

# Course Outline

Energy, Environment, and Utilities

REVISED: January/2018

**Job Title**

Solar Thermal Technician

**72-65-80**

**Career Pathway:**

Energy and Power Technology

**Solar Thermal**

**Industry Sector:**

Energy, Environment, and Utilities

**Credits:** 10

**Hours:** 120

**O\*NET-SOC CODE:**

47-2231.00

**Course Description:**

This competency-based course is a single course designed for alternative and renewable energy technology. It provides students with project-based experiences in solar thermal technology. Technical instruction includes workplace safety policies and procedures, resource management, trade mathematics, and employability skills. Emphasis is placed on solar thermal energy as a viable source of alternative energy, basic plumbing and heating theories, electrical wiring, water heating storage, water pump principles and procedures, solar energy, and the operational fundamentals of solar thermal modules. The competencies in this course are aligned with the California High School Academic Standards and the California Technical Education Model Curriculum Standards.

**CBEDS Title:**

Energy and Environmental Technology

**Prerequisites:**

Enrollment requires a reading level of 6.0 as measured by the CASAS GOALS test.

**CBEDS No.:**

5691

**NOTE:** For Perkins purposes this course has been designated as a **introductory** course.

Tasks designated by an asterisk meet the North American Board of Certified Energy Practitioners (NABCEP) 6 Learning Objectives for the Solar Thermal Associate exam. The competencies of this course are aligned with the knowledge requirements set by the NABCEP. This course cannot be repeated once a student receives a Certificate of Completion.

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## ***COURSE OUTLINE COMPETENCY-BASED COMPONENTS***

A course outline reflects the essential intent and content of the course described. Acceptable course outlines have six components. (Education Code Section 52506). Course outlines for all apportionment classes, including those in jails, state hospitals, and convalescent hospitals, contain the six required elements:

(EC 52504; 5CCR 10508 [b]; Adult Education Handbook for California [1977], Section 100)

### **COURSE OUTLINE COMPONENTS**

### **LOCATION**

#### **GOALS AND PURPOSES**

Cover

The educational goals or purposes of every course are clearly stated and the class periods are devoted to instruction. The course should be broad enough in scope and should have sufficient educational worth to justify the expenditure of public funds.

The goals and purpose of a course are stated in the COURSE DESCRIPTION. Course descriptions state the major emphasis and content of a course, and are written to be understandable by a prospective student.

#### **PERFORMANCE OBJECTIVES OR COMPETENCIES**

pp. 8-18

Objectives should be delineated and described in terms of measurable results for the student and include the possible ways in which the objectives contribute to the student's acquisition of skills and competencies.

Performance Objectives are sequentially listed in the COMPETENCY-BASED COMPONENTS section of the course outline. Competency Areas are units of instruction based on related competencies. Competency Statements are competency area goals that together define the framework and purpose of a course. Competencies fall on a continuum between goals and performance objectives and denote the outcome of instruction.

Competency-based instruction tells a student before instruction what skills or knowledge they will demonstrate after instruction. Competency-based education provides instruction which enables each student to attain individual goals as measured against pre-stated standards.

Competency-based instruction provides immediate and continual repetition and in competency-based education the curriculum, instruction, and assessment share common characteristics based on clearly stated competencies. Curriculum, instruction and assessment in competency-based education are: explicit, known, agreed upon, integrated, performance oriented, and adaptive.

**COURSE OUTLINE COMPETENCY-BASED COMPONENTS  
(continued)**

**COURSE OUTLINE COMPONENTS**

**LOCATION**

**INSTRUCTIONAL STRATEGIES**

p. 19-21

Instructional techniques or methods could include laboratory techniques, lecture method, small-group discussion, grouping plans, and other strategies used in the classroom.

Instructional strategies for this course are listed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructional strategies and activities for a course should be selected so that the overall teaching approach takes into account the instructional standards of a particular program, i.e., English as a Second Language, Programs for Adults with Disabilities.

**UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT**

Cover

The approximate time devoted to each instructional unit within the course, as well as the total hours for the course, is indicated. The time in class is consistent with the needs of the student, and the length of the class should be that it ensures the student will learn at an optimum level.

pp. 8-18

Units of study, with approximate hours allotted for each unit are listed in the COMPETENCY AREA STATEMENT(S) of the course outline. The total hours of the course, including work-based learning hours (community classroom and cooperative vocational education) is listed on the cover of every CBE course outline. Each Competency Area listed within a CBE outline is assigned hours of instruction per unit.

**EVALUATION PROCEDURES**

pp. 21-22

The evaluation describes measurable evaluation criteria clearly within the reach of the student. The evaluation indicates anticipated improvement in performances as well as anticipated skills and competencies to be achieved.

