the solar thermal market.
5. Identify the job requirements and aspects considered crucial or advantageous for job procurement.
6. Define potential focus areas of work.

Module 7: Workshops	
Expected Outcome	Topic
1 - 6	**Organized by our industrial partners to demonstrate** • Cutting edge technology • Latest Innovations in systems and components • Various system components: market selection • Potentials of the solar thermal market • Job requirements • Possible focus areas of work

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

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Module 1: Solar Energy Fundamentals

Description:

This course introduces the fundamentals of solar energy, solar radiation and measurements. The student will be involved in lab activities using the pathfinder, inclinometer, and radiometers to determine sun angles and radiation intensity.

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Explain various aspects of solar radiation, including types of radiation, various sun angles, concept of sun mass and solar constant.
2. Discuss various aspects of Sun's movement and define sun's position using sun chart.
3. Discuss the solar spectrum, short wave and long wave radiations.
4. Define various solar angles, along with measure the same.
5. Discuss the concept of radiometers and radiation measurements as well as perform basic measurements using radiometers like the LiCor 200, Crystalline Silicon reference cells, NIP radiometers.
6. Efficiently use the NREL solar radiation database to perform quick feasibility studies.
7. Define terms such as tilt angles, incidence angle etc.

* *This course is required for the Solar Thermal Installers and Consultants.*

Module 1: Solar Energy Fundamentals		
Expected Outcome	Topic	Suggested Activities
1-3	**Solar Radiation-** □ **I**nsolation, Irradiance • Sun angles • Direct, Diffuse, Global Radiation • Clear Sky, Cloudy Sky • Concept of Air Mass • Solar Constant • Convert solar irradiation into other units □ Sun's Movement • Find true solar south from magnetic (compass) south given a declination map • Basic solar movement and the effect of earth tilt • Angular effects on the irradiance of array • Solar position using solar path diagrams • Factors that reduce/enhance solar irradiation • Average solar irradiation on various surfaces □ Solar Radiation Spectrum • Ultravoilet • Visible • Infrared	
4	**Measure Solar Altitude and Azimuth**	
5	**Measure Solar Radiation** • Thermopiles • Radiometers-Pryanmeters, Pyreheliometers	
6	**National Solar Radiation Database** □ NREL Solar Radiation Maps	
2	**Use of Pathfinder and Sun Charts** □ Effect of horizon on solar irradiation (shading)	
7	**Introduction to terms: Tilt Angles, Incidence angles**	

Expected Outcome	Lab
	LAB: □ Use of Inclinometer to determine altitude and azimuth □ Use of radiometers (pyranometer, pyreheliometer) to measure direct, diffuse and global radiation □ Use of Pathfinder for shading analysis.

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

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Module 2: Solar Thermal Fundamentals and Applications

Description:

This course demonstrates the various kinds of collectors and the working principles of the same. It also addresses various applications of solar thermal. The student will be provided extensive knowledge in all applications of solar thermal for residential as well as commercial applications

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the basics of solar thermal.
2. Define the principle of solar thermal and different kinds of systems such as thermosyphon system and forced-circulation system.
3. Discuss principles of vacuum tubes, different types of vacuum tubes and their applications.
4. Define the working principles of the different kinds of collectors and their applications.
5. Discuss the hot water storage options and requirements.
6. Identify the various required controllers in a hot water system.
7. Define a heat transfer fluid and the various different heat transfer fluids used in different solar hot water applications.
8. Enlist the various solar thermal system types for residential applications.
9. Enlist the various solar thermal system types for commercial applications.
10. Discuss the principles, do's and don'ts for design, installation and maintenance of systems.
11. Define the concept of solar district heating and its applications. Case studies would enable students to identify its feasibility.

* *This course is required for the Solar Thermal Installers and Consultants.*

Module 2: Solar Energy Fundamentals		
Expected Outcome	Topic	Suggested Activities
1	**Solar Heating Basics**	
2	**Types of Solar Thermal Systems-** A. Active Systems- 1. Active Drainback Indirect System 2. Active Antifreeze Indirect System 3. Direct Active System (Pump) B. Passive Systems 1. Thermosyphon Systems	
3	**Vacuums Tubes** A. Principle 1. Types: Heat Pipe and Open Vacuum Tubes 2. Innovations in Vacuum tube technology	
4	**Solar Collectors: Types** A. Evacuated Tube B. Flat Plate C. Fundamental principles D. Comparison of Technology E. Advantages and Disadvantages	
5	**Solar Hot Water Storage**	
6	**Solar Hot Water Controllers and Circulators**	
7	**Heat Exchangers**	
8	**Solar Thermal: Residential Applications** A. Domestic Hot Water B. Pool Heating C. Radiant and Space Heating	
9	**Solar thermal: Commercial Applications** A. Pool Heating B. Space Heating	
10	**Design Principle of Solar Hot Water Systems** A. Proper Location, Orientation and Tilt of System B. Protection Against Freezing C. Tempering Valve and Bypass Capability D. Periodic Maintenance	

