RENEWABLE ENERGY
INTEGRATOR JOB TRAINING GUIDE

ELECTRONICS TECHNICIANS ASSOCIATION
ETA® INTERNATIONAL

- Over 30 Years of Certifying Professionals
- Complete Job Training Guides
- Course–Approved Vendor Training

www.certifymegreen.org *5 Depot Street, Greencastle, IN 46135* *(800) 288-3824*

ICAC
International Certification Accreditation Council

2011 RENEWABLE ENERGY INTEGRATOR MAJOR CATEGORIES

1.0 CODES, STANDARDS AND SAFETY
2.0 RENEWABLE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY
3.0 MAXIMIZING ENERGY EFFICIENCY
4.0 PHOTOVOLTAICS
5.0 WIND ENERGY
6.0 MICROHYDRO
7.0 PASSIVE SOLAR
8.0 SOLAR THERMAL
9.0 GEOTHERMAL HEATING AND COOLING
10.0 ADDITIONAL TECHNOLOGIES
11.0 SYSTEMS INTEGRATION
12.0 DEVELOPING THE SYSTEM DESIGN AND PROPOSAL (DEMONSTRATION)

NOTE: Applied physical science, chemistry and technical mathematics are required prerequisites for success when answering renewable energy integrator questions.

NOTE: These competency requirements are based on residential and small business sized applications, generally less than 100 KW.

KEY:
- U **Useful** - The examinee should be able to describe concepts at a basic level and contrast advantages and disadvantages.
- I **Important** - This concept or task is integral to the certification and requires the application of facts and principles and the skill to draw conclusions.
- C **Critical** - This concept or task is central to the certification and requires a deep understanding of concepts and the ability to complete tasks successfully.
- Blank - Not relevant.

The percentages based on certification level are the weights of each of the categories and translate into the number of questions on a 100-question examination.

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
1.0	**CODES, STANDARDS AND SAFETY**		**10%**	**10%**	**10%**
	1.1	Identify local codes, permitting and inspection processes	I	C	C
	1.2	Explain the differences between Codes, Standards, Regulations and Statutes	C	C	C
	1.3	Describe National Electrical Code:	I	C	C
		1.3.1 Article 90 – Intro to the NEC	I	I	I
		1.3.2 Article 100 - Definitions	I	I	I
		1.3.3 Article 110 - Requirements for Elect. Installations	I	I	I
		1.3.4 Article 200 - Use and ID of Grounded Conductors	I	I	I
		1.3.5 Article 230 - Services	I	I	I
		1.3.6 Article 240 – Overcurrent Protection	I	I	I
		1.3.7 Article 250 - Grounding and Bonding	I	I	I
		1.3.8 Article 300 - Wiring Methods	I	I	I
		1.3.9 Article 310 - Conductors for General Wiring	I	I	I
		1.3.10 Article 312 - Cabinets, Cutout Boxes and Meter Socket Enclosures	I	I	I
		1.3.11 Article 314 - Outlet, Device, Pull and Junction Boxes, Conduit Bodies, and HandHole Enclosures	I	I	I
		1.3.12 Article 330 - Metal-Clad Cable (Type MC)	I	I	I
		1.3.13 Article 338 - Service-Entrance Cable (Types SE and USE)	I	I	I
		1.3.14 Article 342 - Intermediate Metal Conduit (Type IMC)	I	I	I
		1.3.15 Article 344 - Ridgid Metal Conduit (Type RMC)	I	I	I
		1.3.16 Article 348 - Flexible Metal Conduit (Type FMC)	I	I	I
		1.3.17 Article 350 - Liquidtight Flexible Metal Conduit (Type LFMC)	I	I	I
		1.3.18 Article 352 - Rigid Polyvinyl Chloride Conduit (Type PVC)	I	I	I
		1.3.19 Article 356 - Liquidtight Flexible Nonmetallic Conduit (Type LFNC)	I	I	I
		1.3.20 Article 358 - Electrical Metallic Tubing (Type EMT)	I	I	I
		1.3.21 Article 376 - Metal Wireways	I	I	I
		1.3.22 Article 392 - Cable Trays	I	I	I
		1.3.23 Article 400 - Flexible Cords and Flexible Cables	I	I	I
		1.3.24 Article 404 - Switches	I	I	I
		1.3.25 Article 408 - Switchboards and Panel Boards	I	I	I

