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Careers in Green Construction

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Buildings constructed today are very different from those built 100 years ago. As interest in protecting the environment grows, "green," or sustainable, buildings have become more commonplace. At first glance, these buildings might not appear very different from their predecessors, but they feature specialized designs and materials to limit their environmental impact. Creating these new buildings requires skilled workers—such as architects, construction managers, and carpenters—with knowledge of new design and construction techniques.

Green construction is the practice of erecting buildings and using processes that are environmentally responsible and resource efficient. Green buildings limit their environmental impact by conserving as much energy and water as possible and are constructed of recycled or renewable materials in order to achieve maximum resource efficiency.

Green construction has grown dramatically over the past few years. McGraw-Hill Construction estimated the value of green nonresidential building construction in the United States to be $3 billion in 2005.[1] In 2010, McGraw-Hill placed the value between $43 billion and $54 billion, more than 14 times the value just 5 years earlier.[2] The value grew despite a slump—the recession of 2007–09—in the overall construction market. McGraw-Hill estimates that by 2015 the green nonresidential building market will be worth between $120 billion and $145 billion.[3] The construction of new, large projects, such as hospitals, office complexes, and federal buildings—increasingly built to green standards—will continue the growth of green construction.

As the size of the industry grows, so will its workforce. According to a U.S. Green Building Council (USGBC) and Booz Allen Hamilton study, green construction supported more than 1 million workers in the green construction industry between 2000 and 2008. USGBC projects this figure to rise to 3.3 million between 2009 and 2013[4]—and these estimates of the green construction workforce do not include employment for suppliers of green building materials and products, an industry that should also experience increased growth as demand for their goods rises. Although, in the United States, the green construction workforce is still much smaller

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than the general construction workforce—estimated at 7.2 million workers in 2008[5]—its growth has been considerable.

Although green building techniques are used in both residential and industrial construction, commercial construction is the largest player in the industry's growth. Accordingly, this report focuses on the construction of green commercial and office buildings.

The report provides information on various career opportunities in green construction. The first section provides an overview of the green construction industry and common issues that designers and construction managers of green buildings must consider. The remainder of the report details occupations involved in the construction of green commercial and office buildings. The occupational information includes a description of job duties; the credentials needed to work in the occupation, such as education, training, certification, or licensure; and wages.

Going green

Green construction has grown more commonplace because it is more than just an environmental movement: many companies prefer green buildings for financial reasons. According to a 2009 McGraw-Hill Construction survey of high-level executives in firms that own green buildings, 72 percent say that their firm participates in sustainability efforts to lower operating costs.[6] In the same survey, the executives named lowered costs and energy savings as the primary drivers of sustainability. These financial benefits provide incentives to keep constructing green buildings.

Certifications and credentials for green construction

A large and well-known advocate for green construction is the U.S. Green Building Council (USGBC), a nonprofit organization. The USGBC created and maintains standards to rate buildings by their level of sustainability. These standards fall under the building rating system known as Leadership in Energy and Environmental Design (LEED). Using these standards, the sister organization of USGBC, the Green Building Certification Institute (GBCI), judges buildings with a LEED scorecard. Depending on how the building scores, it may receive LEED certified, Silver, Gold, or Platinum status. Buildings earn points in many different categories, including design and energy efficiency.

LEED certification is widely recognized, and some local jurisdictions have incorporated it into their building codes. The U.S. General Services Administration, for example, requires all Federal new construction and major renovation projects to meet LEED Gold standards. Many private developers pursue LEED certification to advertise their green credentials to the public.

Although LEED is the most common green certification in the United States, there are alternatives. Other groups, such as the Green Building Initiative, offer competing certifications in the green construction market. Certification systems have different strengths and weaknesses. Rating systems and categories vary among certifications; some are also more expensive and complicated to earn than others. Firms pursing green building certifications should research which program best suits their needs.

GBCI not only provides certification to buildings, but also accredits professionals in the green building field. LEED Accredited Professionals (LEED APs) may work on a project that is pursuing LEED certification. These individuals might already be working as the project's designer or architect.

