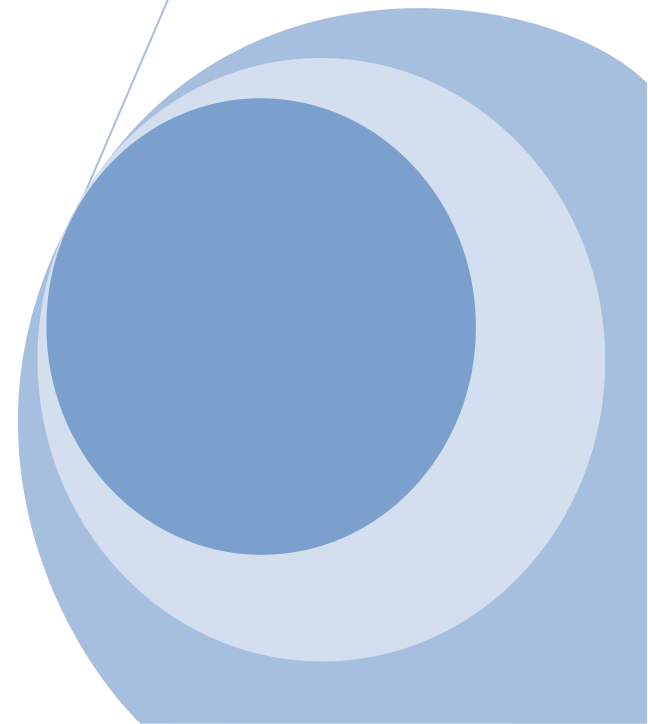




# Certified Residential Energy Auditor (REA) Study Guide

This guide provides an overview of the Certified Residential Energy Auditor (REA) Program, including how to register for the REA Training Seminar and apply for the REA Examination. It includes an outline of the Seminar topics and example questions similar to ones on the REA Examination.

- **REA Objectives**
- **REA Eligibility**
- **REA Examination**
- **Seminar Overview and Course Outline**
- **REA Certification/Examination Application**
- **Example Questions with Answer Key**
- **Preparation**
- **Additional Information Resources**



*The Residential Energy Auditor (REA) certification was developed and added to the Association of Energy Engineers' portfolio of certifications to provide residential energy auditors and those in related professions with a fundamental understanding of residential energy use and opportunities for energy savings. Rising energy costs and increased interest in the environmental impacts of energy use have increased the demand for trained and experienced residential energy auditors. The REA certification identifies residential energy professionals as having the knowledge and experience needed to succeed in the growing field of residential energy auditing.*

## REA Objectives

The REA Certification Program is intended to improve the practice of residential energy auditing via continuing education and professional development, and to identify individuals who demonstrate appropriate knowledge of the principles and practices of residential energy auditing via the completion of an examination and fulfillment of prescribed standards of performance and conduct. By earning the right to put the initials "REA" behind your name, you have distinguished yourself as a professional who has demonstrated a high level of competence in the residential energy auditing field.

## REA Eligibility

The candidate for CEA certification must have:

**A two-year technical degree or higher** in engineering, building management, energy auditing, construction management, science, or a related specialty. No prior specific experience in residential energy auditing is required;

- OR -

**The status of U.S. military veteran** with *at least three years of verifiable relevant technical experience*. No prior specific experience in residential energy auditing is required;

- OR -

**The current status of Certified Energy Manager (CEM) or Certified Energy Auditor (CEA)** in good standing.

### **Note:**

*Candidates who have significant experience in performing residential energy audits but lack the requirements listed above will be considered on a case-by-case basis. Resumes or other documentation of experience should be submitted to the Director of Certification.*

## The REA Examination

All REA candidates must attend one of AEE's preparatory REA training seminars, and complete and pass the four-hour written REA examination, proctored by an AEE-approved exam administrator. REA examination questions are drawn from concepts and experiences basic to residential energy auditing methodology, home energy use, residential energy systems, energy conservation measures, energy calculations, and diagnostic and software tools.

The four hour examination is open book, and questions are a combination of multiple choice and true/false. Roughly half of the questions involve some type of energy calculation. A passing score of at least 70% is required in conjunction with meeting all other eligibility requirements to become certified.