Key: U - Useful I - Important C - Critical

		Level 1	Level 2	Level 3
1.3.26	Article 445 - Generators	I	C	C
1.3.27	Article 480 - Storage Batteries	I	I	I
1.3.28	Article 690 - Solar Photovoltaic (PV) Systems	I	C	C
1.3.29	Article 694 - Small Wind Turbines	I	C	C
1.3.30	Article 705 - Interconnected Electric Power Production Sources	I	C	C
1.4	Describe ANSI/TIA/EIA-570B -Residential Telecommunications Infrastructure Standard	U	I	I
1.5	Describe NFPA 5000 and IBC - Building Construction Safety Code and International Building Code	C	I	I
1.6	Locate International Residential Code (IRC)	I	I	I
1.7	Explain IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems	I	I	I
1.8	Describe IEEE 929 Recommended Practice for Utility Interface	I	C	C
1.9	Describe UL 1703, Standard for Flat-plate Photovoltaic Modules and Panels	I	I	I
1.10	Describe UL 1741, Standard for Static Inverters, Converters, & Controllers for use in Independent Power Systems	I	I	I
1.11	Identify relevant regulatory government agencies (local, regional, national)	C	C	C
1.12	Recognize Basic Safety	I	I	I
1.13	List Personal Protection Equipment:	I	I	I
1.13.1	Describe Eyewear	I	I	I
1.13.2	Describe Hardhat use and integrity	I	I	I
1.13.3	Describe Ear Protection	I	I	I
1.13.4	Describe Respirator Use	I	I	I
1.13.5	Describe Clothing and Sun Protection	I	I	I
1.13.6	Explain Boot Protection	I	I	I
1.13.6.1	Discuss Standard Work Boots	I	I	I
1.13.6.2	Discuss Special Roof Boots	I	I	I
1.14	Practice Personal Safety	I	I	I
1.14.1	Explain Voltage Detection Devices	I	I	I
1.14.2	Identify Rubber Gloves	I	I	I
1.14.3	Describe Avoiding High Voltage	I	I	I