The National Center for Construction Education and Research (NCCER) has developed a certification for construction supervisors that has the endorsement of the GBCI. The Sustainable Construction Manager certification can qualify frontline construction managers as equipped to support the LEED green building goals of the project.

Constructing a green building is not an easy process: there is no one way to accomplish this goal. Because of the diverse nature of green construction, designers and builders must have a comprehensive view of how the different parts of a building work together. Green building techniques can be grouped into five major categories, including the structure's location, energy efficiency, water conservation, indoor air quality, and onsite construction practices.

Location

A building's location—or, more specifically, where it is in relation to where people who come to the location live—goes a long way toward determining how green the building is. Car emissions from people traveling to and from a building impose a significant environmental cost, and choosing an effective location can reduce this impact. For example, constructing an office in a suburban location may require employees to drive to work. If the office were built in an urban area instead, many employees could have a shorter commute or more options to use mass transit.

This calculation is true for other types of buildings, too. For example, locating a grocery store within walking distance of its targeted customers would cut down on the environmental impact of their travel. Urban planners with an awareness of green issues must decide the most environmentally efficient sites for new buildings. Locating construction near existing infrastructure reduces the need to build new roads.

The location of a new building can matter in other ways, too. The greenest construction sites make use of preexisting structures and onsite materials. Instead of tearing down a previously vacant building and erecting a new one, the original might be efficiently renovated to serve a fresh purpose.

The reuse of some sites, called brownfields, might be especially good for the environment. Brownfields are abandoned facilities that can be difficult to redevelop because of environmental complications. An example of a brownfield site would be an old industrial plant that still contains harmful chemicals. The site's developers could have the chemicals safely disposed of and the property redeveloped into an apartment complex, thereby removing a threat to the environment.

Redevelopers of brownfield sites need not act solely for altruistic reasons. They might see a financial boon in locating a building at the brownfield's location or be encouraged by tax credits offered in some local communities for the redevelopment of brownfield sites.

Energy efficiency

A building's level of energy consumption is frequently a good indicator of how green the building is. Buildings use vast amounts of energy, for everything from keeping the lights on during late work hours to keeping the heat on during cold winter months. The U.S. Department of Energy reported that in 2006 commercial buildings were responsible for about 18 percent of all energy consumed in the United States.[7] Because buildings consume so much energy, it is important for them to be energy efficient.

Architects and engineers who design green buildings use different techniques to maximize energy efficiency. One popular practice is daylighting, which is the use of natural light to illuminate a building. Sunlight is readily available during daytime hours, when many buildings are at their highest occupancy. Architects can use their knowledge of structural design and the building's orientation to maximize the amount of natural light within the building. During times with sufficient daylight, traditional indoor lighting can be reduced to conserve energy.

Placing windows in areas that receive sunlight and using low-reflective glass are key components of daylighting. Windows are also useful tools for insulating a building, because some types of glass offer better insulation than others. Double-glazed windows, which have two separate panes of glass separated by millimeters, are best for preventing heat loss.

Designers of green buildings also can use the sun as a source of heat. Depending on the building's orientation, the sun can be an effective supplement to internal heating systems. In warmer climates or seasons, however, the goal may be to lower the building's temperature. In these cases, planners use shade, from either trees or surrounding buildings, to keep the building cool.

To be truly energy efficient, green buildings need to be equipped with green appliances. Some models of every type of appliance—from clothes washers to water heaters—are more energy efficient than others. Appliances that have earned the ENERGY STAR qualification meet energy-efficiency standards set by the U.S. Environmental Protection Agency and the Department of Energy.[8] Procurement and facility managers use the ENERGY STAR qualification to help decide which appliances to purchase and install in green buildings.

Some green buildings not only conserve energy, but also produce it. By installing alternative energy infrastructure onsite, some property owners can take their commitment to energy efficiency a step further. For example, a green building might have photovoltaic solar panels installed on its roof. Another could have a small wind turbine located on its property. These local power sources can also be combined to help make a building self-sustaining or a net producer of energy.