Evaluation procedures are detailed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructors monitor students' progress on a continuing basis, assessing students on attainment of objectives identified in the course outline through a variety of formal and informal tests (applied performance procedures, observations, and simulations), paper and pencil exams, and standardized tests.

**REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT**

Cover

After a student has completed all the objectives of the course, he or she should not be allowed to reenroll in the course. There is, therefore, a need for a statement about the conditions for possible repetition of a course to prevent perpetuation of students in a particular program for an indefinite period of time.

### ***ACKNOWLEDGMENTS***

Thanks to LARRY CALDERON, EDWARD RUIZ, LUZ GRANADOS, and ALEJANDRA SALCEDO for developing and editing this curriculum. Acknowledgment is also given to ERICA ROSARIO for designing the original artwork for the course covers.

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**CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS**  
**Energy, Environment and Utilities Industry Sector**  
**Knowledge and Performance Anchor Standards**

**1.0 Academics**

Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Energy, Environment, and Utilities academic alignment matrix for identification of standards.

**2.0 Communications**

Acquire, and accurately use Energy, Environment, and Utilities sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

**3.0 Career Planning and Management**

Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

**4.0 Technology**

Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Energy, Environment, and Utilities sector workplace environment.

**5.0 Problem Solving and Critical Thinking**

Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Energy, Environment, and Utilities sector using critical and creative thinking; logical reasoning, analysis, inquiry, and problem-solving techniques.

**6.0 Health and Safety**

Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Energy, Environment, and Utilities sector workplace environment.

**7.0 Responsibility and Flexibility**

Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Energy, Environment, and Utilities sector workplace environment and community settings.

**8.0 Ethics and Legal Responsibilities**

Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.

**9.0 Leadership and Teamwork**

Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization.

**10.0 Technical Knowledge and Skills**

Apply essential technical knowledge and skills common to all pathways in the Energy, Environment, and Utilities sector.

**11.0 Demonstration and Application**

Demonstrate and apply the knowledge and skills contained in the Energy, Environment, and Utilities anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the SkillsUSA career technical student organization.

***Energy, Environment, and Utilities Sector***

***Pathway Standards***

**B. Energy and Power Technology Pathway**

The Energy and Power Technology pathway provides learning opportunities for students interested in preparing for careers in the energy and power industries.

Sample occupations associated with this pathway:

- ◆ Energy Efficiency Evaluation Specialist
- ◆ Energy Engineer
- ◆ Energy Generation/Power Distribution, Maintenance, Inspection, and Repair Technicians
- ◆ Energy/Building Retrofit Specialist
- ◆ Plant/Field Weatherization Installer

B1.0 Explore the basic conventional and emerging principles and concepts of the energy industry, including energy production, energy transmission, and alternative energy technologies.

B2.0 Identify various conventional electric power generation fuel sources and the cost and efficiency issues associated with each.

B3.0 Investigate emerging and alternative electric power generation technologies and fuel sources.

B4.0 Understand nonnuclear power generation plant operations (coal, oil, natural gas, solar, wind, geothermal power, hydroelectric, or biofuel).

B5.0 Understand and apply basic knowledge and skills necessary for nuclear power generation and nuclear power plant personnel.

B6.0 Research methods of energy procurement, transmission, distribution, and storage.

B7.0 Understand the interrelationships among components of systems.