11	**Solar District Heating** A. Principle B. Storage C. Piping D. Heating Cycle E. Collecting Cycle F. Advantages and Disadvantages G. Possibilities	

Expected Outcome	Activities
11	This include a field trips for a demonstration of these technologies, including a trip to the APS STAR test center.

This course aligns with National Recognized Certifications by the North American Board of Certified Energy Practitioners (NABCEP) for the Solar Thermal Installer Certification.

Credits:

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Module 3: Code Compliance and Tax Credits

Description:

Various applicable codes required during system installation will be demonstrated, market trends in solar thermal application discussed and the U.S., federal and state policy analyzed,

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the applicable ASHRAE codes for solar heating design, installations, operation and maintenance and testing.
2. Discuss the IAPMO codes for plumbing systems, mechanical systems and the ANSI approved USEC.
3. Discuss the United Facilities Criteria which includes planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the Department of Defense Field.
4. Discuss the requirements of the Factory Mutual Engineering approval guides.
5. Define the mandatory requirements and procedures as outlined by the National Fire Protection Association's National Electric Code.
6. Define the performance code and minimum certification standards as outlined by SRCC.
7. Analyze government policies with solar thermal rebates and incentives.
8. Analyze state policies towards solar thermal. (Arizona State)
9. Analyze existing utility rebate programs.
10. Identify the key performance indicators (KPI) for the solar thermal market and analyze the market trends based on the same.

** This course is required for the Solar Thermal Installers and Consultants.*

Module 3: Code Compliance and Tax Credits		
Expected Outcome	Topic	Suggested Activities
1	**ASHRAE** • ASHRAE 90003 Active Solar Heating Design Manual • ASHRAE 90336 Guidance for Preparing Active Solar Heating Systems Operation and Maintenance Manuals • ASHRAE 90342 Active Solar Heating Systems Installation Manual • ASHRAE 93 Methods of Testing to Determine the Thermal Performance of Solar Collectors	
2	**International Association of Plumbing and Mechanical Officials** • Uniform Plumbing Code (UPC) • Uniform Mechanical Code (UMC) • Uniform Solar Energy Code (2009 USEC was adopted by American National Standards Institute, as the national governing body for the installation, inspection and maintenance of solar energy systems and their component products.)	
3	**Department of Defense** • UFC 3-440-04N Solar Heating of Buildings and Domestic Hot Water	
4	**Factory Mutual Engineering and Research Corp. (FM Global)** • FM P7825 Approval Guide	
5	**Solar Hot Water Controllers and Circulators**	
6	**National Fire Protection Association (NFPA)** • NFPA 70 National Electrical Code	
7	**Performance Code and Minimum Standards-** **Solar Rating and Certification Corporation (SRCC)** • SRCC OG-300-91 Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems	
8	**Federal Tax Incentives for Solar Thermal**	
9	**State Tax Incentives and Production Tax Incentives**	
10	**Utility Rebate Programs**	
	US Market Trends in Solar Thermal • Cost and Market Trend • Key Performance Indicators • Key Influential Factors	

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Module 4: Site Analysis and Report

Description:

This course introduces students to requirements for site analysis, optimum collector orientation, collector sizing as well as performance calculation. Report writing to effectively convey results also comprises of a crucial segment of this course.

Certification(s): Solar Thermal Consultant and Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss aspects of site analysis required for a solar hot water system installation.
2. Define optimal orientation of the collector on the basis of location and roof configuration.
3. Discuss the various collector mounting possibilities and the applicable possibilities for different roof configurations.
4. Carry out a shading analysis to determine annual and daily shading of collector and the corresponding affect on collector performance.
5. Analyze existing hot water system in the house to define the system type and fuel used.
6. Carry out a roof analysis to identify possible locations and piping configuration.
7. Identify the most applicable system type on the basis of house location and requirements.
8. Carry out a system sizing as well as cost analysis to determine the same.
9. Create a site report summarizing all the above mentioned aspects to enable the user to make an informed decision.