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
	1.14.4	Describe Site Safety	I	I	I
	1.14.5	Know First Aid	I	I	I
		1.14.5.1 Summarize Sunburn First Aid	I	I	I
		1.14.5.2 Summarize Electrocution First Aid	I	I	I
		1.14.5.3 Summarize CPR First Aid	I	I	I
1.15		Recognize Equipment Safety	I	I	I
	1.15.1	Summarize Power Tool Safety	I	I	I
	1.15.2	Summarize Hand Tool Safety	I	I	I
1.16		Describe Mounting Procedures	I	I	I
	1.16.1	Discuss Roof Mounting	I	I	I
	1.16.2	Discuss Ground Mounting	I	I	I
	1.16.3	Discuss Pole Mounting	I	I	I
1.17		Identify Procedures for Working Aloft	I	I	I
	1.17.1	Know Ladder Safety Procedures	I	I	I
	1.17.2	Know Lanyard and Harness Procedures	I	I	I
	1.17.3	Describe Personal Fall-Arrest Systems (PFAS)	I	I	I
1.18		Know Electrical Safety	I	I	I
	1.18.1	Summarize Touch Potential	I	I	I
	1.18.2	Summarize Grounding and Bonding	I	I	I
1.19		Chemical Safety	I	I	I
	1.19.1	Locate Material Data Safety Sheets	I	I	I
2.0		**RENEWABLE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY**	**5%**	**10%**	**15%**
2.1		Explain the economics of residential renewable energy production	I	I	C
	2.1.1	Interpret a payback analysis for indicated sources of renewable energy, both singularly and in hybridized combinations	I	C	C
	2.1.2	Identify the local, state and federal laws that affect the installation and means of renewable energy production	C	C	C
	2.1.3	Determine the feasibility of using renewable energy on the site under	I	C	C
	2.1.4	Be able to identify and access legal restrictions and codes for the following:	C	C	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		2.1.4.1	Local energy producer policies on grid-tied systems	I	C	C
		2.1.4.2	Homeowners association covenants	I	C	C
		2.1.4.3	Local codes	I	C	C
		2.1.4.4	State laws	I	C	C
		2.1.4.5	Federal laws	I	C	C
2.2	Explain the Energy Policy Act and its effects on the residential use of renewable energy			I	I	I
2.3	Describe the value of any rebates indicated for residential renewable energy use			I	C	C
2.4	Describe tax incentives indicated for residential renewable energy use:			I	C	C
	2.4.1	Federal		I	C	C
	2.4.2	State		I	C	C
	2.4.3	Local		I	C	C
2.5	Explain the various methods of selling excess power			I	I	I
2.6	Explain what Renewable Energy Credits are and the various methods of deriving revenue from them			I	I	I
2.7	Locate information on the following:					
	2.7.1	Local energy producers pricing		I	I	I
	2.7.2	Local energy producers buy-back rates		I	I	I
	2.7.3	Local energy producers purchase rate on Green Credits		I	I	I
2.8	Calculate the following expected energy requirements for:					
	2.8.1	Monthly average		I	I	I
	2.8.2	Peak projected consumption		I	I	I
	2.8.3	Projected Increases in consumption		I	I	I
	2.8.4	Total recommended installed capacity		I	I	I
2.9	Determine geographical feasibility of the site			C	C	C
	2.9.1	Determine geographical feasibility for deriving renewable energy from:				
		2.9.1.1	Geothermal	C	C	C
		2.9.1.2	Solar Passive Thermal	C	C	C
		2.9.1.3	Micro Hydro	C	C	C
		2.9.1.4	Wind	C	C	C
		2.9.1.5	Photovoltaic	C	C	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		2.9.1.6	Other Energy Sources	U	U	I
	2.9.2		Describe aesthetic considerations for each of the renewable energy sources indicated by the geographical study	I	I	I
	2.9.3		Inspect the local site and determine if the restraints can be mitigated (e.g., can a tree be cut to reduce sun or wind shading)	I	C	C
2.10			Discuss cost of production of all indicated renewable energy sources	U	I	I
2.11			Discuss cost of purchase and installation of all indicated renewable energy sources	U	I	C
2.12			Determine which, if any, renewable energy sources can be recommended (either singularly or in a hybridized combination)	U	I	C
3.0	**MAXIMIZING ENERGY EFFICIENCY**			**10%**	**10%**	**10%**
3.1			Relate how residential electrical loads are typically consumed (for example, lighting, space heating, etc.)	I	C	C
3.2			Describe a residential home energy audit	I	I	C
	3.2.1		Demonstrate ways to increase the efficient use of lighting within the structure	I	I	C
		3.2.1.1	Suggest the appropriate U-factor (insulating value) of windows	U	I	C
		3.2.1.2	Describe the various ways windows are rated	U	I	C
		3.2.1.3	Suggest daylighting options to increase lighting efficiency within the home	U	I	C
		3.2.1.4	Suggest fixture, bulb and control options that will efficiently provide lighting within the structure	U	I	C
	3.2.2		Demonstrate ways to increase the efficiency of space heating/cooling the	I	I	C
		3.2.2.1	Suggest ventilation changes to increase the efficiency of the building's heating/cooling systems	U	I	C
		3.2.2.2	Describe various behaviors and controls that will increase the efficiency of the heating/cooling systems	U	I	C
		3.2.2.3	Suggest building design and landscaping changes that will maximize the efficiency of the heating/cooling systems	U	I	C
		3.2.2.4	Describe the various types of insulation and the advantages and disadvantages of each	U	I	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		3.2.2.5	Define what is meant by R-Value and the recommended levels for various zones within the United States.	U	I	C
