

Workforce Training for Green and Energy Technology Related Jobs

What Is It, How Does It Differ From Conventional Training, and What Is Needed To Succeed?

The economic recovery act and many initiatives prior to it have identified substantial growth of jobs in energy and green technology related fields as a quick and sustainable way to stabilize employment today and grow good quality domestic jobs in a world economy. Although there have been several worthy workforce training initiatives in green technologies, there is not a clear template of what effective workforce training encompasses, for example, what constitute the generic, fundamental skills that need to be taught to all in the workforce, and what are the skills that are sector specific for which training may need to vary by geographic area of the workforce. This white paper provides a framework for effective training for the workforce in green and energy technologies.

Green and energy technologies are merging into a vision of the future of a sustainable and efficient energy-based society. As shown by the table below, this means far less use of combustion processes that produces CO₂ emissions and more use of renewable sources of energy such as wind power and solar energy. It also means conversion of petroleum based fuels and lubricants to bio-fuels and bio-lubricants, and the development of lubricants and materials that reduce friction and wear to improve the efficiency of energy utilization. For industrial processes, it means applying best practices that reduce the utilization of water, the production of pollution, and the adverse impact on the environment.

Energy & Power	Materials & Building	Transportation & Logistics	Air & Water	Manufacturing	Process Industries
<ul style="list-style-type: none"> • Bio-Fuels • Renewable Generation • Energy Storage • Energy Infrastructure Management • Smart Grid (Efficient Transmission) 	<ul style="list-style-type: none"> • Bio-Based Materials • Materials to Minimize Energy Loss • Materials Recovery and Recycling • Energy Efficient Materials Processing • Sustainable Design 	<ul style="list-style-type: none"> • Utilization of Alternative Fuels • Water Based Lubricants • Friction and Wear Reduction • Logistics Optimization Software Systems 	<ul style="list-style-type: none"> • Water Quality Testing • Water Purification • Water Recycling • Water Management • Air Quality Testing • Indoor Air Quality Management • Heating and Ventilation 	<ul style="list-style-type: none"> • Tool and Die Management • Greater Utilization of Net Shape Processes • Improved Machinability • Quality Improvement (Minimization of Scrap) • Water-Based Cutting Fluids 	<ul style="list-style-type: none"> • Minimize Water Usage • Improved Catalysts and Less Heat Utilization • Improved Efficiency of Rotating Machinery • Minimization of Scrap

A study of job opportunities for the green economy found that although going green will certainly produce new types of jobs, “the vast majority of green jobs are in the same areas of employment that people already work in today, in every region and state of the country. For example, constructing wind farms creates jobs for sheet metal workers, machinists and truck drivers, among many others. Increasing

the energy efficiency of buildings through retrofitting relies, among others, on roofers, insulators and building inspectors. Expanding mass transit systems employs civil engineers, electricians, and dispatchers. So green jobs don't just mean new jobs—they can also mean greater job security for people who already work in these fields.”¹ This is clearly shown by the following table from this report.

Strategies for Green Economy Investments	Representative Jobs
Building Retrofitting	Electricians, Heating/Air Conditioning Installers, Carpenters, Construction Equipment Operators, Roofers, Insulation Workers, Carpenter Helpers, Industrial Truck Drivers, Construction Managers, Building Inspectors
Mass Transit	Civil Engineers, Rail Track Layers, Electricians, Welders, Metal Fabricators, Engine Assemblers, Production Helpers, Bus Drivers, First-Line Transportation Supervisors, Dispatchers
Energy-Efficient Automobiles	Computer Software Engineers, Electrical Engineers, Engineering Technicians, Welders, Transportation Equipment Painters, Metal Fabricators, Computer-Controlled Machine Operators, Engine Assemblers, Production Helpers, Operations Managers
Wind Power	Environmental Engineers, Iron and Steel Workers, Millwrights, Sheet Metal Workers, Machinists, Electrical Equipment Assemblers, Construction Equipment Operators, Industrial Truck Drivers, Industrial Production Managers, First-Line Production Supervisors
Solar Power	Electrical Engineers, Electricians, Industrial Machinery Mechanics, Welders, Metal Fabricators, Electrical Equipment Assemblers, Construction Equipment Operators, Installation Helpers, Laborers, Construction Managers
Cellulosic Biofuels	Chemical Engineers, Chemists, Chemical Equipment Operators, Chemical Technicians, Mixing and Blending Machine Operators, Agricultural Workers, Industrial Truck Drivers, Farm Product Purchasers, Agricultural and Forestry Supervisors, Agricultural Inspectors

¹ Job Opportunities for the Green Economy, Political Economy Research Institute, U of Mass., Amherst, June 2008.

