

Commercial Workforce Credentialing Council

Building Energy Auditor Educational/Training Outline

Introduction

A Commercial Building Energy Auditor is an energy solutions professional who assesses building systems and site conditions; analyzes and evaluates equipment and energy usage; and recommends strategies to optimize building resource utilization. The major tasks of a Building Energy Auditor are to:

- Communicate with Stakeholders
- Develop an Action Plan for Energy Auditing
- Collect Data Prior to the Site Visit
- Collect Data on Site
- Analyze the Building Performance Data
- Identify Opportunities for Improving the Building Performance
- Create a Final Report of Findings

Curriculum Design

The process used to define the components to be included in an educational/training program for Building Energy Auditors includes the stages as depicted in the following graphic:



The goals and objectives of an educational/training program must first be defined. For purposes of this program, the goals and objectives of the educational/training program are as follows:

• To prepare an individual to work as an entry level Building Energy Auditor

• To provide basic energy auditing foundational knowledge to allow an individual to function sufficient to obtain the experience required to meet eligibility requirements for obtaining a professional credential as a Building Energy Auditor.

Then a body of knowledge must be identified. In the case of Building Energy Auditors the body of knowledge was identified through a job/task analysis. The body of knowledge was then sequenced and ordered to facilitate instruction of the content.

Curriculum

Following is a proposed curriculum. This curriculum is designed to cover all content for which a Building Energy Auditor should be proficient. However not all content may be taught in a single course. For example some of the content may be part of other building construction programs. To use the course outline, community colleges and vocational institutions are recommended to review existing courses to identify content that may already be incorporated in existing courses. Then a course should be developed only to cover the remaining content not covered in existing courses. Instructional design experts and instructional staff would then select the learning activities to ensure the student learns the content including:

- Selection of textbooks and other appropriate course materials
- Creation of learning activities (lectures, handouts, performance activities, etc.)
- Creation of assessment and evaluation activities to verify learning
- Creation of curriculum evaluation activities

Course Outline

- I. Building Systems and sciences
 - a. Air compressors
 - b. Building automation control systems and programming
 - c. Building HVACR systems
 - d. Building interior and exterior lighting fixtures and controls
 - e. District energy
 - f. Electrical power systems
 - g. Low temperature refrigeration systems
 - h. Onsite energy generation (CHP, PV, wind, thermal, etc.)
 - i. Process systems and controls
 - j. Service hot water and control systems
 - k. Water distribution and control systems
- II. Construction and Energy Auditing Documentation
 - a. Technical construction documents and drawings
 - b. Scopes of work
 - c. Energy auditing contracts
 - d. Industry accepted standards, codes and guidelines

- e. Industry terminology
- f. Equipment lists
- g. Building maintenance logs and work orders
- h. Capital improvement plans
- i. As built plans
- j. Building operating plans
- k. Building operating schedules

III. Energy Data

- a. Utility data
 - 1. Utility bills
 - 2. Utility authorization forms
 - 3. Utility rate structures
 - 4. Utility contracts
 - 5. Utility incentive programs
- b. Weather data
 - 1. Types of weather data (bin data, hourly data, TMY, etc.)
 - 2. Methodologies for normalizing data
 - 3. Methodologies for missing weather data
- c. Occupant data
 - 1. Interviewing key personnel (building systems, operational concerns, etc.)
 - 2. Interviewing facility occupants
 - 3. Interviewing techniques
 - 4. Recording interview responses

IV. Energy Auditing

- a. Basic energy audit components
- b. Types of audits (level 1, 2 or 3)
- c. Building envelopes
 - 1. Building walls, roofs, floors, etc.
 - 2. Building Overall heat transfer coefficients
 - 3. Building air tightness
 - 4. Building fenestration
 - 5. Building exterior shading
 - 6. Building roofing
 - 7. Building windows
 - 8. Building interior shading
 - 9. Building penetrations
 - 10. Documentation procedures
- d. Building systems components
 - 1. Building system equipment
 - 2. Building lighting fixtures, controls and schedules
 - 3. Lighting fixture counts and characteristics (ballasts, amps, etc.)
 - 4. Nameplate data
 - 5. Water distribution system fixture count and nameplate data
 - 6. Ventilation requirements for buildings
 - 7. IEQ