* *This course is required for the Solar Consultants and Advanced Solar Thermal Installers.*

Module 4: Site Analysis and Report		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Site Analysis** Objectives and Overview of Procedure Involved	Site Selection
2	**Orientation** **A.** Determining Optimal Orientation	System Orientation
3	**Collector Mounting** A. Flush Mount B. Tilt Mount **C.** Ground Mount	
4	**Shading Analysis** A. Annual Shading B. Daily Shading **C.** Tools for Shading Analysis: Pathfinder	Tilt Angle
5	**Existing Hot Water Systems** A. Define Aspects of Existing Systems B. Tank/Tankless **C.** Fuel Type	Identify Plumbing Requirements
6	**Roof Analysis** A. Collector Placement **B.** Piping Possibilities- Shaft/ Exterior Wall	
7	**System Types** A. Evacuated Tube **B.** Flat Plate	System Selection
8	**System Sizing and Costing**	
9	**Report writing**	Prepare a Site Report

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Module 5: Professional Conduct

Description:

Students will learn the basics of appropriate professional conduct. An appropriate professional protocol would be discussed.

Certification(s): Solar Thermal Installers

Prerequisite: None

Required Materials: None

Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Portray themselves professionally.
2. Discuss the concept of professional ideals and would be more virtuous and responsible.
3. Develop appropriate interpersonal relationships, not just with client but also the employer.
4. Exhibit demeanor appropriate to their job at hand.
5. Identify aspects crucial for their professional growth as well as their limitations.
6. Have greater respect for professional and personal ethics.
7. Have greater respect for property and law.

Module 5: Professional Conduct *This class would involve open discussions on topics listed below.*		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Professional Conduct**	
2	**Professional Ideals** • Clinical Virtues • Conscientiousness • Collegiality/Cooperation • Objectivity • Responsibility to Community	
3	**Interpersonal relationships**	
4	**Appropriate demeanor.**	
5	**Professional Growth and Awareness of Limitations**	
6	**Honesty and Integrity**	
6	**Respect for Personal and Business Ethics**	
7	**Respect for property and Law**	

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Module 6: System Components and Sizing

Description:

The use and application of various system components, such as pumps, pipes and other fittings would be demonstrated. Workshops by industry partners will help students understand what aspects are critical in the selection of these system components.

Certification(s): Solar Thermal Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Define a schematic system layout for different system types with schematic collector connection, piping layout, controllers, valves and storage.
2. Effectively enlist all system components for a solar hot water system including-
   a) Enlist all collector types and applicability of each.
   b) Enlist different mounting systems for flat roofs, low sloping roofs and define the required system for different applications.
   c) Enlist different kinds of valves, their functions and requirements.
   d) Define the function of a heat exchanger, the different kinds and applications based on system type as well as climatic conditions.
   e) Enlist the various hot water storage options.
   f) Define piping system, pipe insulation options and joining procedure.
3. Effectively enlist the electrical components including-
   a) Define function of controllers, their application and different kinds.
   b) Discuss the thermometer kind required.
   c) Define wiring requirements for a complete system installation.
   d) Define sensor functions, requirements and applications for both collector sensor as well as tank sensor.
4. Enlist the various plumbing components and their functions including-
   a) Discuss the various kinds of pumps.
   b) Discuss valve types, their functions and requirement.
   c) Discuss the function of an expansion vessel.
5. Discuss piping systems, pipe joining and insulations.
6. Discuss safety regulations for all components.
7. Industry regulations for all components.

