Alternative Energy
SW INSTALLER
Job Training Guide
SCHOOL VERSION

Good science, good engineering, good technology and good business practices delivered by ethical, well-trained, and motivated people will lead the way to energy independence.

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

Alternative Energy
Career Path Milestones

Small Wind Installer (SWI)

Level One Apprentice

- Attend an ETAI-approved school
- Pass Level One written exam and hands-on assessment

OR

- OJT with an ETAI-approved employer for a minimum of 12 months
- Pass the Level One written exam

Upon completion of the above, submit your Small Wind OJT JTG package signed-off by your ETAI-approved trainer to ETAI.

Level Two Specialist

- Hold a Level 1 Small Wind Apprentice certification
- OJT with an ETAI-approved employer for a minimum of 18 months
- Pass the ETAI EM1-DC, EM2-AC, and the Level Two written exams
- Show proof of being either a licensed or journeyman electrician (or its equivalent or higher) as determined by the municipality, state or province in which you are employed

Upon completion of the above, submit your Small Wind OJT JTG package signed-off by your ETAI-approved trainer to ETAI.

Level Three Technician

- Hold a Level 2 Small Wind Specialist certification
- OJT with an ETAI-approved employer for a minimum of 36 months
- Pass the ETAI Level Three exam

Upon completion of the above, submit your Small Wind OJT JTG package signed-off by your ETAI-approved trainer to ETAI.

	SCALE VALUE	PROFICIENCY CODE KEY
TASK PERFORMANCE LEVELS	**1**	Can do simple parts of the task. Needs to be told or shown how to do most of the task. **(EXTREMELY LIMITED)**
	2	Can do most parts of the task. Needs help only on hardest parts. **(PARTIALLY PROFICIENT)**
	3	Can do all parts of the task. Needs only a spot check of completed work. **(COMPETENT)**
	4	Can do the complete task completely and accurately. Can tell or show others how to do the task. **(HIGHLY PROFICIENT)**
TASK KNOWLEDGE LEVELS	**a**	Can name parts, tools, and simple facts about the task. **(NOMENCLATURE)**
	b	Can determine step-by-step procedures for doing the task. **(PROCEDURES)**
	c	Can Identify why and when the task must be done and why each step is needed. **(OPERATING PRINCIPLES)**
	d	Can predict, isolate, and resolve problems about the task. **(ADVANCED THEORY)**
SUBJECT KNOWLEDGE LEVELS	**A**	Can identify basic facts and terms about the subject **(FACTS)**
	B	Can identify relationship of basic facts and state general principles about the subject. **(PRINCIPLES)**
	C	Can analyze facts and principles and draw conclusions about the subject. **(ANALYSIS)**
	D	Can evaluate conditions and make proper decisions about the subject. **(EVALUATION)**

***** A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (**Examples: b and 1b**)

****** A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

— Not required for this Level.

+ Reserved for future use.

ALTERNATIVE ENERGY TECHNOLOGY - 2009
SMALL WIND ENERGY GENERATION INSTALLER

The following is a listing of the major categories and items considered necessary to be included in a course of study directed towards the education of workers needed in the small wind installation industry.

The Small Wind Installer will be required to properly perform the following:

- Identify major components of a Small Wind System
- Identify types of SW systems
- Identify mounting and turbine types, and characteristics
- Determine proper Installation for turbine types
- Install basic small wind turbine components
- Determine proper site location
- Understand Basic performance characteristics
- Understand basic systems sizing methods
- Troubleshoot basic systems problems and installation errors

Understand safe working practices for:

- Tower Safety
- Working aloft (ladder, roof, lanyard and harness)
- Working with hand and basic power tools
- Eye and ear protection
- Electrical safety

Certification examination questions and skill demonstrations (when required) are based on the topical outline provided in the ITEMS LIST. The specific COMPETENCIES are derived from the ITEMS LIST.

There are 11 general categories of required knowledge and skills. The ITEM LISTING defines the particular content areas in which the certification candidate must demonstrate proficiency.