Even if they do not produce their own energy onsite, many green buildings can get their energy from renewable sources. Utility-scale solar energy and wind energy are becoming more commonplace and more cost competitive with traditional power options, such as coal and natural gas. Depending on where the building is located and the energy portfolio of its local utility company, facilities managers may have the option to obtain some of their building's power from renewable sources.

Water conservation

Although water covers more than 70 percent of the Earth's surface, only a small percentage of it is usable by humans; the rest is saltwater or frozen in polar ice caps. Given how critical water is to human survival, it is an important resource to conserve. Green buildings contribute to conservation efforts by finding additional sources of water and by being designed to lessen water usage both indoors and outdoors.

Not all types of water are equally valuable. Potable, or drinkable, water is of relatively high quality, and nonpotable water, of lesser quality, can be used where drinking water is not required, such as in toilets. Using common types of nonpotable water for purposes other than drinking helps conserve drinking water.

Greywater is water from showers, bathroom sinks, washing machines, and drinking fountains. Although not safe for human drinking, greywater contains few contaminants and can be used to water landscapes or flush toilets. Rainwater, also unsafe to drink, because of pollutants in the atmosphere, can be collected in basins or runoff channels. In green buildings using nonpotable water, plumbers are required to install separate pipes and storage tanks to separate the nonpotable from the potable water.

To lessen water consumption, green buildings are often filled with water-efficient appliances. Low-flow aerators limit the amount of water coming out of a faucet by blocking parts of the mouth of the faucet. The water that flows out of the faucet is separated into several

different streams instead of a single solid one. Some models add highly pressurized air to the stream of water, allowing the faucet to emit even less water while keeping the water pressure high.

Water also is conserved in newer toilet models. These new dual-flush toilets have two different flush settings: one for solid waste, the other for liquid. Older toilets use about 5 gallons of water for each flush, but new ones may use only 1.6 gallons per flush for solid waste and less than 1 gallon for liquid waste. Waterless urinals, which use a cartridge system, also lower water usage.

When constructing green buildings, planners also have to consider how water will be used outside of the building. Maintaining a landscape can be extremely water intensive. At an office complex in Arizona, for example, the site designers could apply a technique known as xeriscaping—using local plants that thrive in the region for landscaping. Instead of planting deciduous trees, which require significant amounts of water to survive in a dry climate, these landscape architects would use rock gardens and desert plants.

Xeriscaping also includes practices for sprinkler systems in an effort to make landscapes as water efficient as possible. Green developers map each sprinkler head's area of coverage in order to limit overlap. Automatic sprinklers are preset to discharge water in the evenings to reduce the loss of water to evaporation.

Indoor air quality

Green buildings must benefit both the environment and the buildings' occupants. Most green buildings are both well insulated and filled with synthetic products, which can emit harmful chemicals. Long-term exposure to these chemicals may cause occupants to suffer from sick

building syndrome, symptoms of which include headaches and excessive fatigue. When constructing green buildings, planners must be aware of the potential harmful effects of the products used.

Many building materials, including paint and insulation, can pose hazards to a building's occupants. Many paints are defined as volatile organic compounds. A cause of sick building syndrome, these compounds also are found in many disinfectants, air fresheners, and other products. To lessen building occupants' exposure to such compounds, facility managers use paints and finishes with no volatile organic compounds or low levels of these compounds.

A building's insulation may have detrimental effects on its occupants. In some older buildings, asbestos was used as an insulator. Fiberglass, mineral wool, and cellulose are now frequently used as alternatives. The health hazards of asbestos are well documented, but even fiberglass might carry some risks. Small amounts of fiberglass that have entered the airstream can be a respiratory irritant. Other types of insulation also have drawbacks, so facility managers must use their knowledge to decide which type is most suitable for a building's occupants.

Good heating, ventilation, and air-conditioning (HVAC) systems are important contributors to improving indoor air quality. HVAC units can be used to filter harmful particles, such as fungal spores and pollen, from a building's air supply. Ensuring that HVAC units are properly installed and regularly maintained is very important because broken or leaking HVAC units can themselves become sources of mold.