- 8. Data collection (frequency and time periods of data collection)
- 9. Spot measurements
- 10. Comparing trend data to spot measurements for validation
- 11. Building system component data
- 12. Building and equipment operation schedules
- V. Energy auditing tools and software
 - a. Energy auditing tools
 - 1. Air flow measuring devices
 - 2. Combustion analyzers
 - 3. Data loggers
 - 4. Manometer
 - 5. Non-contact thermometer
 - 6. Power measurement tools
 - 7. Relative humidity sensors
 - 8. Temperature sensors
 - 9. Velometers
 - 10. Ballast discriminator
 - 11. CO2 meter
 - 12. Duct sizing tools
 - 13. Light level meter
 - 14. Pipe sizer
 - 15. Psychrometric measurement tools
 - 16. Sound level meters
 - 17. tachometer
 - 18. Ultra sonic flow meter
 - b. Energy auditing software
 - 1. 3EPlus
 - 2. Air master
 - 3. Blast
 - 4. CAD Viewer
 - 5. DOE2
 - 6. EERE
 - 7. E-Grid
 - 8. Energy Plus
 - 9. EPA Portfolio Manager
 - 10. eQuest
 - 11. FEMP BLCC (Federal Energy Manger Program, Building Life Cycle Costing)
 - 12. HAP Carrier
 - 13. IES
 - 14. MotorMaster
 - 15. Open Studio
 - 16. Phast (DOE tool)
 - 17. Photometrics
 - 18. PV Watts
 - 19. Spreadsheet
 - 20. Trace 700 Trane

21. Transys

VI. Analyzing building performance data

- a. Energy and cost baselines and models
- b. Calibrating baseline models to data
- d. Energy benchmarks
- e. Energy end use breakdowns
- VII. Building performance
 - a. Building performance potential savings opportunities
 - b. Energy Efficient Measures (EEM)
 - c. IM&V methodologies
 - d. Emissions and greenhouse gas impacts
 - e. EEM impacts
 - f. EEM implementation costs
 - 1. Material quantity takeoffs
 - 2. Labor rates
 - g. Economic analysis of EEMs

VIII. Safety

- a. 'Basic Personal Protective Equipment (PPE)
- b. Safety practices
- c. OSHA
- d. Environmental, health and safety (EHS) hazards and risks

Learning Objectives

The following learning objectives are identified as the desired outcome of instruction. These objectives should be reviewed and sequenced according to like objectives by subject matter experts familiar with the content.

- 1. Upon completion of the course, the student will be able to identify the stakeholders in an energy audit.
- 2. Upon completion of the course, the student will describe how to identify an owner's project team
- 3. Upon completion of the course, the student will be able to describe the purpose of conducting a meeting with the client's representative
- 4. Upon completion of the course, the student will be able to create a project contact list
- 5. Upon completion of the course, the student will be able to identify the responsibilities of the owner's project team members
- 6. Upon completion of the course, the student will be able to determine problem resolution methodologies
- 7. Upon completion of the course, the student will be able to develop a energy audit scope and process
- 8. Upon completion of the course, the student will be able to discuss the audit scope of work with a client