Thus it can be seen that workforce training for a “green” economy is not so much about learning entirely new skills, but rather learning new methods and how to use new materials with existing skills. This point is the key difference and has extremely significant implications because conventional industrial practices are based on performing well established recipes whereas “green” industrial practices will require the workforce to evaluate and adopt new materials and methods. This key difference and its implications are explained and demonstrated by the following examples.

Energy Efficient Buildings

Renovating buildings to be energy efficient has been cited as “green” way to quickly create jobs while gaining long-term benefits relative to reducing energy consumption and increasing sustainability. Nonetheless, renovating (or building new) buildings to be energy efficient also demonstrates the serious problems that can result when the workforce is not properly trained to use the new materials and construction methods that are required.

Exterior insulation finishing systems (EIFS) are energy efficient and can be inexpensively applied to a wide range of new and existing buildings, including homes, apartments, condominiums, high-rise buildings, offices, malls, shopping centers, and hotels to name a few. In other words, EIFS represents the type of “green” technology that would likely be used today to improve the energy efficiency of buildings, and the history of EIFS demonstrates the critical importance of proper workforce training.

EIFS became very popular in the mid- 1970's due to the oil embargo and the resultant surge in interest in high energy efficiency wall systems, which EIFS provides. In the late 1980s problems started developing due to water leakage in EIFS-clad homes. This created a national controversy and numerous lawsuits. The problem was not that EIFS allowed water penetration. The problem was that barrier-type EIFS systems do not allow water that may penetrate the building envelope (due to leaks around windows and flashing for example) to escape, and many building with barrier type EIFS systems developed mold and rot problems that prevented inhabitation of the structures and that required complete removal of the buildings' exterior, removal of the mold, repair of rotted areas, and reapplication of an exterior covering. The EIFS itself was not leaking, but use of EIFS required use of improved construction practices in conventionally used components of the building, and in some cases the EIFS was improperly installed without the necessary means to allow water that did enter the structure to escape.

This situation is likely to be repeated today without proper workforce training in the green technologies that will be used to improve the energy efficiency of structures. Even today, the problems that occurred with EIFS still impede the use of this inexpensive, energy-efficient “green” technology. Proper workforce training and a certification program are needed to prevent repeats of EIFS type problems. Certification of designers, contractors, installers, and maintenance personnel would dramatically improve the quality of building construction and remediation, and this is critical since poor quality is completely inconsistent with achieving efficiency.

Although EIFS type situations will be encountered without proper workforce training, other factors also have to be addressed. Green construction and remediation requires a framework that evaluates what is inefficient for a given structure, the cost of the needed remediation, the cost savings that will result, the proper selection of materials and installation methods, proper installation techniques, and periodic inspection and maintenance. Workforce training for the full spectrum of issues involved in energy-efficient building construction and remediation would encompass the following topics.

- Building Assessment and Efficiency Remediation Design – Buildings differ in the ways they are designed and built, and in the ways they are inefficient. Wall or roof insulation can be inadequate, windows can provide inadequate insulation, windows and doors may leak air, heating and ventilation may be inadequate or non-uniform, lighting may be inefficient, etc. Each of these problems requires a different fix that has to also consider the existing materials and design of the building. To address this situation, a measurement-based building assessment needs to be conducted, and therefore the workforce needs to be trained in the underlying building design principles, assessment methodologies, and instrumentation (such as infra-red thermometers and air flow monitors) usage. Additionally, there needs to be an analysis of if the efficiency improvement techniques will produce poor indoor air quality, or excessive moisture retention in the building that will lead to mold formation. Training needs to be provided in the inspection techniques and instruments cited above and in the use and understanding of programs that are available to predict moisture buildup and HVAC requirements.
- Building Materials (Selection and Use) – Buildings utilize a wide variety of materials including wood, metals, and numerous synthetic materials, and new materials are being introduced at an increasing rate. There are often several types of materials to choose from for a given construction component, for example cellulose-based insulation or fiberglass insulation. Each material has advantageous and disadvantages that need to be considered in light of the geographic region, the type and design of the building, and the prevailing weather conditions. Training needs to be provided in the major classes of building materials, and in how to find and understand materials' properties and how to make appropriate selections. This topic is one of the critical topics to avoid more EIFS situations.
- Construction and Installation Practices – This topic is another one that is critical to avoid more EIFS situations. The reality is that construction is the last manufacturing sector that has no formal quality control, and construction and installation mistakes are the norm. Flashing provides an excellent and germane example. Proper flashing is critical to prevent water leaks where different materials and components meet, but failure to install flashing or to install it properly is common. Improper flashing is a severe problem with conventional construction and causes structural damage, but improper flashing can be a catastrophic problem with new energy efficient materials such as EIFS. Training needs to be provided in proper construction and installation practices with an emphasis on newer, more energy efficient materials. Training in quality assurance methods is also critically needed.