Onsite practices

A truly green building is a building made with green materials. Although it is an open question whether natural or synthetic materials are better for the environment, materials used in green construction frequently are purchased from companies that have environmentally friendly practices. For example, wood used in a green building's floors might be from a company that values the biodiversity and future health of forests. Green building certification programs usually award points for such purchases.

In many green buildings, recycled and renewable resources are commonly used. For example, both medium-density fiberboard and bamboo are green alternatives to traditional wood. Medium-density fiberboard is frequently considered a recycled product; many kinds are composed of recycled industrial wood trimmings. Bamboo, by contrast, is considered a rapidly renewable resource because of its quick growth.

Whether recycled or renewable products, the most environmentally efficient supplies are those obtained from local sources. The environmental costs of transporting building materials can be substantial. Heavy trucks burning fossil fuels and emitting carbon can make the transportation of even the greenest materials harmful to the environment.

Construction firms may undertake onsite practices to minimize a building project's environmental impact. Construction firms dedicated to green practices implement strict recycling plans, in which materials that would normally be disposed of are identified and reused for new purposes. Many jurisdictions require

construction companies to conduct waste stream audits to reduce wasted materials. Green construction firms routinely make use of preconsumer recycled content, which comes from the materials left over at the end of a construction job. Many common construction materials can be reused in other projects. Recycled concrete, for example, is frequently used as gravel or the base layer for new roads.

Occupations in green construction

Many organizations, both national and local, offer training for green construction trades. The National Center for Construction Education and Research (NCCER), a not-for-profit foundation created to develop standardized construction training programs, has developed a number of green training modules recognized by the U.S. Green Building Council and Green Building Certification Institute. The Laborers' International Union of North America and the Associated Builders and Contractors (ABC) also have been heavily involved in developing training programs. Workers already proficient in their trade but looking to add green skills should check with a local NCCER sponsor or local employment, trade, or union centers for training opportunities.

Training in green practices is more important for some occupations than for others. For example, although the work of construction laborers might be different on a green construction site, these workers usually do not require much specialized training. Specialty trade workers—who need to be proficient in installing energy- and water-efficient appliances and who might use new techniques—usually require more. The design occupations, such as architects and engineers, require a considerable amount of education and training specific to green construction.

For each occupation discussed, job duties are listed, along with the necessary credentials, including education, training, certification, or licensure. Certification demonstrates competency in a skill or set of skills and is typically earned by passing an examination, gaining work experience, receiving training, or some combination of the three. Licensing is done by states and typically requires passing an examination and complying with eligibility requirements, such as a minimum level of education, work experience, or training, or completing an internship, residency, or apprenticeship. No states mandate or license workers to work on green buildings specifically.

Finally, wage data are presented. Although lacking wage data specifically for occupations in the green construction industry, BLS is currently in the process of collecting data to measure green jobs. These data are expected to be available in 2012. The wages presented for each occupation are from the nonresidential building construction industry group.

Design occupations

Green buildings make use of new ideas and technologies, so the workers who design them are required always to be open to innovation. Designers of green buildings work together to make their projects as environmentally friendly as possible. These workers are required to evaluate both standard construction issues, such as the number of load-bearing columns required in a structure, and new ones, such as a building's orientation to the sun. To make buildings that appeal to the masses, designers have to strike the correct balance between being attractive and being environmentally friendly.

Job duties

Architects design buildings and other structures. They are responsible for the overall look of buildings, but an architect's work goes far beyond appearance: Buildings also must be functional, safe, and economical, and must suit the needs of the people who use them.

Architects use computer-aided design and drafting (CADD) software and building information modeling technologies to design and manage projects. They often work closely with engineers, urban planners, interior designers, landscape architects, and other professionals. Architects spend a great deal of their time coordinating information from, and the work of, others engaged in the same project.

The work of architects is critical to determining how green a building is. For example, architects designing a green building might devise ways to maximize the building's energy efficiency. To accomplish this, they might apply daylighting principles and design a building with large banks of windows that face the sun. Or because buildings consume significantly more energy as they grow in size, the architects might design a building with little extra space.