- 9. Upon completion of the course, the student will be able to describe industry accepted standards, codes and guidelines associated with energy auditing.
- 10. Upon completion of the course, the student will be able to identify safety practices associated with energy auditing
- 11. Upon completion of the course, the student will be able to describe what an energy audit is
- 12. Upon completion of the course, the student will be able to outline a process of how an energy audit will be conducted
- 13. Upon completion of the course, the student will be able to discuss contract concerns
- 14. Upon completion of the course, the student will be able to identify site specific requirements (access, safety, etc.)
- 15. Upon completion of the course, the student will be able to create an audit schedule
- 16. Upon completion of the course, the student will be able to discuss energy auditing reporting requirements (scheduling of reporting, to whom, etc.)
- 17. Upon completion of the course, the student will be able to conduct pre-audit activities
- 18. Upon completion of the course, the student will be able to identify building owners objectives and criteria
- 19. Upon completion of the course, the student will be able to read and create a scope of work
- 20. Upon completion of the course, the student will be able to demonstrate knowledge of building systems.
- 21. Upon completion of the course, the student will be able to describe the components of a building and a process system assembly
- 22. Upon completion of the course, the student will be able to identify industry accepted terminology
- 23. Upon completion of the course, the student will be able to describe the types of audits (level 1, 2 and 3)
- 24. Upon completion of the course, the student will be able to describe criteria for determining success of an energy audit
- 25. Upon completion of the course, the student will be able to review the auditor's project team roles and responsibilities
- 26. Upon completion of the course, the student will be able to assign audit team based on skills required, scope of work, and staff availability
- 27. Upon completion of the course, the student will be able to generate a preliminary list of systems and assemblies to be audited
- 28. Upon completion of the course, the student will be able to demonstrate the ability to read technical documents and drawings
- 29. Upon completion of the course, the student will be able to identify the equipment that should be audited
- 30. Upon completion of the course, the student will be able to identify building assemblies that should be audited
- 31. Upon completion of the course, the student will be able to determine the performance parameters that should be measured
- 32. Upon completion of the course, the student will be able to describe audit processes and tasks
- 33. Upon completion of the course, the student will be able to describe components of buildings, process systems and assemblies
- 34. Upon completion of the course, the student will be able to identify historic building practices
- 35. Upon completion of the course, the student will be able to determine the impact of age of a building on the building systems

- 36. Upon completion of the course, the student will be able to utilize audit tools and forms
- 37. Upon completion of the course, the student will be able to identify the various methodologies for energy analysis (energy model, bin data, etc.)
- 38. Upon completion of the course, the student will be able to select a specific methodology for energy analysis (energy model, bin data, etc.)
- 39. Upon completion of the course, the student will be able to compile interview questions
- 40. Upon completion of the course, the student will be able to select tools and equipment needed for an energy audit (data loggers, light meters, specialized tools, etc.)
- 41. Upon completion of the course, the student will be able to develop customized tools and forms for use in an energy audit
- 42. Upon completion of the course, the student will be able to select appropriate documentation forms for use energy audits
- 43. Upon completion of the course, the student will be able to describe data collection protocols
- 44. Upon completion of the course, the student will be able to describe M&V methodologies
- 45. Upon completion of the course, the student will be able to utilize energy measurement equipment
- 46. Upon completion of the course, the student will be able to describe energy measurement techniques
- 47. Upon completion of the course, the student will be able to describe typical energy analysis methodologies
- 48. Upon completion of the course, the student will be able to create a project schedule for an energy audit
- 49. Upon completion of the course, the student will be able to identify energy audit tasks
- 50. Upon completion of the course, the student will be able to identify access limitations of areas in a facility where an energy audit is being conducted
- 51. Upon completion of the course, the student will be able to estimate the time required to complete each task of an energy audit
- 52. Upon completion of the course, the student will be able to sequence the tasks associated with an energy audit
- 53. Upon completion of the course, the student will be able to create an initial project schedule for an energy audit
- 54. Upon completion of the course, the student will be able to Identify safety and access requirements for a facility
- 55. Upon completion of the course, the student will be able to evaluate site EHS plans
- 56. Upon completion of the course, the student will be able to assess potential risks associated with specific tasks and types of facility during an energy audit
- 57. Upon completion of the course, the student will be able to identify PPE required for specific energy audits
- 58. Upon completion of the course, the student will be able to describe environmental, health and safety (EHS) hazards and risks
- 59. Upon completion of the course, the student will be able to create a list of emergency points of contact for an energy audit
- 60. Upon completion of the course, the student will be able to describe methods for arranging for site access
- 61. Upon completion of the course, the student will be able to conduct pre-site visit data collection activities