**CBE**  
**Competency-Based Education**  
**COMPETENCY-BASED COMPONENTS**  
**For the Solar Thermal Course**

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. ORIENTATION AND SAFETY</p> <p>Understand and evaluate classroom and workplace policies and procedures used in accordance with federal, state, and local safety and environmental regulations.</p>	<ol style="list-style-type: none"> <li>1. Describe the scope and purpose of the course.</li> <li>2. Describe the overall course content as a part of the Linked Learning Initiative.</li> <li>3. Describe classroom policies and procedures.</li> <li>4. Describe the different occupations in the Energy and Utilities Industry Sector which have an impact on the role of solar thermal installers.</li> <li>5. Describe the opportunities available for promoting gender equity and the representation of non-traditional populations in renewable electricity generation technologies.</li> <li>6. Explain the impact of Environmental Protection Agency (EPA) legislation practices in protecting and preserving the environment. *</li> <li>7. Describe and demonstrate the procedures for contacting proper authorities for the removal of hazardous materials based on the EPA standards. *</li> <li>8. Describe the National Electrical Code (NEC) and its role in safeguarding the work conditions of solar thermal installers/craftsmen. *</li> <li>9. Describe and demonstrate the use of the Safety Data Sheet (SDS) as it applies to the solar thermal field. *</li> <li>10. Describe the role of the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ in increasing the use of clean and renewable technology in California. *</li> <li>11. Describe the City of Los Angeles Building and Safety Codes and their applications to the solar thermal field. *</li> <li>12. Describe the provisions of the California Title 24 Energy Efficiency Standards (a.k.a. 2010 California Green Building Standards Code) as they relate to the Energy and Utilities Industry Sector. *</li> <li>13. Identify classroom and workplace first aid and emergency procedures based on the American Red Cross (ARC) standards.</li> <li>14. Describe the California Occupational Safety and Health Administration (Cal/OSHA) and its electrical safety standards governing solar thermal installers/craftsmen. *</li> </ol>	<p><b>Career Ready Practice:</b> 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12</p> <p><b>CTE Anchor:</b> Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5 Career Planning and Management: 3.1, 3.2, 3.4, 3.5, 3.6, 3.7, 3.9 Technology: 4.1, 4.3 Health and Safety: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16 Responsibility and Flexibility: 7.2, 7.3, 7.5, 7.8 Ethics and Legal Responsibilities: 8.1, 8.2, 8.3, 8.4 Leadership and Teamwork: 9.3, 9.4 Technical Knowledge and Skills: 10.1, 10.2</p>



COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(8 hours)	15. Describe how each of the following insures a safe workplace: <ol style="list-style-type: none"> <li>Employee's rights as they apply to job safety</li> <li>Employee's obligations as they apply to safety</li> <li>Employee's training on how to accurately test high voltages</li> <li>Employee's training on how to identify potential electrical/ non-electrical hazards *</li> <li>Employee's training on how to use safety equipment *</li> </ol> 16. Pass the safety exam with 100% accuracy.	<b>CTE Pathway:</b> B1.1, B1.7, B3.1 B4.3, B7.4
B. RESOURCE MANAGEMENT  Understand resource management principles and techniques applied in the solar thermal field.	<ol style="list-style-type: none"> <li>Define the following:             <ol style="list-style-type: none"> <li>resources</li> <li>management</li> <li>sustainability</li> </ol> </li> <li>Describe the management of the following resources in the solar thermal field:             <ol style="list-style-type: none"> <li>time</li> <li>materials (including sustainable and green)</li> <li>personnel</li> </ol> </li> <li>List specific examples of effective management of the following resources in the solar thermal field:             <ol style="list-style-type: none"> <li>time</li> <li>materials (including sustainable and green)</li> <li>personnel</li> </ol> </li> <li>Describe the benefits of effective resource management in the solar thermal field:             <ol style="list-style-type: none"> <li>profitability</li> <li>sustainability</li> <li>company growth</li> </ol> </li> <li>Describe the economic benefits and liabilities of managing resources in an environmentally responsible way.</li> </ol>	<b>Career Ready Practice:</b> 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12  <b>CTE Anchor:</b> <b>Academics:</b> 1.0 <b>Communications:</b> 2.2, 2.4 <b>Career Planning and Management:</b> 3.5, 3.7 <b>Technology:</b> 4.1, 4.3 <b>Problem Solving and Critical Thinking:</b> 5.1, 5.2, 5.3, 5.4 <b>Health and Safety:</b> 6.1, 6.2, 6.3, 6.6, 6.10 <b>Responsibility and Flexibility:</b> 7.1, 7.2, 7.4, 7.6, 7.8 <b>Ethics and Legal Responsibilities:</b> 8.1, 8.2 <b>Leadership and Teamwork:</b> 9.1, 9.2 <b>Demonstration and Application:</b> 11.3, 11.4  <b>CTE Pathway:</b> B2.4
(4 hours)		