	3.2.3		Demonstrate ways to increase the efficiency of providing hot water within the	I	I	C
		3.2.3.1	Relate the advantages and disadvantages of a demand (tankless) hot water system	U	I	C
		3.2.3.2	Evaluate how a solar thermal system might be integrated into the	U	I	C
		3.2.3.3	Relate the advantages and disadvantages of the various fuel options for hot water systems	U	I	C
	3.2.4		Demonstrate ways to increase the efficiency of electrical appliances used within the building.	I	I	C
		3.2.4.1	Describe the Energy Star rating system	U	I	C
		3.2.4.2	Evaluate the performance of specific high-energy appliances and determine if replacement is economical	U	I	C
	3.2.5		Demonstrate ways to reduce the use of power by electronics or other electrical	U	I	C
	3.2.6		List the various ways to inspect the building shell, what these techniques seek to measure, and their limitations.	I	I	C
		3.2.6.1	List the common problem spots for heating/cooling leaks within a typical structure	U	I	C
3.3			Research and understand the various energy efficiency programs available to residential and small businesses.	U	I	C
4.0	**PHOTOVOLTAIC SYSTEMS**			**20%**	**10%**	**5%**
4.1			Describe photovoltaic system types	I	C	C
4.2			Describe required components for a photovoltaic system	I	C	C
4.3			Demonstrate knowledge of solar radiation fundamentals	I	C	C
	4.3.1		Explain the following terms and units of measurements and their use in	I	C	C
		4.3.1.1	Insolation	I	C	C
		4.3.1.2	Peak Sun hours	I	C	C
		4.3.1.3	Orientation	I	C	C
		4.3.1.4	Azimuth	I	C	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		4.3.1.5	Magnetic declination	I	C	C
		4.3.1.6	Irradiation and Irradiance	I	C	C
		4.3.1.7	Tilt angle	I	C	C
			4.3.1.7.1 Winter loads	I	C	C
			4.3.1.7.2 Summer loads	I	C	C
		4.3.1.8	Solar Noon	I	C	C
		4.3.1.9	Altitude	I	C	C
		4.3.1.10	Latitude	I	C	C
4.4	Research and compile site data for the proposed site of a photovoltaic system			I	C	C
4.5	Conduct a site analysis for the proposed site of a photovoltaic system			I	C	C
4.6	Describe the modules necessary to create a photovoltaic system			I	C	C
	4.6.1	List the types of modules		I	C	C
	4.6.2	List the characteristics of various modules and the function of each		I	C	C
		4.6.2.1	Define standard test conditions	I	C	C
			4.6.2.1.1 Define the following terms as they relate to a photovoltaic module's Standard test conditions:	I	C	C
			4.6.2.1.1.1 PTC (PV USA test condition) ratings	I	C	C
			4.6.2.1.1.2 STC (Standard test condition) ratings	I	C	C
	4.6.3	Describe a photovoltaic module's performance		I	C	C
		4.6.3.1	Describe external factors and how they affect a photovoltaic module's performance	I	C	C
			4.6.3.1.1 Temperature	I	C	C
			4.6.3.1.2 Dirt (Soiling)	I	C	C
			4.6.3.1.3 Solar Intensity	I	C	C
		4.6.3.2	Explain the use of a module's I-V Curve (current-voltage)	I	C	C
		4.6.3.3	Define the following terms as they relate to a photovoltaic module's perfomance:	I	C	C
			4.6.3.3.1 Maximum Power Point (Vmp) and (Imp)	I	C	C
			4.6.3.3.2 Short Circuit Current (Isc)	I	C	C
			4.6.3.3.3 Open Circuit Voltage (Voc)	I	C	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
			4.6.3.3.4 Load Resistance	I	C	C
	4.6.4	Explain the theory of operation of a photovoltaic module:		I	C	C
		4.6.4.1	Describe photovoltaic module cell types	I	C	C
		4.6.4.2	Explain how a photovoltaic module operates in series with another	I	C	C
		4.6.4.3	Explain how a photovoltaic module operates in parallel with another module	I	C	C
		4.6.4.4	Explain how a photovoltaic module operates when connected in a seriesparallel array	I	C	C
	4.6.5	List safety considerations when working with photovoltaic modules		I	C	C
4.7	Identify the various array mounting techniques			I	C	C
	4.7.1	Explain the procedures for roof mounting of photovoltaic arrays		I	C	C
		4.7.1.1	Explain wind loading as it applies to roof mounted photovoltaic arrays	I	C	C
		4.7.1.2	Identify structural issues that may affect roof mounted photovoltaic	I	C	C
	4.7.2	Explain the procedures for ground mounted photovoltaic arrays		I	C	C
	4.7.3	Explain the procedures for pole mounted photovoltaic arrays		I	C	C
		4.7.3.1	Describe single- and dual-axis photovoltaic array tracking systems	I	C	C
4.8	Explain the battery's role in both an on-grid and off-grid system configurations			I	I	C
	4.8.1	Identify the various types of batteries used in a photovoltaic system		I	I	C
	4.8.2	List the specifications for batteries used in a photovoltaic system		I	I	C
	4.8.3	State the optional configurations available to organize a battery bank		I	I	C
		4.8.3.1	Explain how batteries are hooked up in series and their expected performance in this configuration	I	I	C
		4.8.3.2	Explain how batteries are hooked up in parallel and their expected performance in this configuration	I	I	C
	4.8.4	Explain the theory of operation of the various types of batteries used with photovoltaic systems		I	I	C
		4.8.4.1	Explain charging stages	I	I	C
	4.8.5	List the safety issues relating to batteries used with photovoltaic systems		I	I	C
4.9	Explain the use of photovoltaic charge controllers			I	I	C
	4.9.1	Describe the operation and characteristics of the charge controllers:		I	I	C