Module 6: System Components and Sizing		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Schematic System Layout** • Active • Passive • Direct • Indirect	
2	**System Components –** • Solar Collectors - Evacuated Tube - Flat Plate - Requirements and Applicability of each collector type. • Mounting Systems - Roof Mount - Ground Mount - Awning Mount • Heat Exchanger - Internal Heat Exchanger - External Heat Exchanger • Hot Water storage - Multiple Tanks - Parallel Tanks - Series Tanks - Connecting Existing System	
3	**Electric Components** • Controller - Differential Controller System - Integrated Controller System - Indirect Controller System • Electrical & Wiring Requirements • Thermometers • Wiring • Sensors - Collector Sensor - Tank Sensor	
4	**Plumbing Components** • Pumps • Valves - Pressure Relief Valve - Freeze Prevention Valve - Ball Valve - Tempering Valve - P/T Relief Valve	

	- Shut Off Valve / Isolation Valve - Non-Return Valves • Air Purger • Tempering Valves • Expansion Vessel • Pressure relief valve and Pressure gauge • Filling Loop • Double Check Valve	
5	• Piping - Pipe Joining - Pipe Insulation - Pipe Sizing -	
6	**Safety Instructions for All Components**	
7	**Industry Regulations and Requirements for all Components**	

Activities:

- Workshops by industry partners on
  - Component types
  - Aspects critical to optimal performance
  - Cutting edge equipment

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Module 7: System Installation, Structural Considerations and Troubleshooting

Description:

This course will demonstrate the assembly and mounting of solar collectors as well as installation of plumbing system and hardware. Basic troubleshooting and system repairs would also be demonstrated. The lab component of this course will provide students an opportunity to do all the activities themselves.

Certification(s): Solar Thermal Installers

Prerequisite: None

Required Materials: None

Credit Hours: 3

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Identify structural considerations for collector mounting on different roof configurations and constructions.
2. Perform installation checks to ensure that all criteria for system installation are met such as piping access, adequate area and access.
3. Efficiently install system components including:
   - Correct connection of multiple collectors,
   - Correct installation of controllers,
   - Correct connection of water storage tanks in any of the 3 configurations (multiple, series, parallel)
   - Carry out adequate installation and filling of heat exchanger,
   - Carry out proper connection of pipe runs
   - Adequately connect all required control valves.
4. Efficiently install plumbing systems, carry out cross manifold arrangements, and install valves and manometers.
5. Efficiently join and insulate pipes for both circulation loops- cold water loop and hot water loop.
6. Correctly carry out sealing for the circulation loops.
7. Effectively assemble and mount a system along with its hardware and fittings for different roof configurations including flat roofs and low sloping roofs.
8. Proficiently perform system filling and pressurization.
9. Perform basic system checks for leaks or defects as well as perform system cleaning.
10. Effectively maintain and repair systems for minor defects.
11. Discuss the various safety requirements for system installation, filling and pressurization and checking as well as adhere to the same.

Module 7: System Installation, Structural Considerations and Troubleshooting		
Expected Outcome	Topic	Suggested Activities/Lab
1	**System Components –** • Solar Collectors - Evacuated Tube - Flat Plate - Requirements and Applicability of each collector type	
2	**Structural Considerations for HW installation** • Roof Construction • Structural Requirements	
3	**Prior to Installation Checks** • Location of solar hot water tank • Access for piping from solar tank to roof • Location for control panel and expansion vessel	
4	**Installation Procedure** • Connecting Multiple Collectors • Controller Installation • Temperature Sensor Installation • Storage Tank Installation - Multiple Storage Tanks - Series Storage Tanks - Parallel Storage Tanks - Solar hot water tank with heat exchanger - Pipe runs from solar tank to roof - Expansion vessel - Control panel with circulation pump	
5	**Installation Of Plumbing System & Hardware** **Plumbing Schematic** • Installation of Plumbing Components - Pumps - Valves - Expansion Vessel • Cross Manifold Plumbing Arrangements • Valves Manifold Plumbing Arrangement	
5	**Installation of Piping System and Components** • Pipe Joining • Pipe Insulation	

	• Pipe Sizing • Water Loop - Cold Water Loop - Hot Water Loop	
6	**Circulation Loop** • Sealing - For Copper Pipe Joints- Resilient Seal - Non-Copper Pipes- Silicon tape Sealing and Pipe Seal Compound	
7	**Assembly & Mounting Of Solar Collectors** • Collector Mounting - Flush Installation • Collector Mounting - Angled Installation • Flat Roof Collector Frame • Low Sloping Roof Collector Frame • Installing Collector Roof Straps	
8, 9, 10	**Filling & Pressurizing Domestic Solar Hot Water System** **Systems Checks and Cleaning** • Storage tank cleaning and checking • Circulation loop and collector cleaning • Circulation loop leak check • Filling/flushing heat transfer liquid • Heat transfer fluid maintenance • PH value • Disposal of heat transfer fluid • Filling and flushing of fluid loop	
11	**Installation Safety Requirements** • Valves (During System Filling) • Pumps • Operation Safety requirements	

Activities:

Lab (1 Credit) - *Group projects to install collectors, system hardware and pipe fittings.*

- Students would be required to design and size all system components
- Installation of all Components
- Plumbing Connection
- Piping Connection
- System Checking and Cleaning
- Filling and Pressurization

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Module 8: Collector and System Certification

Description:

This course demonstrates the rating standards as defined by the Solar Rating and Certification Corporation and students would be familiarized with the procedure involved in the certification of a solar hot water system.