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. TRADE MATHEMATICS</p> <p>Understand and apply the mathematical requirements in the solar thermal field.</p> <p>(12 hours)</p>	<ol style="list-style-type: none"> <li>1. Describe the practical applications of math in the solar thermal field.</li> <li>2. Describe and demonstrate problem-solving techniques involving whole number problems using arithmetic operations (addition, subtraction, multiplication, and division).</li> <li>3. Describe and demonstrate problem-solving techniques involving various fraction problems using arithmetic operations.</li> <li>4. Describe and demonstrate problem-solving techniques involving various decimal problems using addition, subtraction, multiplication, and division.</li> <li>5. Describe and demonstrate techniques for changing fractions to decimals.</li> <li>6. Describe and demonstrate techniques for changing decimals to fractions.</li> <li>7. Describe the English and metric systems of measuring length.</li> <li>8. Describe the English and metric systems of measuring weight.</li> <li>9. Describe the English and metric systems of measuring volume or capacity.</li> <li>10. Describe and demonstrate English and metric problem-solving techniques for various measuring problems using arithmetic operations.</li> <li>11. Describe and demonstrate English and metric measuring techniques of objects by using tools common to the trade.</li> <li>12. Express units in ascending and descending powers of ten.</li> <li>13. Convert the English numbering system to metric system.</li> <li>14. Convert metric system to the English numbering system.</li> <li>15. Calculate square roots of English numbers.</li> <li>16. Describe and demonstrate problem-solving techniques for geometric problems.</li> <li>17. Describe and demonstrate problem-solving techniques for algebraic problems.</li> <li>18. Describe and demonstrate problem-solving techniques using percentages.</li> <li>19. Describe and demonstrate techniques for reading and interpreting graphs.</li> <li>20. Describe and demonstrate techniques for using a calculator.</li> <li>21. Convert British Thermal Units (BTU's) into other heating and power units and vice versa.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 4, 5</p> <p><b>CTE Anchor:</b> Academics: 1.0 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4</p> <p><b>CTE Pathway:</b> B2.4, B7.3, B7.5</p>
<p>D. SOLAR ENERGY</p> <p>Understand the fundamentals of solar energy.</p>	<ol style="list-style-type: none"> <li>1. Define the following: <ol style="list-style-type: none"> <li>a. true solar south</li> <li>b. magnetic south</li> <li>c. irradiance</li> <li>d. irradiation</li> </ol> </li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 4, 5, 10, 11</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(10 hours)	<ul style="list-style-type: none"> <li>e. insolation</li> <li>f. array azimuth</li> <li>g. angle of inclination</li> <li>h. solar azimuth angle</li> <li>i. solar altitude angle</li> </ul> <p>2. Describe the effects of the following on seasonal sunlight exposure:</p> <ul style="list-style-type: none"> <li>a. solar path</li> <li>b. earth orbit</li> <li>c. earth tilt</li> </ul> <p>3. Describe the following:</p> <ul style="list-style-type: none"> <li>a. difference between true solar south and magnetic south</li> <li>b. factors that reduce/enhance solar irradiation</li> <li>c. angular effects of irradiance on an array</li> <li>d. average solar irradiation on various surfaces</li> <li>e. conversion of solar irradiation into a variety of units</li> <li>f. effect of horizon on solar irradiation</li> <li>g. effects of weather on solar irradiation</li> <li>h. use of the Solar Pathfinder</li> </ul>	<p>CTE Anchor: Technology: 4.1, 4.3, 4.5 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.10, 6.13, 6.16 Responsibility and Flexibility: 7.5 Ethics and Legal Responsibilities: 8.1, 8.2 Technical Knowledge and Skills: 10.1, 10.2, 10.6 Demonstration and Application: 11.1, 11.2, 11.3</p> <p><b>CTE Pathway:</b> B1.2, B1.6, B.1.8, B3.1, B4.6</p>
<p>E. SOLAR THERMAL ENERGY: ALTERNATIVE ENERGY</p> <p>Understand solar thermal energy as a viable source of alternative energy.</p>	<p>1. Define and describe the following sources of energy:</p> <ul style="list-style-type: none"> <li>a. renewable energy <ul style="list-style-type: none"> <li>i. solar/photovoltaics (PV)</li> <li>ii. biofuels</li> <li>iii. geothermal</li> <li>iv. wind</li> <li>v. water</li> </ul> </li> <li>b. non-renewable energy <ul style="list-style-type: none"> <li>i. fossil fuels – oil, natural gas, coal</li> <li>ii. nuclear fuel</li> </ul> </li> </ul> <p>2. Describe the need for alternative energy in today’s economy based on the following:</p> <ul style="list-style-type: none"> <li>a. economic security</li> <li>b. environmental impact</li> <li>c. accessibility</li> <li>d. reliability</li> <li>e. cost effectiveness</li> </ul> <p>3. Describe the history of solar thermal.</p>	<p><b>Career Ready Practice:</b> 1, 3, 4, 5, 7, 10, 12</p> <p><b>CTE Anchor:</b> Career Planning and Management : 3.1, 3.4, 3.7, 3.9 Technology: 4.5 Problem Solving and Critical Thinking: 5.3, 5.4 Responsibility and Flexibility: 7.1, 7.6, 7.8 Ethics and Legal Responsibilities:</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(8 hours)	4. Describe the basic operational aspects of solar thermal in terms of: <ul style="list-style-type: none"> <li>a. durability</li> <li>b. maintenance requirements</li> <li>c. efficiency</li> <li>d. cost effectiveness</li> <li>e. variety in application</li> </ul>	8.1, 8.2  Leadership and Teamwork: 9.4, 9.5 Technical Knowledge and Skills: 10.1, 10.2, 10.3, 10.5, 10.6  <b>CTE Pathway:</b> B1.1, B1.2, B1.3, B1.4, B2.1, B2.2, B2.3, B2.4, B3.1, B3.3, B3.4, B3.5, B3.6, B4.2, B4.3, B4.4, B4.6, B5.3, B6.3
F. SOLAR THERMAL SITE ANALYSIS	<ol style="list-style-type: none"> <li>1. Describe the fundamentals of solar radiation.</li> <li>2. Explain how the sun's annual path affects seasonal performance variation based on orientation and tilt of collectors.</li> <li>3. Demonstrate the use of shading analysis tools.</li> <li>4. Explain the effects of compass declination for various geographical locations in the U.S.</li> <li>5. Explain the physical principles (conduction, convection, radiation, absorption, reflection, thermal mass, etc.) that affect solar technologies.</li> <li>6. Explain the various roof types, materials (shingle, tile, built-up, metal, synthetic surface), structures (rafters/trusses) and how they impact the installation of solar collectors.</li> <li>7. Describe the structural roof and wind loads that affect solar collector installations.</li> <li>8. Evaluate the required installation area, orientation, and tilt for proposed collector installation.</li> <li>9. Determine the extent of existing and future shading for proposed collector location using typical sun path calculators or similar devices.</li> <li>10. Evaluate the structural integrity and suitability of roof and ground-mount collector installation sites.</li> <li>11. Determine soil conditions and integrity for footing design and pipe path. (Local codes or site conditions may require additional engineering expertise.)</li> </ol>	<b>Career Ready Practice:</b> 1, 3, 4, 5, 10, 11  <b>CTE Anchor:</b> Academics 1.0 Career Planning and Management: 3.4, 3.7, 3.9 Technology: 4.1, 4.3, 4.5, 4.6 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.2, 6.4, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.16 Ethics and Legal Responsibilities: 8.1, 8.2, 8.3