Examinations are graded by AEE's Director of Certification and are identified by number rather than by candidate name to assure confidentiality and objective grading. The Certification Director keeps examination scores on file for a period of three years. Applicants who do not receive certification status can request that their applications be resubmitted to the CEA Board, if during that three-year period their education or experience level changes.

## Fundamentals of Residential Energy Auditing Seminar

This 3-day program is designed to provide the specific training needed by professionals preparing to sit for AEE's Residential Energy Auditor (REA) certification exam.

The program covers all major aspects of home energy use, residential energy systems and technologies, energy conservation measures (ECMs), energy auditing methodology and calculations, and diagnostic and software tools. The course material assumes no prior knowledge of the topic and incorporates all the basic information residential energy auditors need.

For those wishing to qualify for the REA certification, the REA examination will be administered on the morning of the day following the seminar to pre-qualified applicants.

### **Certification**

Please Note: In order to qualify to sit for the REA exam, you must submit your completed REA application, along with a \$300 application fee. For information on obtaining your REA application form, or for further information on the REA program, visit [www.aeecenter.org/certification](http://www.aeecenter.org/certification).

## Basic Skills Required for this Seminar

Although the REA certification is not highly technical, there are a number of equations and calculations utilized in the seminar that are essential to understanding the basic principles of residential energy auditing. Those needing a refresher program covering effective use of a hand calculator and use of equations may wish to consider participating in the Basics of Energy Management online seminar prior to taking this course. For information, visit [www.aeecenter.org/training](http://www.aeecenter.org/training).

# Seminar Outline

## Introduction / Objectives

### Energy Basics

#### Utility Billing

- "Base" vs. "seasonal" energy use
- Estimating space heating/cooling energy use from bill data

#### Principles of Heat Transfer

- Introduction / basic principles
- Conduction / convection (infiltration) / radiant
- Heating Degree Days
- Heat transfer calculations

#### Residential Energy Overview

- Typical consumption by end-use
- Factors affecting residential energy consumption

#### Building Envelope

- Defining the envelope
- Areas of conductive losses/gains
- Radiant heat gains
- Sources of infiltration
- Building envelope ECMs (Energy Conservation Measures)
- Indoor air quality
- Calculating energy and cost savings

#### Space Heating

- Factors affecting space conditioning energy use
- Electric space heating systems
- Fossil fuel heating systems
- Space heating calculations and ECMs

#### Air Conditioning

- Vapor compression cycle and components
- System types/configurations
- Efficiency ratings
- Air conditioning calculations and ECMs

#### Water Heating

- Factors in water heating energy use
- Electric / gas / other water heating systems
- Water heating energy calculations
- Water heating ECMs

#### Lighting and Appliances

- Lighting efficiency
- Lighting energy calculations
- Lighting ECMs

- Residential appliances
- Efficient appliances / Energy Star

#### **Financial Calculations / Tax Credits**

- Simple payback calculations
- Federal tax credits for qualifying ECMs

#### **Residential Energy Audit Overview**

- Types of residential energy audits
- Home Energy Ratings / Energy Star / LEED for residential buildings

#### **Conducting a Residential Energy Audit**

- Preparation
- Observations / what to look for
- Measurements / calculations
- Diagnostic tools / instruments
- Presenting recommendations

## **Certified Residential Energy Auditor (REA) Program & Exam Application**

**Please note:** In addition to completing and submitting the seminar registration, in order to take the REA exam, applicants must also complete the REA Certification online application

### REA Certification Online Application:

[https://www.aeecenter.org/custom/certifications/form.cfm?form\\_id=21](https://www.aeecenter.org/custom/certifications/form.cfm?form_id=21)

The REA exam is administered at each Fundamentals of Residential Energy Auditing seminar site, on the morning following the last day of the seminar.

#### **Notification of Exam Results**

Within thirty days of the date of the exam, you will be notified of your score. Your application fee must be paid before your score can be released. Please do not call AEE about your test results before the end of the thirty-day period. Exam results are not available on the AEE website.

**Review by Certification Board:** If you receive a passing score and have paid the examination fee, and if your file is complete, including all supporting documents, your file will be sent to the Certification Board for final review. You will be notified at that time that you will receive the Board's approval or denial within sixty days.