Certification(s): Solar Thermal Installers
Prerequisite: None
Required Materials: None
Credit Hours: 1

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Discuss the ASHRAE Standard 93, the standard employed by the Solar Rating Certification Corporation (SRCC) for system testing.
2. Discuss the ASHRAE Standard 96, the standard employed by SRCC for testing unglazed flat plate, liquid solar collectors.
3. Discuss the various standards defined by SRCC for collector and system certification including the Operations Guidelines-100, OG-300 etc.
4. Describe the various tests carried out for collector and system certification, durability requirements and flow rates.
5. Discuss the various labels assigned by SRCC for collector and system certifications.

Module 8: Collector and System Certification		
Expected Outcome	Topic	Suggested Activities/Lab
1	**ASHRAE Standard 93, "Methods of Testing to Determine the Thermal Performance of Solar Collectors," and**	
2	**ASHRAE Standard 96, "Methods to Testing to Determine the Thermal Performance of Unglazed, Flat Plate, Liquid Solar Collectors."**	
3	**Standards by Solar Rating and Certification Corporation** □ Collector Certification • OG-100 Operating Guidelines for Certifying Solar Collectors	

	• Standard 150 Test Methods and Minimum Standards for Certifying Innovative Solar Collectors • RM-1 Methodology for Determining the Thermal Performance Rating for Solar Collectors. • Standard 600 Test Methods and Minimum Standards for Certifying Solar Collectors.	
4	**System Certification** • OG-300 Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems • TM-1 Solar Domestic Hot Water System and Component Test Protocols • The certification procedure and requirements for systems and collector.	
4	**Technical Explanation of the Collector Testing and Rating Program** • Required Tests • Durability Requirements • Flow Rates	
5	**SRCC Collector Certification Labels**	

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Module 9: Applied Project

Description:

The applied project, offered as an elective, provide as the students a unique opportunity to intern with one of our industry partners to gain hands on experience in the selection, installation and maintenance of a system. All aspects taught in the program would be demonstrated in the form of an applied project and students would be provided an opportunity to intern on a project with our leading industry partners.

Certification(s): Solar Thermal Installers

Prerequisite: None

Required Materials: None

Credit Hours: 6

Expected Outcomes:

Upon successful completion of this course a student will be able to:

1. Perform site surveys for orientation, mounting system requirement, piping access and layout
2. Perform shading analysis to identify area of collector under shade annually and daily.
3. Identify most appropriate system type in accordance to client requirements, site survey and shading analysis.
4. Effectively size the system on the basis of site survey, shading analysis and system type.
5. Effectively install a system including the collector, controller, pluming systems, piping layout etc.
6. Effective carry out the filling and depressurization of a system.
7. Perform basic system checks including circulation loop tests, cleaning and checking of tank and checking of heat transfer fluid.
8. Identify factors indicative of optimal system performance and monitor the system for the same.
9. Identify code compliance measures for installation, operations and maintenance as well as compliance of National electric Code for safety requirements.
10. Define procedure for system certification and mandatory requirements for the same.

Module 9: Applied Project		
Expected Outcome	Topic	Suggested Activities/Lab
1	**Site Survey**	
2	**Shading Analysis**	
3	**Identification of most appropriate system type**	
4	**System Sizing**	
5	**System Installation** • Installation of Collectors • Installation of Controllers • Piping • Plumbing • Insulation of Piping loop and storage tank.	
6	**Filling and depressurization of System**	
7	**Performing Basic System Checks**	
8	**Monitor System performance**	
9	**Code compliance measures in operations and maintenance**	
10	**System certification process and standards.**	
This would be carried out in collaboration with FAFCO or another company where interested students would be taken to an actual domestic hot water installation site for a demonstration and hands-on experience of everything they have been taught. *Hands on experience with a leading industry partner would significantly contribute to a student's expertise and confidence.*		

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