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(20 hours)		Technical Knowledge and Skills: 10.1, 10.2 Demonstration and Application: 11.1, 11.2, 11.3 <b>CTE Pathway:</b> B1.7, B4.6, B5.9, B6.4, B7.0, B7.4, B7.5
G. ADVANCED INSTALLATION SAFETY FOR NABCEP	<ol style="list-style-type: none"> <li>1. Identify the major government, certification, research, training, and information organizations that impact solar thermal and heating in the U.S. (i.e., DOE, SRCC, IAPMO, SANDIA, NREL, FSEC, SEI, NABCEP, IREC, DSIRE, OSHA, ETC.).</li> <li>2. Demonstrate safe and accepted practices and safety equipment for personnel protection.</li> <li>3. Identify appropriate codes and standards concerning installation, operation and maintenance of solar thermal systems and equipment. Identify physical personnel safety hazards associated with solar heating installations (roof work, attic temperature, electrical, etc.).</li> <li>4. Identify environmental hazards associated with solar heating installations through demonstrated awareness of pertinent Safety Data Sheets and other appropriate documents.</li> <li>5. Determine components that require identification tag and/or label (per system certification guidelines).</li> </ol>	<b>Career Ready Practice:</b> 1, 5, 6, 7, 11, 12 <b>CTE Anchor:</b> Academics: 1.0, 2.4, 2.5 Career Planning and Management: 3.3, 3.4, 3.5, 3.6, 3.9 Technology: 4.1, 4.3 Problem Solving and Critical Thinking: 5.3, 5.4 Health and Safety: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16 Ethics and Legal Responsibilities: 8.1, 8.2, 8.3 Technical knowledge and Skills: 10.1, 10.2



COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(25 hours)	<ol style="list-style-type: none"> <li>7. Identify freeze protection, over heating protection, and other mechanisms/procedures to address low and high temperatures and water quality issues.</li> <li>8. Describe national certification programs for collectors and systems.</li> <li>9. Apply national collector and system ratings to determine collector and system selection and sizing.</li> </ol>	<p>5.1, 5.2, 5.3, 5.4</p> <p>Health and Safety: 6.9, 6.10, 6.11, 6.12, 6.13, 6.16</p> <p>Responsibility and Flexibility: 7.5, 7.8</p> <p>Ethics and Legal Responsibilities: 8.1</p> <p>Technical Knowledge and Skills: 10.1, 10.3, 10.4</p> <p><b>CTE Pathway:</b> B1.2, B1.7 B3.1, B4.6</p>
J. INSTALLATION METHODS	<ol style="list-style-type: none"> <li>1. Determine types of system layout and components location and configuration.</li> <li>2. Describe the various roof mounting strategies (stand-off, rack, lag-bolt, j-bolt mounting methods).</li> <li>3. Identify collector and roof mounted storage tank dead load requirements.</li> <li>4. Identify locations for roof/wall, foundation penetrations, and structural attachments and determine multi-collector piping strategy.</li> <li>5. Explain the method of weather sealing roof penetrations and other structural devices with code and industry acceptable flashings and sealants.</li> <li>6. Determine water heater ports to be used for solar and plumbing lines.</li> <li>7. Determine water heater dip tube strategy (purpose, location, and internal configuration) and plumbing retrofit method to be used if conventional water heater tank (electric or gas) is used.</li> <li>8. Determine that water heater and storage tanks are installed per manufacturer's installation recommendations and local codes.</li> <li>9. Determine expansion of pipes and its effect on hangers and the integrity of the pipe.</li> <li>10. Determine type, length, and diameter of insulation, copper piping, and plastic piping required and describe ultraviolet radiation protective methods and materials for exposed insulation.</li> <li>11. Determine, describe, and locate the type of flashing and sealant</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 5, 10, 11, 12</p> <p><b>CTE Anchor:</b> Career Planning and Management: 3.1, 3.4, 3.5, 3.6, 3.9</p> <p>Technology: 4.1, 4.2</p> <p>Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4</p> <p>Health and Safety: 6.6, 6.8, 6.10, 6.11, 6.15, 6.16</p> <p>Responsibility and Flexibility: 7.5</p> <p>Ethics and Legal Responsibilities: 8.1, 8.2</p> <p>Technical Knowledge and Skills: 10.2, 10.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(10 hours)	<p>to use for specific roof types.</p> <ol style="list-style-type: none"> <li>12. Determine slope strategy of piping to avoid traps on horizontal runs.</li> <li>13. Describe pipe hangers and supports and determine underground piping methods.</li> <li>14. Identify plumbing, valves and other mechanical/plumbing components required for each type of system.</li> <li>15. Determine location of all components.</li> <li>16. Describe the installation of valves and monitoring system components as specified in component manufacturer or system manufacturer installation manual and schematic.</li> <li>17. Describe the operation and installation of differential controller, sensors, photovoltaic module controller and Direct Current (DC) pump.</li> <li>18. Select ultraviolet radiation protective method(s) for external wiring.</li> <li>19. Determine that the system mechanical installation has structural integrity and is weather sealed.</li> <li>20. Determine that the system plumbing installation is correctly installed.</li> <li>21. Determine that the electrical installation is correctly installed.</li> <li>22. Describe system start up, operation and shut down functionality.</li> </ol>	<p>Demonstrate and Application: 11.1, 11.2</p> <p><b>CTE Pathway:</b> B1.7, B4.2, B4.5, B4.6</p>
K. COLLECTORS AND COMPONENT USAGE	<ol style="list-style-type: none"> <li>1. Describe the various types and designs of solar collectors used in thermal systems.</li> <li>2. Identify and explain the operational function and installation requirements of differential controllers and associated sensors.</li> <li>3. Identify and explain the operational function and installation requirements of solar water heating system energy monitoring/metering equipment and sensor placement.</li> <li>4. Identify and explain the operational function and installation requirements of circulators and pumps used in various solar water heating systems (types, materials, uses, restrictions, Alternating Current (AC) and DC, low and high head, multi-speed, matching DC pumps with PV modules, pump curves, sizing, etc.).</li> <li>5. Identify and explain the operational function and installation requirements of the various valves that are used in all manners of solar water heating systems (including, but not limited to: air vents, air separators, anti-scald, tempering, boiler drain, mechanical and electric check, freeze, isolation, pressure gauge, pressure relief, temperature-pressure relief, vacuum breaker, solenoid, diverter, balancing, etc.).</li> </ol>	<p><b>Career Ready Practice:</b> 3, 5, 11, 12</p> <p><b>CTE Anchor:</b> Career Planning and Management: 3.6 Technology: 4.1 Problem Solving and Critical Thinking: 5.3, 5.4 Health and Safety: 6.1, 6.2, 6.7, 6.8, 6.9, 6.10, 6.13, 6.16 Ethics and Legal Responsibilities: 8.1</p>



COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
( 5 hours )	<ol style="list-style-type: none"> <li>6. Identify and explain the operational function and installation requirements of system monitoring components (flow meter, temperature gauge, BTU meter, controller integrated BTU meter, etc.).</li> <li>7. Identify and explain the operational function and installation requirements of solar water heating system piping, (including, but not limited to, copper piping and fittings[types and sizes], solder types[including brazing], pipe hangers, plastic piping[commonly-used types, sizing, temperature and support restrictions], flow rates, sizing, etc.).</li> <li>8. Identify and explain the operational function and installation requirements of insulation used in solar water heating systems. (This includes Ultra Violet (UV) protection materials and methods, rubber versus plastic, residential verses commercial, use on piping, use on water heaters, use on heat exchangers, etc.).</li> <li>9. Identify and explain the types and operational function and installation requirements of solar storage tanks, expansion tanks, and heat exchangers.</li> <li>10. Identify and explain the operational function and installation procedures of heat transfer fluids. (Types, uses, maintenance, restrictions, SD sheets [Safety Data], GRAS designation [Generally Recognized As Safe].)</li> <li>11. Identify and explain the operational function and installation requirements of water supply. (Water conditions as they relate to system type, pH and TDS [Total Dissolved Solids] checks and what the resulting values signify.)</li> </ol>	<p>Technical Knowledge and Skills: 10.1, 10.2, 10.4</p> <p>Demonstration and Application: 11.1, 11.2, 11.3</p> <p><b>CTE Pathway:</b> B1.7, B4.2, B4.5, B5.8, B5.9</p>
<p>L EMPLOYABILITY SKILLS:</p> <p>Understand, apply, and evaluate the employability skills required in the solar thermal field</p>	<ol style="list-style-type: none"> <li>1. Describe employer requirements for the following: <ol style="list-style-type: none"> <li>a. punctuality</li> <li>b. attendance</li> <li>c. attitude toward work</li> <li>d. quality of work</li> <li>e. teamwork</li> <li>f. timeliness</li> <li>g. communication skills</li> <li>h. computer skills and software applications</li> </ol> </li> <li>2. Identify potential employers through traditional and internet sources.</li> <li>3. Describe the role of electronic social media in job search.</li> <li>4. Design sample resumes and cover letters.</li> <li>5. Describe the importance of filling out a job application legibly, with accurate and complete information.</li> <li>6. Complete sample job application forms correctly.</li> </ol>	<p><b>CAREER READY PRACTICE:</b> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</p> <p><b>CTE Anchor:</b> Academics: 1.0, 2.2, 2.3, 2.4, 2.5 Career Planning and Management: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 Technology: 4.1, 4.3</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
( 3 hours )	<ul style="list-style-type: none"> <li>7. Describe the importance of enthusiasm on a job.</li> <li>8. Describe the importance of appropriate appearance on a job.</li> <li>9. Describe the importance of the continuous upgrading of job skills.</li> <li>10. Describe customer service as a method of building permanent relationships between the organization and the customer.</li> <li>11. Describe and demonstrate appropriate interviewing techniques.</li> <li>12. Identify the informational materials and resources needed to be successful in an interview.</li> <li>13. Design sample follow-up letters.</li> <li>14. Demonstrate appropriate follow-up procedures.</li> </ul>	<p>Health and Safety: 6.2, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11 , 6.12, 6.13, 6.14, 6.15, 6.16</p> <p>Responsibility and Flexibility: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8</p> <p>Ethics and Legal Responsibilities: 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7</p> <p>Leadership and Teamwork: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7</p> <p>Technical Knowledge and Skills: 10.4</p> <p>Demonstration and Application: 11.1, 11.2, 11.3, 11.4, 11.5</p> <p><b>CTE Pathway:</b> B1.7</p>

## ***SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES***

### **TEXTBOOKS**

Laughton, Chris. *Solar Domestic Water Heating: The Earthscan Expert Handbook for Planning, Design and Installation*. Earthscan Publishers 2010

Schaeffer, John. *Real Goods Solar Living Source Book – Special 30<sup>th</sup> Anniversary Edition*. Gaiam Real Goods, 2007.

Ramlo, Bob. *Solar Water Heating—Revised &Expanded Edition: A Comprehensive Guide to Solar Water and Space Heating Systems*, New Society Publishers, 2013

Kemp, William H. *The Renewable Energy Handbook Revised Edition, 3<sup>rd</sup> edition*. Aztex Press, 2009.