Civil engineers design and supervise the construction of roads, buildings, airports, tunnels, dams, bridges,

and water supply and sewage systems. Their work requires them to consider many factors, from the construction costs and expected lifetime of a project to government regulations and environmental hazards. The major specialties of civil engineering are structural, water resources, construction, transportation, and geotechnical engineering.

The knowledge civil engineers possess allows them to be involved in just about every part of green building design. They might work on issues as diverse as erosion control and traffic flow patterns. By adopting green practices in every piece of a building, civil engineers can ensure that the final product is environmentally friendly.

Electrical engineers develop, test, and supervise the manufacture of electrical equipment. They focus on the generation and supply of power and specialize in areas such as power systems engineering or electrical equipment manufacturing.

Electrical engineers frequently design the lighting systems of buildings. The importance of energy efficiency in green buildings places a premium on well-trained electrical engineers. For example, electrical engineers might work closely with architects to plan areas of a building where daylighting is the primary source of light. They may use sensors that automatically trigger traditional lighting only when the daylight is insufficient, thereby helping to reduce energy usage.

Landscape architects plan the location of roads and walkways and the arrangement of flowers, shrubs, and trees. They analyze the natural elements of a site, such as the climate, soil, drainage, vegetation, and slope of the land. Landscape architects also assess existing buildings, roads, walkways, and utilities to determine what improvements are necessary. At all stages, they evaluate the project's impact on the local ecosystem.

Landscape architects who work on green building sites apply their expertise to plan attractive scenery while also conserving water. To do this, they practice xeriscaping, or using local plants that require less water. Landscape architects working on green buildings also might plan drainage channels to diffuse rainwater throughout planting beds.

Mechanical engineers work on power-producing machines, such as electric generators, internal combustion engines, and steam and gas turbines. They also might work on machines that consume power, such as refrigeration and air-conditioning equipment, machine tools, material-handling systems, elevators and

escalators, and industrial production equipment. Some mechanical engineers design tools that other engineers need for their work.

Mechanical engineers can specialize in many different types of equipment. When designing green buildings, they are consulted on any proposed equipment. Mechanical engineers specializing in air-conditioning systems, for example, would be able to provide valuable input on the strengths and weaknesses of different setups. They also might install systems to record and measure energy savings.

Urban planners develop long- and short-term plans for the use of land and the growth and revitalization of urban, suburban, and rural communities. They help local officials alleviate social, economic, and environmental problems by recommending locations for roads, schools, and other infrastructure. Urban planners also suggest zoning regulations for private property and work with developers to meet those regulations.

Some planners might help make decisions about protecting ecologically sensitive regions. They are involved in environmental issues, including pollution control, wetland preservation, forest conservation, and the location of new landfills.

Urban planners specializing in green development work with local authorities to develop zoning areas in which new buildings are required to meet standards of environmental efficiency. They also help guide infrastructure additions, such as new roads, to benefit the maximum number of people possible. When determining the ideal location for a green building, urban planners work closely with the rest of the building design staff.

Credentials

Architects, engineers, and urban planners who work in green building design usually have at least a bachelor's degree in a relevant discipline. However, many jobs require more education, such as a master's degree or professional degree, and many architects, engineers, and urban planners who work in green construction have the LEED Accredited Professional (AP) credential. (For more information on the LEED AP program, see the box on page 2.)

Architects need to complete the requirements for either a bachelor of architecture—frequently a 5-year program—or master of architecture degree. A master's degree in architecture usually takes 2 or 3 years and requires the previous completion of a bachelor's degree (bachelor of arts or bachelor of science). Licensure is a requirement for all architects working in the United States. Becoming licensed usually requires earning a professional degree from an accredited school, completing a 3-year internship, and passing a national exam.

Engineers typically are licensed and are expected to complete continuing education to keep current with rapidly changing technology. Most companies prefer to hire engineers with 3–5 years of experience in their respective fields and who have knowledge of commonly used building techniques. Entry-level engineers may be hired as interns or junior team members and work under the close supervision of more senior engineers. As they gain experience and knowledge, they are assigned more difficult tasks and given greater independence.