- Construction and Installation Safety – Job site safety is so critical that it should not be left out of any certification program, and this becomes even more important with new materials so that they are handled and installed safely. For example, it may be unhealthy to breathe the vapors of an adhesive, or to breathe fiber residue. Training in job site safety needs to be provided with an emphasis on using what has been learned from prior accidents and adverse health impacts.
- Inspection and Maintenance – It is one thing to improve energy efficiency and another thing to maintain that improvement. Inspection and maintenance are critical to maintaining energy efficiency. Training needs to be provided, especially relative to new materials and installation techniques, in inspection techniques and requirements, inspection intervals, and instrumentation, as well as in maintenance techniques with a special emphasis on what is different for new and emerging construction materials.

Alternative Fuels and Lubricants

Our second example is provided by bio-fuels and bio-lubricants, which are promising alternatives for petroleum-based fuels and lubricants. Bio-fuels and bio-lubricants will provide reduced emissions, lower the impact on the environment from their processing, be produced locally using American agricultural products, and lessen our dependence on foreign sources of petroleum. Much funding and work is being expended to develop bio-fuels and bio-lubricants technologies to the point at which practical products can be produced. Unfortunately, the mere availability of bio-fuels and bio-lubricants will not result in widespread usage because of the lack of training of the workforce to use these new fuels and lubricants.

Bio-fuels and bio-lubricants will not be introduced into the stream of commerce without being characterized to be compatible with materials in fuel systems and engines, and to be in compliance with applicable standards for use of fuels and lubricants in automotive engines and aerospace engines. The problems that can be encountered are demonstrated by the experience with the introduction of ethanol into gasoline.

Ethanol was originally introduced into fuels because the addition of a small amount of oxygen to the fuel helped raise its resistance to uncontrolled detonation and lowered emissions. Unfortunately, ethanol was introduced without adequate testing of its compatibility with engine components and with fuel storage and delivery systems. Many problems were encountered. These included embrittlement of elastomers used for seals and corrosion of metals in fuel systems. Ethanol blended gasoline is (unlike gasoline by itself) a magnet for water, and it also acts as a solvent for sludge and scale that may have accumulated in storage tanks over time. Before converting to ethanol blends, station owners had to remove all accumulated water, sludge, and scale in their tanks, but some did not because of poor training. For bio-fuels and bio-lubricants, there will need to be training in the handling of these products to prevent incompatibility with regular fuels in pipe lines and pumps, and algae growth.

What the ethanol experience shows is that the workforce needs to be trained to properly characterize new fuels, to be able to evaluate the suitability of new fuels, and to know how to handle new fuels. The same is true for lubricants. As in the building example described above, “green” technology requires the workforce to have more knowledge and operate at a higher level of understanding. A certification program in bio-fuels and bio-lubricants would cover the following needs.

- Understanding the Properties of Fuels and Lubricants – All engines require fuels and lubricants that meet specific requirements. For fuels, these factors include properties such as octane number (or cetane number for diesel), stability, viscosity, lubricity, safety, and materials compatibility. For lubricants, these factors include the viscosity over a temperature range, stability, and extreme pressure performance. The effect of fuels and lubricants on engine performance, durability and emissions is also important. All of these factors and considerations vary relative to the type of engine (gasoline, diesel, jet, etc.). Training is needed to be able to find and understand the requirements of various types of engines and the specifications of various types of fuel.
- Measuring Fuel and Lubricant Properties – Those who produce alternative fuels and lubricants face the challenge of measuring the properties that end users need to know. Some improvements to fuels that are being investigated may utilize mixing at the pump, and in this case fuel suppliers will also need to be able to measure the fuel properties that confirm mixing of the proper amounts of components. Training needs to be provided for the various test methods and equipment that are used to characterize fuels and lubricants, and in analyzing the data.
- Materials Compatibility – Training needs to be provided on understanding materials compatibility and on knowing where to find the information that is needed on compatibility. Bio-fuels and bio-lubricants may have different materials compatibilities than conventional fuels and lubricants.
- Storage and Delivery – Training is needed on the selection and maintenance of storage and delivery systems for fuels and lubricants. These systems are likely to change in some ways for proper handling of bio-fuels and bio-lubricants.