SMALL WIND (SW) ENERGY GENERATION INSTALLER

MAJOR CATEGORIES:

1.0 THEORY OF WIND ENERGY	Level 1	Level 2	Level 3
1.1 Wind Characteristics	A	B	C
1.2 Weather Patterns	A	B	C
1.3 Atmospheric Structure	A	B	C
1.4 Metrological Tables, Reports, and Forecast	A	C	D
1.5 Wind Measurements	A	C	C
1.6 Physics of Wind Energy			
1.6.1 Aerodynamics	A	B	C
1.6.2 Drag Force	A	B	C
1.6.3 Energy	A	B	C
1.6.4 Force	A	B	C
1.6.5 Power	A	B	C
1.6.6 Torque	A	B	C
1.6.7 Radial Velocity	A	B	C
1.7 Environmental Impact			
1.7.1 Noise	A	B	C
1.7.2 Wildlife	A	B	C
1.7.3 Aesthetics	A	B	C
1.7.4 Economic	A	B	C
1.7.5 RFI/EMI	A	B	C
2.0 SITE EVALUATION			
2.1 Perform a Local Code, Ordinance, and Restriction search for a proposed site	2b	3c	3c
2.2 Conduct a metrological records search and develop an energy feasibility analysis for the proposed site.	2b	3c	3c
2.3 Conduct an aesthetic analysis for a proposed site.	2b	3c	3c
2.4 Conduct a noise analysis for a proposed site.	2b	3c	3c
2.5 Conduct a RFI analysis for a proposed site.	2b	3c	4d
2.6 Determine the ground suitability to support the indicated mounting.	2b	3c	4d
2.7 Determine mounting type for a proposed site	2b	3c	4d
2.8 Determine the power capacity necessary to support the customer's needs.	2b	3c	4d
2.9 Determine and locate mandatory setbacks	2b	3c	4d
2.10 List the Local, State, and National incentives for a proposed site.	2b	3c	4d
2.11 Develop a customer proposal for the installation of a proposed site.	--	3c	4d
2.12 Obtain the Local Permit for Installation	--	3c	4d

3.0 SAFETY			
3.1 Describe the safety concerns and procedures for:	D	D	D
3.1.1 Fire	D	D	D
3.1.2 Electrical	D	D	D
3.1.2.1 Touch Potential	D	D	D
3.1.2.2 Grounding and Bonding	D	D	D
3.1.3 Mechanical	D	D	D
3.1.4 Chemical	D	D	D
3.1.5 Heights	D	D	D
3.1.5.1 Ladder	D	D	D
3.1.5.1.1 Self-supporting	D	D	D
3.1.5.1.2 Extension	D	D	D
3.1.5.2 Lanyard and Harness	D	D	D
3.1.5.3 Personal Fall-Arrest Systems (PFAS)	D	D	D
3.1.6 Lightning	D	D	D
3.1.7 Equipment	D	D	D
3.1.7.1 Power Tool Safety	D	D	D
3.1.7.2 Hand Tool Safety	D	D	D
3.1.8 Materials Handling	D	D	D
3.2 Key OSHA Requirements	D	D	D
3.2.1 29 CFR 1910 Occupational Safety and Health Standards	D	D	D
3.2.2 29 CFR 1926 Safety and health regulations for Construction	D	D	D
3.2.3 Avoiding High Voltage	D	D	D
3.2.4 Site Safety (working hazards)	D	D	D
3.2.5 First Aid	D	D	D
3.2.5.1 Sunburn	D	D	D
3.2.5.2 Electrocution	D	D	D
3.2.5.3 CPR	D	D	D
3.3 Battery Installation Safety	D	D	D
3.3.1 Special Personal Eyewear Protection	D	D	D
3.3.2 Acid Mitigation	D	D	D
4.0 SMALL WIND ELECTRICAL GENERATION SYSTEM THEORY			

4.1 Describe the Conversion Process	B	C	D
4.2 Describe the theory of operation for the following types of Small Wind Electrical Generation Systems:			
4.2.1 Wind Turbines	A	B	C
4.2.1.1 Vertical	A	B	C
4.2.1.2 Horizontal	A	B	C
4.2.1.3 Shrouded	A	B	C
4.2.2 Inverters	B	C	D
4.2.2.1 Grid-tied	B	C	D
4.2.2.2 Non Grid-tied	B	C	D
4.2.3 Controllers	B	C	D
4.2.4 Storage devices	B	C	D
4.2.5 Blades	B	C	D
4.2.6 Gearboxes	A	C	D
4.2.6.1 Fixed Speed	A	C	D
4.2.6.2 Variable Speed	A	C	D
4.2.7 Hydraulic Systems	A	C	D
4.2.8 Brakes	A	C	D
4.2.9 Bearings	A	C	D
4.2.10 Servo Positioning Systems	A	C	D
4.2.11 Sensors	A	C	D
4.2.12 Pitch Control Systems	B	C	D
4.2.13 Transformers	C	C	D