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		4.9.1.1	Shunt controllers	I	I	C
		4.9.1.2	Single-stage series controllers	I	I	C
		4.9.1.3	Diversion controllers	I	I	C
		4.9.1.4	Pulse-width modulation	I	I	C
		4.9.1.5	Maximum power point tracking controllers	I	I	C
		4.9.1.6	Voltage step down controllers	I	I	C
	4.9.2	Describe the safety issues relating to charge controllers used with photovoltaic		I	I	C
4.10	Explain the use of inverters with photovoltaic systems			I	I	C
	4.10.1	Describe the various types of inverters used with photovoltaic systems:		I	I	C
		4.10.1.1	Waveform types	I	I	C
			4.10.1.1.1 Square wave	I	I	C
			4.10.1.1.2 Modified	I	I	C
			4.10.1.1.3 Sine wave	I	I	C
		4.10.1.2	Grid-tie	I	I	C
		4.10.1.3	Stand-alone	I	I	C
		4.10.1.4	Grid-tied with battery backup	I	I	C
		4.10.1.5	AC couple	I	I	C
		4.10.1.6	Micro inverters	I	I	C
	4.10.2	Explain the theory of operation of inverters		I	I	C
	4.10.3	List the safety issues relating to inverters used with photovoltaic systems		I	I	C
4.11	Explain the organization of photovoltaic systems wiring			I	I	C
	4.11.1	Describe the wire sizes used with photovoltaic systems		I	I	C
		4.11.1.1	Explain the expected voltage drop with the various wire sizes and currents carried	I	I	C
	4.11.2	Describe the over-current and over-voltage protection used with of photovoltaic systems wiring		I	I	C
	4.11.3	Explain conduit fill adjustments and how they relate to photovoltaic system wiring		I	I	C
	4.11.4	Explain the use of disconnects and how they relate to photovoltaic system wiring		I	I	C
	4.11.5	Explain the use of grounding how it relates to photovoltaic systems wiring		I	I	C
	4.11.6	List the safety issues relating to wiring used with photovoltaic systems		I	I	C