Wages

BLS does not currently have wage data specific to the green construction industry. However, BLS does have wage data for the nonresidential building construction industry group, which includes construction of commercial and office buildings. The table shows BLS data for design occupations in this industry group for May 2010. The wages shown are median annual wages for the United States as a whole; wages vary by employer and location.

Selected occupations in the nonresidential building construction industry group	Median annual wages, 2010[1]
Architects, except landscape and naval	$77,210
Civil engineers	76,120
Electrical engineers	84,350
Landscape architects[2]	62,090
Mechanical engineers	80,400
Urban and regional planners[2]	63,040

[1] Occupational Employment Statistics data are available at **www.bls.gov/oes**. The data do not include benefits.

[2] Wage data for these occupations are not available in the nonresidential building construction industry group, so the dollar amounts shown are wages across all industries.

Building construction occupations

Erecting any building is a complex task, and green buildings are no different. Experienced construction workers without a lot of green knowledge might have to learn how to perform tasks in new or different ways. Also,

when constructing green buildings, workers might find themselves using unusual design schematics or materials they are unfamiliar with. However, the biggest change for these workers is the adoption of onsite procedures designed to lessen the ecological impact of the construction. When building green, construction workers have to be conscious of how their work affects the surrounding environment.

Job duties

Construction managers plan, direct, coordinate, and budget a wide variety of construction projects, including roads, schools, hospitals, and other residential, commercial, and industrial structures. They may supervise an entire project or, on larger projects, just part of one. As coordinators of all design and construction processes, construction managers select, hire, and oversee specialty trade contractors, such as carpenters, plumbers, or electricians.

Construction managers coordinate and supervise the construction process from the conceptual development stage through final construction to ensure that the project is completed on time and within budget. They often meet with owners, engineers, architects, and any others working on the same project.

When working on green buildings, construction managers are responsible for ensuring that onsite processes are environmentally friendly. This could mean setting up a recycling plan for unused construction materials or protecting environmentally sensitive areas of the site. Because construction managers also select the general contractors and trade contractors, they are responsible for choosing contractors who have knowledge of green building techniques.

Construction laborers perform a wide range of tasks on construction sites. They use a variety of equipment, including pavement breakers, jackhammers, and small mechanical hoists. For some jobs, construction laborers use computers and other high-tech input devices to control robotic pipe cutters and cleaners. They often assist workers in the specialty trades, including carpenters, plasterers, and masons.

The duties of construction laborers on a green building site are similar to their duties on other projects. However, they fulfill these duties in a more environmentally conscious fashion. For example, construction laborers must follow green onsite procedures, such as material recycling plans, decided upon by their managers.

Construction equipment operators use machinery to move construction materials, earth, and other heavy objects at construction sites. They use machines to clear and grade land prior to construction. Construction equipment operators also dig trenches to lay sewer and other utilities, and they hoist heavy construction materials.

Operating heavy construction equipment on a green jobsite requires special care. These workers have to take precautions in order not to damage sensitive areas of the site. For example, construction equipment operators might have to work on sites that host a threatened animal's habitat or an eroding watershed.

Credentials

Most construction managers gain experience working on projects in other positions before they are selected to manage a project. Education is becoming important, and most project managers hold a bachelor's degree or higher in construction management, business management, or engineering. Advanced degrees, such as a master's degree in business administration (MBA), are becoming more common. Construction managers on green projects might have the LEED Green Associate credential or have taken the NCCER's Sustainable Construction Supervisor Training and Certification Program.

Although many construction laborer jobs have no specific education or training requirements, some construction laborers may receive formal technical and on-the-job training. High school classes in English, mathematics, physics, construction drawings, welding, and other career and technical education classes can be helpful preparation. Many construction laborers learn their skills on the job by assisting more experienced workers.

Construction equipment operators learn their skills through a variety of venues, including on-the-job training, equipment career schools, NCCER or ABC sponsors, apprenticeships, or, union instruction. Depending on the type of equipment, the operator may be required to be certified by an accredited party or by the manufacturer.