- 62. Upon completion of the course, the student will be able to describe how to obtain utility information
- 63. Upon completion of the course, the student will be able to describe how to request copies of actual utility bills from owners or utility company
- 64. Upon completion of the course, the student will be able to complete utility authorization forms
- 65. Upon completion of the course, the student will be able to obtain relevant information from the utility representative
- 66. Upon completion of the course, the student will be able to describe how to obtain utility rate structures
- 67. Upon completion of the course, the student will be able to describe the purposes for obtaining utility contracts (third party suppliers, delivery company, etc.)
- 68. Upon completion of the course, the student will be able to explain utility incentive programs
- 69. Upon completion of the course, the student will be able to verify energy data is correct and complete
- 70. Upon completion of the course, the student will be able to complete energy calculations
- 71. Upon completion of the course, the student will be able to describe how to obtain facility data
- 72. Upon completion of the course, the student will be able to explain the purposes for obtaining an equipment list during an energy audit
- 73. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit maintenance logs and work orders
- 74. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit the latest capital improvement plan
- 75. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit technical documents
- 76. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit the results of any previously completed audit reports and whether recommendations were implemented
- 77. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit results of any previously completed, in process or planned renovations or upgrades
- 78. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit building operating plans
- 79. Upon completion of the course, the student will be able to explain the purposes for obtaining during an energy audit operating schedules
- 80. Upon completion of the course, the student will be able to gather historical weather data
- 81. Upon completion of the course, the student will be able to identify methodologies to normalize data
- 82. Upon completion of the course, the student will be able to determine what data is required for an energy audit and the duration/interval of data required
- 83. Upon completion of the course, the student will be able to describe how to identify weather location
- 84. Upon completion of the course, the student will be able to describe to identify weather data
- 85. Upon completion of the course, the student will be able to describe and select methodologies for filling in missing data
- 86. Upon completion of the course, the student will be able to fill in missing data using an appropriate methodology

- 87. Upon completion of the course, the student will be able to describe the various data types for weather (bin data, hourly data, TMY, etc.)
- 88. Upon completion of the course, the student will be able to describe how to collecting data onsite
- 89. Upon completion of the course, the student will be able to describe how to obtain information from facility staff
- 90. Upon completion of the course, the student will be able to interview key personnel on building systems/processes
- 91. Upon completion of the course, the student will be able to interview key personnel on operational concerns
- 92. Upon completion of the course, the student will be able to record interview responses using an appropriate methodology
- 93. Upon completion of the course, the student will be able to describe how to follow up on interview question responses
- 94. Upon completion of the course, the student will be able to describe common maintenance procedures and roles in a facility
- 95. Upon completion of the course, the student will be able to describe all operations within a typical facility
- 96. Upon completion of the course, the student will be able to obtain information from facility occupants
- 97. Upon completion of the course, the student will be able to collect information from facility occupants on physiological and psychological perceptions regarding IEQ
- 98. Upon completion of the course, the student will be able to describe IEQ
- 99. Upon completion of the course, the student will be able to describe typical energy audit sampling protocols and procedures
- 100. Upon completion of the course, the student will be able to describe how to assess the building envelope during an energy audit
- 101. Upon completion of the course, the student will be able to conduct a visual inspection (walls, roof, floors, etc.) relating to an energy audit
- 102. Upon completion of the course, the student will be able to obtain data to estimate overall heat transfer coefficients during an energy audit
- 103. Upon completion of the course, the student will be able to evaluate air-tightness during an energy audit
- 104. Upon completion of the course, the student will be able to evaluate the fenestration during an energy audit
- 105. Upon completion of the course, the student will be able to evaluate exterior shading during an energy audit
- 106. Upon completion of the course, the student will be able to evaluate the roof during an energy audit
- 107. Upon completion of the course, the student will be able to evaluate windows during an energy audit
- 108. Upon completion of the course, the student will be able to evaluate interior shading during an energy audit
- 109. Upon completion of the course, the student will be able to evaluate penetrations during an energy audit
- 110. Upon completion of the course, the student will be able to document observations during an energy audit