Key: U - Useful I - Important C - Critical

		Level 1	Level 2	Level 3
4.12	Describe stand-alone photovoltaic systems	I	I	C
4.12.1	Design a stand-alone photovoltaic system	I	I	C
4.12.2	Explain how stand-alone photovoltaic systems are sized	I	I	C
4.12.3	Explain how stand-alone photovoltaic systems are hybridized with a generator	I	I	C
4.12.4	Explain the theory of operation of stand-alone photovoltaic systems	I	I	C
4.12.5	List the safety issues relating to stand-alone photovoltaic systems	I	I	C
4.13	Describe grid-tied photolytic systems	I	I	C
4.13.1	Design a grid-tied photolytic system	I	I	C
4.13.2	Explain how grid-tied photolytic systems are sized	I	I	C
4.13.3	Explain how grid-tied photolytic systems are hybridized with a generator	I	I	C
4.13.4	Explain Net-metering	I	I	C
4.13.5	Explain the theory of operation of grid-tied photolytic systems	I	I	C
4.13.6	List the safety issues relating to grid-tied photolytic systems	I	I	C
4.14	Explain the following aspects of photovoltaic systems installation:	I	I	C
4.14.1	Conduct a site evaluation	I	I	C
4.14.2	Photovoltaic array installation	I	I	C
4.14.3	Battery installation	I	I	C
4.14.4	Controller installation	I	I	C
4.14.5	Inverter installation	I	I	C
4.14.6	System wiring installation	I	I	C
4.14.7	Hook up, operational check, and commissioning	I	I	C
4.14.8	Documentation	I	I	C
4.14.9	Safety issues of installation	I	I	C
4.14.10	Cost analysis	I	I	C
4.15	Explain maintenance and troubleshooting principles used with installed photovoltaic	I	I	C
5.0	**WIND ENERGY**	**20%**	**10%**	**5%**
5.1	Describe the system components necessary for small wind energy systems	I	I	C
5.2	Describe the key types of small wind energy systems that could be used to provide	I	I	C
5.3	Explain the fundamentals of producing energy with small wind energy systems	I	I	C

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
	5.4	Explain the procedure for collecting site data needed to conduct a site analysis before installing a small wind energy system	I	I	C
	5.5	Explain the procedure for conducting a site analysis before installing a small wind energy	I	I	C
	5.6	Describe the following attributes concerning small wind energy system:	I	I	C
		5.6.1 Types	I	I	C
		5.6.2 Characteristics	I	I	C
		5.6.3 Performance	I	I	C
		5.6.4 Theory of operation	I	I	C
		5.6.5 Safety	I	I	C
	5.7	Describe the following steps in small wind energy system installation:	I	I	C
		5.7.1 Site evaluation	I	I	C
		5.7.2 Wind energy generator installation	I	I	C
		5.7.3 Battery installation	I	I	C
		5.7.4 Controller installation	I	I	C
		5.7.5 Inverter installation	I	I	C
		5.7.6 System wiring installation	I	I	C
		5.7.7 Hook up, operational check, commissioning	I	I	C
		5.7.8 Documentation	I	I	C
		5.7.9 Safety issues of installation	I	I	C
		5.7.10 Cost analysis	I	I	C
	5.8	Explain maintenance and troubleshooting principles used with installed small wind energy systems	I	I	C
6.0	**MICROHYDRO**		**5%**	**5%**	**5%**
	6.1	Describe the system components necessary for microhydro energy systems	U	U	I
	6.2	Describe the various types of microhydro energy systems that could be used to provide electricity to applications less than 100KW	U	U	I
	6.3	Explain the fundamentals of producing energy with microhydro energy systems	U	U	I
	6.4	Explain the procedure for collecting site data needed to conduct a site analysis before installing a microhydro energy system	U	U	I
	6.5	Explain the procedure for conducting a site analysis before installing a microhydro system	U	U	I