Wages

BLS does not currently have wage data specific to the green construction industry. However, BLS does have wage data for the nonresidential building construction industry group, which includes construction of commercial and office buildings. the table shows BLS data for selected occupations in this industry group for May 2010. The wages shown are median annual wages for the United States as a whole; wages vary by employer and location.

Selected occupations in the nonresidential building construction industry group	Median annual wages, 2010[1]
Construction managers	$85,030
Construction laborers	31,000
Operating engineers and other construction equipment operators	46,160

[1] Occupational Employment Statistics data are available at **www.bls.gov/oes**. The data do not include benefits.

Specialty trade occupations

After the designers and construction crews have played their roles in making a green building, skilled craft workers are needed to finish the job. These workers use their unique skill sets and utilize renewable or recycled materials to lessen a building's environmental impact. Although tradespeople work closely with construction workers on the site, they are more highly trained and have more specific tasks. Their duties vary with their specialty and the project.

Job duties

Carpenters construct, install, and repair structures and fixtures made from wood and other materials, including plastic, fiberglass, and drywall. In accordance with their construction drawings, carpenters first do the layout—measuring, marking, and arranging materials. They use hand and power tools, such as chisels, planes, saws, drills, and sanders, to cut and shape the materials. Carpenters then join the materials together with nails, screws, or other fasteners. In the final step, they check the accuracy of their work with instruments such as levels or rulers before making any necessary adjustments.

Carpenters trained in green techniques play an important role in reducing waste and improving building efficiency. One technique, called optimum value engineering, allows carpenters to use less lumber by increasing the amount of spacing between framing members. This technique also allows for more insulation to be added, increasing the energy efficiency of the building.

Electricians do both installation and maintenance work on the energy systems of buildings. When working in construction, electricians check their construction drawings to determine where to place equipment, such as circuits and outlets. After finding the proper locations, they install and connect wires to circuit breakers, transformers, outlets, or other components and systems. When installing wiring, electricians use both hand tools—such as screwdrivers and wire strippers—and power tools—such as drills and saws. Electricians also are responsible for testing the new components.

Electricians can help improve a building's energy efficiency by installing motion sensors to automatically turn off lights when no people are present. They can also recommend green products, such as smart power strips that stop plugged-in electronics from consuming unnecessary energy. Some electricians might be able to connect local solar photovoltaic panels to a building's energy system.

HVAC installers install, maintain, and repair heating, ventilation, and air-conditioning systems. HVAC systems vary among buildings, but all are composed of many mechanical, electrical, and electronic components, such as motors, fans, and pumps. Following construction drawings, technicians install heating and air-conditioning systems by putting in fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring to controls and check the unit to confirm that it works properly.

A good HVAC system is one of the most important contributors to a building's healthy indoor air environment. Built-up water in HVAC systems can be a fertile breeding ground for airborne contaminants, such as mold, that may spread through the building. Skilled HVAC installers can prevent this from happening by properly installing and maintaining the ventilation system.

Plumbers working in the construction industry follow detailed construction drawings to install piping in

new buildings. To conserve resources, plumbers lay out their materials and fit the piping into the building's structure. They measure and mark areas in which pipes will be installed and connected, while checking for obstructions, such as electrical wiring.

To assemble a system, plumbers use saws, pipe cutters, and pipe-bending machines to cut and shape lengths of pipe and then link them together. When the system is ready, plumbers install the appliances that use water and connect the system to the outside water supply.

Plumbers' knowledge of building codes and different system options has allowed them to become more involved in the design process. When working on green buildings, plumbers can recommend and install water-efficient appliances, such as dual-flush toilets, or systems that reuse gray water.

Insulation installers apply insulating materials to pipes and ducts, under floors, and in ceilings and walls. When covering a steampipe, for example, these workers measure and cut sections of insulation to the proper length before securing it over the pipe.

When insulating floors, ceilings, or walls, insulation workers use machines that blow loose-fill insulation, such as fiberglass. When covering a wall or other flat surface, these workers may use a hose to spray foam insulation onto a wire mesh that provides a rough surface to which the foam can cling and that adds strength to the finished surface.