## REA Examination - Sample Questions

1. 1 million British Thermal Units are equal to...
  - a. 1 MBtu
  - b. 10 Therms
  - c. 10 MMBtu
  - d. None of the above
  
2. What percent of the radiant heat gain through a window will be blocked by installing a tinted film or solar screen with a Solar Heat Gain Coefficient of 0.35?
  - a. 35%
  - b. 3.5%
  - c. 65%
  - d. It depends on the U-value of the window
  
3. If an Energy Conservation Measure will save 1 MMBtu/year in space heating energy and the home is heated by an 80% efficient natural gas furnace, what will be the annual savings in Therms?
  - a. 12.5 Therms
  - b. 125 Therms
  - c. 100 Therms
  - d. 10 Therms
  
4. How much heat can an air-source heat pump with an HSPF of 6.8 provide for each kWh?
  - a. 6.8 Btu
  - b. 6.8 MMBtu
  - c. 6800 Btu
  - d. it depends on the size of the heat pump
  
5. When checking insulation in an attic, it is also important to check for...
  - a. Adequate ventilation
  - b. Pipe and wire penetrations through the ceiling
  - c. Signs of excessive moisture
  - d. All of the above

6. A 10,000 Btu/hr window air conditioner draws 1.25 kW of power – what is its EER?
  - a. 8.0
  - b. 10.0
  - c. 12.5
  - d. None of the above
  
7. Which would have the greater potential heat content - five gallons of propane or four Therms of natural?
  - a. The natural gas
  - b. The propane
  - c. They are equal
  - d. It depends on the heating system efficiency
  
8. A customer has an estimated annual water heating cost of \$480. What would be the annual energy cost savings for replacing the existing electric water heater (0.88 Energy Factor) with a new high-efficiency water heater (0.93 Energy Factor)?
  - a. \$25.81
  - b. \$33.60
  - c. \$57.60
  - d. It depends on the cost per kWh
  
9. What would be the annual energy cost savings for replacing four 60W incandescent lamps with 13W compact fluorescents (assume 8 hr./day and \$0.13/kWh)?
  - a. \$19.73
  - b. \$91.10
  - c. \$71.36
  - d. None of the above
  
10. What would be the annual heating energy savings for reducing the air change rate from 1.0 ACH to 0.6 ACH in a 1,500 sq. ft. home with 8' ceilings in a location with 2800 HDD?
  - a. 64.5 MBtu
  - b. 6.45 MMBtu
  - c. 645 Therms
  - d. None of the above

Answer Key:

- 1- B
- 2- C
- 3- A
- 4- C
- 5- D
- 6- A
- 7- B
- 8- A
- 9- C
- 10- B

## Preparation

The REA Seminar does not require any prior training. However, if attendees have previously had training in topics like heat transfer, residential heating and cooling load calculations or other related topics, it would be helpful to review that material before attending the Seminar.

Although the Seminar does not involve any advanced engineering calculations, there are quite a few basic calculations that require familiarity with a calculator and basic mathematics. Some familiarity with basic algebra would be helpful, but not necessarily required.

### Examples of Calculations Used in the Seminar

The following examples are typical of the types of calculations covered in the Seminar. Each example shows a step-by-step solution (but keep in mind that there is usually more than one way to arrive at the correct answer).

#### Example 1:

Calculate the BTU/hr. input required to deliver 60,000 BTU/hr. output with an 80% efficient gas furnace....

*When calculating input based on output, we divide by the system efficiency...*

$$60,000/.80 = 75,000 \text{ BTU/hr.}$$



Calculate the BTU/hr. that can be delivered by a 75% efficient gas boiler with an input rating of 80,000 BTU/hr.

*When calculating output based on input, we multiply by the system efficiency...*

$$80,000 * .75 = 60,000 \text{ BTUH}^*$$

*\*BTUH is a common abbreviation for BTU/hr.*

### Example 2:

A home has a calculated heat loss of 68,000 BTU/hr. at an indoor/outdoor temperature difference of 40 degrees. By how much would the heat loss be reduced for each degree of thermostat setback?