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
6.6	Describe the following attributes concerning a microhydro energy system:				
	6.6.1	Types	U	U	I
	6.6.2	Characteristics	U	U	I
	6.6.3	Performance	U	U	I
	6.6.4	Theory of operation	U	U	I
	6.6.5	Safety	U	U	I
6.7	Describe the following steps to microhydro energy system installation:				
	6.7.1	Site evaluation	U	U	I
	6.7.2	Microhydro energy generator installation	U	U	I
	6.7.3	Battery installation	U	U	I
	6.7.4	Controller installation	U	U	I
	6.7.5	Inverter installation	U	U	I
	6.7.6	System wiring installation	U	U	I
	6.7.7	Hook up, operational check, commissioning	U	U	I
	6.7.8	Documentation	U	U	I
	6.7.9	Safety issues of installation	U	U	I
	6.7.10	Cost analysis	U	U	I
6.8	Explain maintenance and troubleshooting principles used with installed microhydro energy systems		U	U	I
7.0	**PASSIVE SOLAR**		**10%**	**10%**	**5%**
7.1	Describe the concept of passive solar heating		U	U	I
	7.1.1	State the theory of operation for the following:	U	U	I
		7.1.1.1 Thermal mass	U	U	I
		7.1.1.2 Thermal lag	U	U	I
		7.1.1.3 Thermal cycle	U	U	I
		7.1.1.4 Direct gain	U	U	I
		7.1.1.5 Indirect gain	U	U	I
		7.1.1.6 Trombe walls	U	U	I
		7.1.1.7 Isolated solar gain	U	U	I

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
	7.1.2	Explain how to conduct a site evaluation for the use of passive heating		U	U	I
	7.1.3	Describe solar heating design procedures		U	U	I
	7.1.4	Describe the steps to solar heating installation		U	U	I
	7.1.5	Explain the safety issues relating to passive heating		U	U	I
7.2	Describe the concept of solar lighting			U	U	I
	7.2.1	State the theory of daylighting for the following:		U	U	I
		7.2.1.1	Reflected	U	U	I
		7.2.1.2	Solar tubes	U	U	I
		7.2.1.3	Skylights	U	U	I
		7.2.1.4	Clerestory windows	U	U	I
7.3	Describe the concept of solar cooling			U	U	I
	7.3.1	Explain the theory of solar cooling for the following:		U	U	I
		7.3.1.1	Reflected	U	U	I
		7.3.1.2	Convective cooling	U	U	I
		7.3.1.3	Radiative cooling systems (evaporation)	U	U	I
8.0	**SOLAR THERMAL**			**10%**	**10%**	**5%**
8.1	Describe the concept of active solar heating				U	I
	8.1.1	State the theory of operation for the following:			U	I
		8.1.1.1	Thermal mass		U	I
		8.1.1.2	Thermal lag		U	I
		8.1.1.3	Radiant floor heating		U	I
	8.1.2	Explain how to conduct a site evaluation for the use of solar heating			U	I
	8.1.3	Describe solar heating design procedures			U	I
	8.1.4	Describe the steps to solar heating installation			U	I
	8.1.5	Explain the safety issues relating to passive heating			U	I
8.2	Describe the concept of solar water heating			U	U	I
	8.2.1	State the theory of operation of solar water heating		U	U	I
	8.2.2	Explain how to conduct a site evaluation for the use of solar water heating		U	U	I
	8.2.3	Design the following solar water heating systems:		U	U	I

Key: U - Useful I - Important C - Critical

				Level 1	Level 2	Level 3
		8.2.3.1	Flat plate	U	U	I
		8.2.3.2	Evacuated tube	U	U	I
		8.2.3.3	Compact systems	U	U	I
		8.2.3.4	Closed loop systems	U	U	I
		8.2.3.5	Pumped systems	U	U	I
		8.2.3.6	Glazed Collector systems	U	U	I
	8.2.4	Describe solar water heater installation procedures			U	I
	8.2.5	Explain the safety issues relating to solar water heating			I	C
8.3	Describe the concept of solar pool heating				U	I
	8.3.1	State the theory of operation of solar pool heating			U	I
	8.3.2	Explain how to conduct a site evaluation for the use of solar pool heating			U	I
	8.3.3	Describe solar pool heating designs			U	I
	8.3.4	Describe solar pool heating installation procedures			U	I
	8.3.5	Explain the safety issues relating to solar pool heating			U	I
9.0	**GEOTHERMAL**			**5%**	**5%**	**5%**
9.1	Describe the concept of geothermal heating and cooling			U	I	C
9.2	Explain the theory of operation of the following Earth loops			U	I	C
	9.2.1	Horizontal loops		U	I	C
	9.2.2	Vertical loops		U	I	C
	9.2.3	Pond/lake loops		U	I	C
	9.2.4	Open loops (well-water systems)		U	I	C
9.3	Explain the theory of operation of heat pumps				I	I
	9.3.1	Air source			I	I
	9.3.2	Ground source			I	I
	9.3.2	Absorption			I	I
9.4	Describe codes as they affect the design and installation of geothermal heating and cooling systems				I	I
9.5	Site evaluation				I	I
9.6	Explain the procedures for installing geothermal heating and cooling systems for the				I	I