- 111. Upon completion of the course, the student will be able to demonstrate knowledge of building physics associated with an energy audit.
- 112. Upon completion of the course, the student will be able to demonstrate knowledge of building pressurization and its relationship to an energy audit
- 113. Upon completion of the course, the student will be able to demonstrate knowledge of building sciences and its relationship to an energy audit
- 114. Upon completion of the course, the student will be able to demonstrate knowledge of general building construction materials and their relationship to energy audits
- 115. Upon completion of the course, the student will be able to demonstrate knowledge of heat transfer and its relationship to energy audits
- 116. Upon completion of the course, the student will be able to demonstrate knowledge of solar mapping and its relationship to energy audits
- 117. Upon completion of the course, the student will be able to demonstrate knowledge of window types and their relationship to energy audits
- 118. Upon completion of the course, the student will be able to assess building systems and components as part of an energy audit
- 119. Upon completion of the course, the student will be able to evaluate the condition and operation of equipment during an energy audit
- 120. Upon completion of the course, the student will be able to evaluate the condition and operation of building lighting fixtures, controls and schedules during an energy audit
- 121. Upon completion of the course, the student will be able to evaluate lighting fixtures and characteristics (ballasts, amps, etc.) during an energy audit
- 122. Upon completion of the course, the student will be able to evaluate nameplate data during an energy audit
- 123. Upon completion of the course, the student will be able to evaluate the water distribution systems and nameplate data during an energy audit
- 124. Upon completion of the course, the student will be able to determine the ventilation requirements for the building during an energy audit
- 125. Upon completion of the course, the student will be able to evaluate the IEQ during an energy audit
- 126. Upon completion of the course, the student will be able to set up collection of data and establish frequency and time period of data collection during an energy audit
- 127. Upon completion of the course, the student will be able to obtain spot measurements using audit tools during an energy audit
- 128. Upon completion of the course, the student will be able to compare trend data to spot measurements for validation
- 129. Upon completion of the course, the student will be able to collect data during an energy audit
- 130. Upon completion of the course, the student will be able to evaluate the accuracy of data collected during an energy audit
- 131. Upon completion of the course, the student will be able to document observations made during an energy audit
- 132. Upon completion of the course, the student will be able to verify building and equipment operation schedules during an energy audit
- 133. Upon completion of the course, the student will be able to demonstrate knowledge of air compressors
- 134. Upon completion of the course, the student will be able to demonstrate knowledge of electrical power systems

- 135. Upon completion of the course, the student will be able to demonstrate knowledge of onsite energy generation (CHP, PV, wind, thermal, etc.)
- 136. Upon completion of the course, the student will be able to demonstrate knowledge of process systems and controls
- 137. Upon completion of the course, the student will be able to demonstrate knowledge of systems interactions and controls
- 138. Upon completion of the course, the student will be able to demonstrate the ability to analyzing building performance data
- 139. Upon completion of the course, the student will be able to establish energy and cost baselines
- 140. Upon completion of the course, the student will be able to review data collected during an energy audit
- 141. Upon completion of the course, the student will be able to synchronize data collected based on time stamps
- 142. Upon completion of the course, the student will be able to identify factors that impact usage
- 143. Upon completion of the course, the student will be able to build a baseline model using data collected during an energy audit
- 144. Upon completion of the course, the student will be able to calibrate baseline models to data
- 145. Upon completion of the course, the student will be able to evaluate the accuracy of baseline data
- 146. Upon completion of the course, the student will be able to apply rate structures to baselines
- 147. Upon completion of the course, the student will be able to calibrate baseline costs to data
- 148. Upon completion of the course, the student will be able to describe heating and cooling degree days and balance point temperatures
- 149. Upon completion of the course, the student will be able to establish benchmarks for energy auditing
- 150. Upon completion of the course, the student will be able to survey benchmarking sources
- 151. Upon completion of the course, the student will be able to select appropriate benchmarks for energy auditing
- 152. Upon completion of the course, the student will be able to convert data into common metrics
- 153. Upon completion of the course, the student will be able to compare performances of buildings to benchmarks
- 154. Upon completion of the course, the student will be able to demonstrate knowledge of benchmarking
- 155. Upon completion of the course, the student will be able to demonstrate knowledge of typical energy usage by building types
- 156. Upon completion of the course, the student will be able to disaggregate the energy end use breakdown for an energy audit
- 157. Upon completion of the course, the student will be able to determine categories for end use in a facility
- 158. Upon completion of the course, the student will be able to analyze data collected by systems in a facility
- 159. Upon completion of the course, the student will be able to compute energy use by systems in a facility
- 160. Upon completion of the course, the student will be able to reconcile energy usage with baselines
- 161. Upon completion of the course, the student will be able to describe typical percentage of end usage by occupancy type