4.0 SMALL WIND ELECTRICAL GENERATION SYSTEM THEORY Cont'd	Level 1	Level 2	Level 3
4.2.14 Interconnecting Wiring	B	C	D
4.2.15 Interface	B	C	D
4.2.16 Nacelles	B	C	D
4.2.17 Motors	C	C	D
4.2.18 Motor Controls	C	C	D
4.2.19 Meters	C	C	D
4.2.20 Disconnects	B	C	D
4.2.21 PLCs	B	C	D
4.2.22 Instrumentation	B	C	D
4.2.23 Bonding and Grounding	C	C	D
4.2.24 Voltage Regulators	B	C	D
4.2.25 Wind Turbine Governor	C	D	D
4.2.26 Lightning Protection	C	D	D
4.2.27 Yaw Systems	B	C	D
4.2.28 Mounts	C	D	D
4.2.28.1 Pole	C	D	D
4.2.28.2 Lattice	C	D	D
4.2.29 Guy Wires	C	D	D
4.2.30 Protective Anti-Climbing Fencing	C	D	D
4.2.31 Utility Buildings	A	C	D
4.2.32 Flux magnitude and angle controller (FMAC)	A	B	C
4.2.33 Fault Ride-Through (FRT)	A	B	C
4.2.34 Converters	A	B	C
4.2.34.1 Generator-Side Converter (GSC)	A	B	C
4.2.34.2 Network-Side Converter (NSC)	A	B	C
4.2.34.3 Voltage Source Converter (VSC)	A	B	C
4.2.34.4 Power Converters	A	B	C
4.2.35 Thyristor-Switched Capacitor (TSC)	A	B	C
4.2.36 Fixed Shunt-Connected Capacitors	A	B	C
4.2.37 Isolated-Gate Bipolar Transistor (IGBT)	A	B	C
4.2.38 Soft-Starter	A	B	C
4.2.39 Crow-Bar	A	B	C

4.0 SMALL WIND ELECTRICAL GENERATION SYSTEM THEORY Cont'd	A	B	C
4.2.40 Reactive Power Compensation Equipment	A	B	C
4.2.41 RC Snubber Circuit	--	B	C
4.2.42 Firing Pulse Generator	--	B	C
5.0 CODES AND STANDARDS			
5.1 IEC 1400-2 Small Wind Turbine Systems	A	B	B
5.2 IEC 1400-11 Acoustic Emission Measurements	A	B	B
5.3 IEC 1400-12-1 Performance Measurements	A	B	C
5.4 IEC 1400-13 Structural Loads Measurements	A	B	C
5.5 IEC 1400-14 Decoration of Apparent Sound Power Level and Tonality	A	B	C
5.6 IEC 1400-21 Power Quality Measurements	A	B	C
5.7 IEC 1400-22 Wind Turbine Certification	A	C	D
5.8 IEC 1400-23 Blade Structural Testing	A	A	B
5.9 AGMA 6006-A03 Standard Design and Specification of Gearboxes for Wind Turbines	A	A	B
5.10 IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems	A	C	D
5.11 NEC Article 100 General Wiring	B	C	D
5.12 NEC Article 250 Grounding and Bonding	C	D	D
5.13 NEC Article 445 Generators	B	C	D
5.14 NEC Article 685 Integrated Electrical Systems	B	C	D
5.15 NEC Article 694 Small Wind Electric Systems	B	C	D
5.16 NEC Article 700 Emergency Systems	B	C	D
5.17 NEC Article 705 Interconnected Electric Power Production Sources	C	D	D
5.18 NFPA 500 Building Construction and Safety Code	B	C	D
5.19 NFPA 900 Building Energy Code	B	D	D
5.20 UL 1741 Standards for Static Inverters, Converters & Controllers for use in Independent Power Systems	B	C	D
5.21 ASSE A10.21-20xx American National Standard for the Safe Construction and Demolition of Wind Generation/Turbine Facilities	A	B	D
5.22 FAA Form 7460	A	B	D
5.23 FAA Wind Letter Volume 22, Issue 8	A	B	D
6.0 APPLIED CALCULATIONS AND FORMULAS			