*Since heat transfer is directly proportional to temperature difference, we can simply divide the calculated heat loss by the temperature difference to get the heat loss per degree of temperature difference...*

$$68,000 \text{ BTUH} / 40 \text{ degrees} = 1700 \text{ BTUH per degree OR } 2.5 \% \text{ per degree}$$

### Example 3:

Calculate the cooling energy savings in BTU/hr. for increasing the R-value of a ceiling from R-11 to R-30

- Area = 1500 sq. ft.
- Indoor temperature 75 degrees
- Attic temperature 120 degrees

*Using the conduction heat transfer equation...first calculate the heat gain with R-11*

$$Q = (\text{Area} * \Delta T) / R\text{-value}$$

$$Q1 = (1500 * (120 - 75)) / 11 = 6136 \text{ BTU/hr.}$$

*Then calculate the heat gain with R-30...*

$$Q2 = (1500 * (120 - 75)) / 30 = 2250 \text{ BTU/hr.}$$

*Then subtract to get the savings...*

$$\text{Savings} = 6136 - 2250 = 3886 \text{ BTU/hr.}$$

#### Example 4:

Calculate the heating energy savings in BTU/hr. for reducing a home's ACH from 1.0 to 0.6

- Volume = 12,000 cu. ft.
- Indoor temp. 70 degrees; outdoor temp. 20 degrees
- Use .02 for HC

*Using the equation for infiltration heat transfer, calculate the heat loss with 1.0 ACH, then calculate the heat loss with 0.6 ACH, and subtract to get the savings...*

$$Q = \text{Volume} * \text{ACH} * \Delta T * \text{HC}$$

$$Q_1 = 12,000 * 1.0 * (70-20) * .02 = 12,000 \text{ BTU/hr.}$$

$$Q_2 = 12,000 * 0.6 * (70-20) * .02 = 7,200 \text{ BTU/hr.}$$

$$\text{Savings} = (12,000 - 7,200) = 4,800 \text{ BTU/hr.}$$

*Alternate method:*

*Since the only value that changes is the ACH, we can calculate the savings in one step by using the difference in ACH ( $\Delta\text{ACH}$ )...*

$$Q = 12,000 * 0.4 * (70-20) * .02 = 4,800 \text{ BTU/hr.}$$

#### Example 5:

An exterior frame wall has R-13 cavity insulation plus one inch of rigid foam sheathing (R-5). Assuming that 20% of the wall area is framing with an R-Value of 3, what is the overall R-Value of the wall?

*To account for the effect of the framing, we calculate a weighted average of the R-Values of the cavity insulation and of the framing; then add the R-Value of the sheathing which covers the entire area...*

$$R = (13 * .8) + (3 * .2) + 5$$

$$R = 10.4 + .6 + 5 = 16$$

### Example 6:

Calculate the cost per million BTU for an 80% efficient gas furnace at a rate of \$.89/Therm (1 Therm = 100,000 BTU)

*Divide the million BTUs by the fuel factor (100,000 BTU/Therm) times the efficiency to get the Therms...*

$$1,000,000 / (100,000 * .80) = 12.5 \text{ Therms}$$

*Then multiply by the cost per Therm to get the cost per million BTUs...*

$$12.5 \text{ Therms} * \$.89/\text{Therm} = \$11.13$$

### Example 7:

A home with electric baseboard heating has an annual space heating cost of \$1800. What would be the estimated annual heating cost with a heat pump with an average COP of 2.5?

*Since the baseboard heating is 100% efficient (COP = 1.0), we can simply divide the annual cost with the baseboard heating by the average COP of the heat pump to get the estimated annual heating cost with the heat pump...*

$$\text{Annual Cost (Heat Pump)} = \$1800 / 2.5 = \$720$$

## Additional Information Resources:

U.S. Depart of Energy:

<http://www.eere.energy.gov>

U.S. EPA Energy Star:

[http://www.energystar.gov/index.cfm?c=assess\\_performance.conduct\\_assessments](http://www.energystar.gov/index.cfm?c=assess_performance.conduct_assessments)

State Energy Offices

[http://apps1.eere.energy.gov/state\\_energy\\_program/seo\\_contacts.cfm](http://apps1.eere.energy.gov/state_energy_program/seo_contacts.cfm)

AEE Certification Programs

<http://www.aeecenter.org/certification>

Real-time online seminars

<http://www.aeecenter.org/realtime>

Professional Reference Books

<http://www.aeecenter.org/books>

Technical Papers on Energy / Energy Auditing

<http://aeecenter.metapress.com>