- 162. Upon completion of the course, the student will be able to identify opportunities for improving building performance
- 163. Upon completion of the course, the student will be able to identify deviations from best practices in energy management
- 164. Upon completion of the course, the student will be able to interpret the data collected onsite and prior to an energy audit
- 165. Upon completion of the course, the student will be able to verify if rate structures are correct
- 166. Upon completion of the course, the student will be able to compare collected information to target or best practice of each system in an energy audit
- 167. Upon completion of the course, the student will be able to correlate data to make comparisons with activities occurring in the building
- 168. Upon completion of the course, the student will be able to enumerate potential energy savings opportunities
- 169. Upon completion of the course, the student will be able to describe proposed EEM in sufficient detail to develop savings and cost for a facility
- 170. Upon completion of the course, the student will be able to describe typical energy efficiency measures (EEMs) and their impact on economics
- 171. Upon completion of the course, the student will be able to demonstrate a basic understanding of engineering practices and principles
- 172. Upon completion of the course, the student will be able to demonstrate knowledge of industry best practices and principles related to energy management
- 173. Upon completion of the course, the student will be able to demonstrate knowledge of industry best practices for various building systems
- 174. Upon completion of the course, the student will be able to demonstrate knowledge of when a building needs to be "tuned up" versus new installations
- 175. Upon completion of the course, the student will be able to determine energy impacts of various energy savings measures
- 176. Upon completion of the course, the student will be able to input various energy savings measure into baseline tools
- 177. Upon completion of the course, the student will be able to collect additional performance information as required during an energy audit
- 178. Upon completion of the course, the student will be able to estimate the impact of various energy measures (maintenance and energy impacts) on energy consumption
- 179. Upon completion of the course, the student will be able to estimate the impact of any interaction among energy saving measures
- 180. Upon completion of the course, the student will be able to estimate emission and greenhouse gas impacts of energy savings measures
- 181. Upon completion of the course, the student will be able to identify M&V methodologies as required
- 182. Upon completion of the course, the student will be able to demonstrate knowledge of greenhouse gas calculations
- 183. Upon completion of the course, the student will be able to estimate implementation costs associated with various energy savings measures
- 184. Upon completion of the course, the student will be able to identify material quantities for various energy savings measures
- 185. Upon completion of the course, the student will be able to determine labor hours for various energy savings measure

- 186. Upon completion of the course, the student will be able to identify potential vendors and contractors for various energy savings measures
- 187. Upon completion of the course, the student will be able to describe how to identify rebates and incentives for various measures
- 188. Upon completion of the course, the student will be able to estimate the net cost of various energy savings measures
- 189. Upon completion of the course, the student will be able to demonstrate knowledge of industry equipment
- 190. Upon completion of the course, the student will be able to conduct an economic analysis of various energy savings measures
- 191. Upon completion of the course, the student will be able to select economic analysis methods for an energy audit
- 192. Upon completion of the course, the student will be able to perform economic analysis for various energy savings measure
- 193. Upon completion of the course, the student will be able to prioritize energy savings measures
- 194. Upon completion of the course, the student will be able to demonstrate basic engineering economic knowledge
- 195. Upon completion of the course, the student will be able to demonstrate knowledge of financial analysis methodologies and thresholds
- 196. Upon completion of the course, the student will be able to producing an energy audit report
- 197. Upon completion of the course, the student will be able to write a summary audit report
- 198. Upon completion of the course, the student will be able to draft and energy audit report
- 199. Upon completion of the course, the student will be able to review an energy audit report with client
- 200. Upon completion of the course, the student will be able to incorporate comments into energy audit reports
- 201. Upon completion of the course, the student will be able to issue final energy audit reports
- 202. Upon completion of the course, the student will be able to present energy audit reports to client