6.1 Speed	2b	2b	2b
6.2 Power	3c	3c	3c
6.3 Wind Shear	2b	3c	3c
6.4 Power Density	2b	3c	3c
6.5 Swept Area	2b	3c	3c
6.6 Ohms Law	4d	4d	4e
6.7 Series and Parallel Calculations	4d	4d	4e
6.8 Kirchhoff's Rules	4d	4d	4e
6.9 Raceway and Box Calculations	1a	3c	3c
6.10 Conductor Sizing and Protection Calculations	1a	3c	3c
6.11 Voltage-Drop Calculations	1a	3c	3c
6.12 Transformer Calculations	4d	4d	4d
6.13 Performance and Efficiency Ratings	4d	4d	4d
7.0 ESTIMATING HOME ENERGY NEEDS			
7.1 Energy Conservation	2b	3c	3c
7.1.1 Identify electrical appliances that may be replaced by more energy efficient ones	2b	3c	3c
7.1.2 Explain the appliance Energy Star rating system	2b	3c	3c
7.2 Electrical Load Requirements	2b	4c	4c
7.2.1 Compiling Load Calculation Information	3c	4c	4c
7.2.1.1 Grid-Tied	3c	4c	4c
7.2.1.2 Off Grid	3c	4c	4c
7.2.2 Standard load calculation method	3c	4c	4c
7.2.3 Optional load calculation method	3c	4c	4c
7.2.4 Explain how to use a load summary worksheet	A	C	C
7.2.5 Identify peak consumption periods	3c	4c	4c
7.2.6 Identify the maximum projected load (off grid only)	3c	4c	4c
7.2.7 Calculate the whole home monthly and yearly projected load	3c	4c	4c
8.0 PLANS AND BLUE PRINTS			
8.1 Elevation drawings	A	B	C
8.2 Grid lines	A	B	C
8.3 Legend	A	B	C
8.4 Revision Block	A	B	C
8.5 Scale	A	B	C

8.6 Schematics	A	B	C
8.7 Sectional Drawings	A	B	C
8.8 Specifications	A	B	C
8.9 Structural drawings	A	B	C
8.10 Symbols	A	B	C
8.11 Title block	A	B	C
9.0 INSTALLATION			
9.1 Site Preparation	2b	4d	4d
9.2 Preparing the List of Materials	2b	3c	4d
9.3 Soil Testing	A	C	D
9.4 Foundations Construction	A	C	D
9.5 Mount Installation	2b	3c	4d
9.5.1 Pole	2b	3c	4d
9.5.1.1 Assembly	2b	3c	4d
9.5.1.2 Connecting to the Foundation	2b	3c	4d
9.5.1.3 Erecting	2b	3c	4d
9.5.1.4 Guying	2b	3c	4d
9.5.2 Lattice	2b	3c	4d
9.5.2.1 Assembly	2b	3c	4d
9.5.2.2 Connecting to the Foundation	2b	3c	4d
9.5.2.3 Erecting	2b	3c	4d
9.5.2.4 Guying	2b	3c	4d
9.6 Installing the Turbine to the Mount	2b	3c	4d
9.7 Running the Transmission Wiring	3c	3c	4d
9.8 Connectorization and Cable Termination	3c	3c	4d
9.9 Mounting and Connecting the Inverter	2b	3c	4d
9.10 Mounting and Connecting the Controller	2b	3c	4d
9.11 Installing the Disconnects	2b	3c	4d
9.12 Connecting to the Home Wiring System	2b	3c	4d
9.13 Connecting to the Grid	--	3c	4d
9.14 Installing the Storage Device	2b	3c	4d

9.0 INSTALLATION Cont'd.			
9.14.1 Battery	2b	3c	4d
9.14.2 Kinetic	--	2b	3c
9.14.2.1 Compressed Air	--	2b	3c
9.14.2.2 Flywheel	--	2b	3c
9.14.2.3 Hydro	--	2b	3c
9.14.3 Magnetic	--	2b	3c
9.14.4 Capacitive	1a	3c	4d
9.15 Installing and connecting Bonding and Grounding	2b	3c	4d
9.16 Installing and Connecting Lighting Protection Devices	2b	3c	4d
9.17 Setting up Net Metering	2b	3c	4d
9.18 Synchronization	--	3c	4d
9.19 Operational Check-Out	2b	3c	4d
9.20 Preparing the Grid connection Documentation	1a	3c	4d
9.21 Complete the NEG (Net Excess Generation) contract.	--	3c	4d
9.22 Commissioning	A	3c	4d
10.0 SMALL WIND MAINTENANCE			
10.1 Inspection	2b	3c	4d
10.2 Repair	3c	3c	4d
10.3 Corrosion Control	3c	3c	4d
10.4 Waterproofing	3c	3c	4d
10.5 Time Change Items	3c	3c	4d
10.6 Lubrication and Oil Change	3c	3c	4d
10.7 Tools	3c	3c	4d
10.8 Test Equipment	3c	3c	4d
10.9 Blade Balancing	3c	3c	4d
10.10 Shaft Alignment	3c	3c	4d
10.11 Troubleshooting	3c	4d	4d