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
	9.6.1	Installations for new structures		I	I
	9.6.2	Retrofit installations		I	I
9.7		Explain the safety issues relating to geothermal heating and cooling		I	I
10.0	**ADDITIONAL TECHNOLOGIES**		**5%**	**5%**	**5%**
10.1		Residential and Small Business Fuel Cells	U	I	I
	10.1.1	Describe the system components for fuel cells	U	I	I
	10.1.2	Describe the various types of fuels cells that could be used to provide electricity	U	I	I
	10.1.3	Explain the fundamentals of producing energy with fuel cells	U	I	I
	10.1.4	Describe the following attributes concerning residential fuel cells:	U	I	I
		10.1.4.1 Types	U	I	I
		10.1.4.2 Characteristics	U	I	I
		10.1.4.3 Performance	U	I	I
		10.1.4.4 Theory of Operation	U	I	I
		10.1.4.5 Safety	U	I	I
10.2		Stirling			
	10.2.1	Describe the system components necessary for Stirling energy systems		U	U
	10.2.2	Describe the various types of Stirling energy systems that could be used to provide electricity to the home		U	U
	10.2.3	Explain the fundamentals of producing energy with Stirling energy systems		U	U
10.3		Light Emitting Diode (LED) Luminaries		U	U
	10.3.1	Describe the operation of the LED		U	U
	10.3.2	Describe the operation of the LED driver electronics:		U	U
		10.3.2.1 Buck inverters		U	U
		10.3.2.2 Constant current sources		U	U
		10.3.2.3 Power factor correction		U	U
	10.3.3	Contrast LED luminaries with compact flourescent and incandescant technologies		U	U
10.4		Tankless Hot Water Heaters		U	U
	10.4.1	Describe the basic operation and advantages		U	U

Key: U - Useful I - Important C - Critical

			Level 1	Level 2	Level 3
	10.4.2	Contrast single-point, point of use, and whole-house systems		U	U
	10.4.3	Explain the electrical operation:		U	U
		10.4.3.1 Triac AC power control		U	U
		10.4.3.2 Zero-crossing AC power control		U	U
11.0	**SYSTEMS INTEGRATION**		0%	5%	10%
	11.1	Use renewable energy management and residential integration software		I	C
	11.2	Use computer assisted drawing software for residential integrators		I	C
	11.3	Use renewable energy site analyses and design software for residential integrators		I	C
	11.4	Use site feasibility study software for residential integrators		I	C
12.0	**DEVELOPING THE SYSTEM DESIGN & PROPOSAL (HANDS-ON)**		0%	5%	20%
	12.1	Develop a material list for a residential renewable energy project		I	C
	12.2	Develop a labor estimate for a residential renewable energy project		I	C
	12.3	Develop plans for a residential renewable energy project		I	C
	12.4	Explain the procedure for obtaining permits for a residential renewable energy project		I	C
	12.5	Develop a work schedule for a residential renewable energy project		I	C
	12.6	Calculate the cost for a residential renewable energy project		I	C
	12.7	Calculate the price for a residential renewable energy project		I	C
	12.8	Write the contract for a residential renewable energy project		I	C
	12.9	Present the proposal to a customer for a residential renewable energy project		I	C
RENEWABLE ENERGY INTEGRATOR MAJOR CATEGORIES WEIGHTS TOTALS			100%	100%	100%

-end-