Proposed Partnership for Development and Delivery of Green Workforce Training

Workforce training for green technologies requires a mix of academics and industry experience that has not been required in the past. This indicates that new partnerships will be needed. Community colleges have been a critical component of workforce training, and they will continue to be a critical component. Nonetheless, it will become increasingly difficult to build relevant and current training facilities solely at academic institutions because of the rapidly evolving nature of green technologies. Historic areas of workforce training such as machining and heating and ventilation have stable technical bases.

Equipment and machines continually evolve, but workforce training can be provided based on well-established principles and with equipment and machines that are not the most current models. This is not the case for green technologies, where the principles are not fully developed and much of the equipment does not even exist today.

This situation will necessitate new partnerships between community colleges and non-traditional suppliers of workforce training. Waubonsee Community College (WCC) and the Institute of Tribology and Coatings (ITC), which is a not-for-profit R&D organization, and its for-profit scientific and engineering services subsidiary, ITC Experts, offer an excellent example of such a partnership. Located within a couple of miles of each other, WCC is an expert in the delivery of workforce training, and ITC and ITC Experts are core entities in green technologies, both their development and utilization.

WCC's has a long track record of providing workforce training services that are specifically tailored for each individual client. Workforce training is delivered at client sites or any of Waubonsee's facilities, and at a time most convenient to clients, 24 hours a day, 7 days a week. Waubonsee also offers many degree and certificate programs, and has the experience to design the types of programs that will be needed for student and workforce training in green technologies and industry. Waubonsee also provides excellent facilities that are conveniently located to the potential customer base in Northern Illinois.

ITC is a not-for-profit R&D organization that specializes in the sciences that form tribology, the study of lubrication, fuels, and materials as related to friction and wear. As such, ITC is an organization that is dedicated to developing the knowledge and standards that are required to put new green technologies in the stream of commerce, and to act as a clearinghouse of information that is central to student and workforce training in green technologies and industry. ITC operates as a collaborative of academic institutions, technical societies and trade associations, industrial organizations, and retired professionals. Co-located with its closest collaborator, the Falex Corporation, ITC operates a laboratory with the most comprehensive array of equipment related to the tribological testing of fuels, lubricants, and materials. Many of the ASTM tests in these areas are based on the equipment in this lab. ITC's for profit subsidiary, ITC Experts, provides scientific and engineering services to industry, and thus supplies to this partnership the specific knowledge of industry practices to take workforce training from the academic to the applicable. For example, ITC Experts provides consulting to contractors and building owners about problems with buildings such as proper flashing methods, requirements for properly installing EIFS, and inspection and analysis of water intrusion and other building envelope problems.

ITC can be a highly valuable strategic partner for Waubonsee. As a not-for-profit organization, training is an essential part of ITC's mission. ITC has won Illinois DECO grants to provide unique internships to students, and these programs have received accolades from the State. Many of ITC Experts' staff members are certified OSHA trainers and are routinely involved in industrial training and safety issues. ITC also provides extraordinary access to workplace insight as well as deep workforce training

experience and valuable facilities. For example, ITC and the Falex Corporation are highly involved in the Army's development of field instrumentation for diesel fuels, and Falex is a supplier of a full range of equipment for testing fuels for vehicles and aircraft. ITC has also invested heavily in developing innovative Internet-based collaboration tools, which can provide the basis for a unique way to interact with the workforce and provide continual training.

The establishment of the types of workforce training described herein for green technologies and industry requires the partnering of organizations such as WCC, ITC, and ITC Experts. The ability of the Federal Government and state governments to achieve the jobs growth they desire in green technologies and industry can only happen with the training that partnerships such as this one provide. Green technologies are only now emerging, green jobs will be created and do not now exist to a great degree, and training for a green economy is ill defined at this point. Close collaboration between community colleges and a not-for-profit such as ITC provides the insight to define and deliver the training that is truly needed and valuable.