11.0 TERMINOLOGY			
11.1 Demonstrate an understanding and the proper use of the following terms, within the context of Small Wind energy, to the level coded herein:			
11.1 Airfoil	B	B	B
11.2 Air Gap	B	B	B
11.3 Anemometer	B	C	D
11.4 Angle of Attack	B	C	C
11.5 Area of a Circle	B	B	B
11.6 Axial Alternator	B	B	B
11.7 Betz Coefficient	B	C	D
11.8 Bridge Rectifier	C	C	D
11.9 Chord	B	C	C
11.10 Coercivity	--	A	A
11.11 Cogging	--	A	A
11.12 Commutator	B	C	C
11.13 Cowling	B	B	B
11.14 Cut-In	B	C	D
11.15 Darrieus	--	A	A
11.16 De-loaded	A	C	D
11.17 Delta	B	C	D
11.18 Direct Drive (DD) Technology	B	C	C
11.19 Double Fed Induction Generator (DF)	B	C	C
11.20 Downwind	B	C	D
11.21 Drag	B	C	D
11.22 Dump Load	B	C	D
11.23 Duty Cycle	B	C	D
11.24 Dynamo	A	A	A
11.25 Eddy Currents	B	C	D
11.26 Excitation	A	B	C
11.27 Ferrite Magnets	--	B	C
11.28 Flicker	A	B	C
11.29 Freewheeling	B	C	C
11.30 Full Conversion (FC) Drive Train	B	C	C
11.0 TERMINOLOGY Cont'd.			

11.31 Furling	B	C	D
11.32 Furling Tail	B	C	D
11.33 Gauss	--	C	C
11.34 Guy Radius	B	C	D
11.35 H-Rotor	A	A	A
11.36 Harmonic Distortion	A	B	C
11.37 HAWT (See Horizontal Axis Wind Turbine)	A	A	A
11.38 Horizontal Axis Wind Turbine	A	B	B
11.39 Hysteresis Switching	--	B	C
11.40 Induction Motor	A	B	C
11.41 Leeward	A	A	A
11.42 Lenz Effect	A	B	C
11.43 Lift	A	B	B
11.44 Maximum Energy Product	--	B	C
11.45 MegaGauss Oersted	--	B	C
11.46 Moment (Force)	A	B	C
11.47 Nacelle	A	A	A
11.48 Permanent Magnet Alternator	A	A	A
11.49 Pillow Blocks	A	B	C
11.50 Pitch	A	A	A
11.51 Pulse Width Modulation	A	B	C
11.51.1 Carrier-based (CB-PWM)	--	A	B
11.51.2 None Regular Sampled (NRS-PWM)	--	A	B
11.51.3 Regular Sampled (RS-PWM)	--	A	B
11.51.4 Switching Frequency Optimal (SFO-PWM)	--	A	B
11.51.5 Selective Harmonic Elimination (SHEM-PWM)	--	A	B
11.52 Rated Power Output	A	B	D
11.53 Root	A	B	C
11.54 Rotor	A	B	B
11.55 Rotor Speed Runaway	B	C	D
11.56 Savonius	--	B	C
11.57 Servo Motor	A	B	C
11.0 TERMINOLOGY Cont'd.			

11.58 Setting Angle	B	C	C
11.59 Shunt	A	B	C
11.60 Shunt Regulator	A	B	C
11.61 Slip Ring	B	C	C
11.62 Star	B	C	D
11.63 Start-Up	B	C	D
11.64 Stator	A	A	A
11.65 SuperGEAR^{tm} (SG)	B	C	C
11.66 Tail Boom	A	B	C
11.67 Tape Drive Motor	A	A	A
11.68 Taper	A	B	C
11.69 Thrust	A	B	C
11.70 Thrust Bearing	B	C	C
11.71 Tilt-Up	B	C	C
11.72 Tip Speed Ratio	B	C	D
11.73 Torque	B	B	C
11.74 Trailing Edge	B	B	C
11.75 Twist	B	B	C
11.76 Upwind	B	B	C
11.77 Vane	B	B	B
11.78 Variable Pitch	B	C	D
11.79 Vertical Axis Wind Turbine	B	C	D
11.80 Volt-Amp	C	C	C
11.81 Watt	C	C	C
11.82 Wind Speed	B	C	C
11.81.1 Cut-in	B	C	C
11.81.2 Rated	B	C	C
11.81.3 Cut-out	B	C	C
11.83 Windward	A	B	B
11.84 Yaw	A	B	B
11.85 Yaw Axis	A	B	B
END OF SMALL WIND (SW) ENERGY GENERATION INSTALLER COMPETENCIES			