### **RESOURCES**

Employer Advisory Board members

CTE Model Curriculum Standards

<http://www.cde.ca.gov/ci/ct/sf/documents/energyutilities.pdf>

North American Board of Certified Energy Practitioners (NABCEP) [www.nabcep.org](http://www.nabcep.org)

NABCEP Solar Heating Installer Resource Guide <http://www.nabcep.org/wp-content/uploads/2013/08/NABCEP-SH-Guide-8-5-13.pdf>

NABCEP Solar Heating Installer Learning Objectives. <http://www.nabcep.org/wp-content/uploads/2016/08/NABCEP-SHA-Learning-Objectives-8.15.16.pdf>

NABCEP Solar Heating Installer Resource Guide Resource List:

\**Active Solar Preheat Systems: Unified Facilities Criteria (UFC 3-440-01.pdf)*, U.S. Department of Defense, [www.wbdg.org](http://www.wbdg.org)

\**Code of Federal Regulations, Chapter 29 Part 1926-Safety and Health Regulations for Construction*, Occupational Safety and Health Administration, [www.osha.gov](http://www.osha.gov)

\**The Copper Tube Handbook*, Cooper Development Association, [www.copper.org](http://www.copper.org)

\**Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers (2<sup>nd</sup> Edition)*, 2010, by Deutsche Gesellschaft fur Sonnenenergie. ISBN 978-1-84407-760-1, James & James (Science Publishers) Ltd.

[www.earthscan.co.uk](http://www.earthscan.co.uk)

\*Solar Water and Pool Heating Manual: Design and Installation & Repair and Maintenance, January, 2006. Florida Solar Energy Center, [www.fsec.ucf.edu](http://www.fsec.ucf.edu)

\*SRCC Document OG 300, Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems, May 2002, Solar Rating and Certification Corporation, [www.solar-rating.org](http://www.solar-rating.org)

\*Uniform Plumbing Code, 2009. International Association of Plumbing & Mechanical Officials, <http://www.iapmo.org>

Uniform Solar Energy Code, 2009. International Association of Plumbing & Mechanical Officials, <http://www.iapmo.org>

National Fire Protection Association. National Electrical Code 2014. National Fire Protection Association, 2011.

California State License Board-C-46 Solar Contractors Guide.  
<http://www.cslb.ca.gov/Resources/StudyGuides/C46StudyGuide.pdf>

[www.americangreenjobs.net](http://www.americangreenjobs.net)

[www.ases.org](http://www.ases.org)

[www.careers.pennenergyjobs.com](http://www.careers.pennenergyjobs.com)

[www.cleantechrecruits.com](http://www.cleantechrecruits.com)

[www.irecusa.org](http://www.irecusa.org)

[www.renewableenergyjobs.com](http://www.renewableenergyjobs.com)

[www.solarenergy.org](http://www.solarenergy.org)

[www.solarelectricpower.org](http://www.solarelectricpower.org)

[www.seia.org](http://www.seia.org)

[www1.eere.energy.gov](http://www1.eere.energy.gov)

## **COMPETENCY CHECKLIST**

Field Code Changed

## ***TEACHING STRATEGIES and EVALUATION***

### **METHODS AND PROCEDURES**

- A. Lecture and discussion
- B. Multimedia presentations
- C. Demonstrations and participations
- D. Individualized instruction
- E. Peer teaching
- F. Role-playing
- G. Guest speakers
- H. Field trips and field study experiences
- I. Projects

### **EVALUATION**

SECTION A – Orientation and Safety – Pass the safety test with 100% accuracy.

SECTION B – Resource Management – Pass all assignments and exams on resource management with a minimum score of 80% or higher.

SECTION C – Trade Mathematics – Pass all assignments and exams on trade mathematics with a minimum score of 80% or higher.

SECTION D – Solar Energy – Pass all assignments and exams on solar energy with a minimum score of 80% or higher.

SECTION E – Solar Thermal Energy; Alternative Energy – Pass all assignments and exams on photovoltaic energy; alternative energy with a minimum score of 80% or higher.

SECTION F – Solar Thermal Site Analysis – Pass all assignments and exams on PV fundamentals with a minimum score of 80% or higher.

SECTION G – Advanced Installation Safety for NABCEP – Pass all assignments and exams on basic electrical theories with a minimum score of 80% or higher.

SECTION H – Maintenance and Troubleshooting – Pass all assignments and exams on basic electrical wiring with a minimum score of 80% or higher.

SECTION I – System Types, Applications, Sizing and Components – Pass all assignments and exams on basic electrical wiring with a minimum score of 80% or higher.

SECTION J – Installation Methods – Pass all assignments and exams on basic electrical wiring with a minimum score of 80% or higher.

SECTION K – Collectors and Component Usage – Pass all assignments and exams on basic electrical wiring with a minimum score of 80% or higher.

SECTION L – Employability Skills – Pass all assignments and exams on employability skills with a minimum score of 80% or higher.

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**Statement for Civil Rights**

All educational and vocational opportunities are offered without regard to race, color, national origin, gender, or physical disability.

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