Properly insulated buildings lower energy consumption by keeping heat in during the winter and out in the summer. However, if a building is poorly insulated, wasted energy is not the only problem: diminished indoor air quality, resulting from insulating products that emit airborne irritants, is also a concern. Insulation workers are important for both lowering a building's energy costs and creating a healthy indoor environment.

Painters apply paint, stain, varnish, and other finishes to buildings. When selecting the right paint or finish, they take into account its durability, ease of handling, and method of application. To ensure that the paint will adhere properly, painters might remove old coats of paint by sanding or with water and abrasive blasting, fill nail holes and cracks, and wash walls to remove dirt, grease, and dust. On new surfaces, painters apply a primer or sealer to prepare the surface for the topcoat. To apply the paint and finishes, painters use tools such as brushes, rollers, or paint sprayers. When working on a tall building, painters must handle all of this equipment while suspended on scaffolds.

Many paints contain volatile organic compounds, which can lower the indoor air quality and cause sick building syndrome. Before applying paints and other finishes, painters should be aware of the products they will use. When possible, they choose to apply those with no volatile organic compounds or low levels of such compounds.

Glaziers cut and install glass to create the windows and skylights of new buildings. Glaziers usually install glass that has been precut by suppliers to design specifications. If it isn't delivered precut, glaziers must cut the glass themselves with specialized tools. Glaziers place the glass panels into the proper positions with suction cups. Once the glass is in place, glaziers secure it with putty, metal clips, or other techniques.

To help increase the energy efficiency of green buildings, glaziers frequently install double-paned windows. These windows lose less heat to the outdoor environment than single-paned alternatives. Skilled glaziers also are necessary to ensure that the window's glass is sealed properly into its frame. Any open seams would allow heat to escape and hurt the building's energy efficiency rating.

Roofers repair and install roofs—usually made from a combination of tar, asphalt, gravel, rubber, thermoplastic, and metal—to protect buildings from water damage. Most commercial buildings use low-slope roofs covered with several layers of materials. Roofers begin by installing a layer of insulation on the roof deck, before applying a tarlike substance on top of it. The process is repeated until the roof's seams are sealed and the surface

is waterproof. The top layer is then glazed to make a smooth finish or has gravel embedded in it to create a rough surface.

An increasing number of low-slope roofs are covered with single-ply membranes of waterproof rubber or of thermoplastic compounds. Roofers roll these sheets over the roof's insulation and seal the seams. Adhesive, mechanical fasteners, or stone ballast hold the sheets in place. Roofers must make sure that the building is strong enough to hold the stone ballast.

Temperatures in urban areas are often higher than those in nearby rural areas; hence, it may cost more to cool an urban building. This issue, called the heat island effect, can be mitigated through the work of skilled roofers. Cool roofs, which are made of reflective materials that deflect the sun's heat away from the building, can lower internal temperatures. Some roofers install "green" roofs, which cover the top of a building with vegetation, to achieve the same effect.

Roofers, especially those who are also trained as electricians, also might install solar photovoltaic panels. More information on these workers can be found in a BLS report on **careers in solar energy** and in an *Occupational Outlook Quarterly* article about **solar photovoltaic installers**.

Credentials

Most of the workers in these specialty trade occupations learn their skills through formal training programs, apprenticeships, and trade schools. Craft training and apprenticeship programs usually consist of technical instruction and an additional 3 or 4 years of on-the-job training. Trainees and apprentices also must pass practical and written tests to demonstrate their knowledge of the trade. Many craft training or apprenticeship programs can be found through an NCCER or ABC training program sponsor or a local union chapter.

Continual learning is important for trade workers, because they need to acquire new, green skills. A carpenter, for example, should know current advanced framing techniques. Other trade occupations need to become familiar with green products and be able to install them.

Depending on the state in which they practice, some of these workers need to be licensed. Most states and communities require electricians, plumbers, and HVAC installers to be licensed. Licensing requirements vary, but workers typically must have several years of experience and pass an esxamination that tests their general knowledge and familiarity with local building codes.

Wages

BLS does not currently have wage data specific to the green construction industry. However, BLS does have wage data for the nonresidential building construction industry group, which includes construction of commercial and office buildings. The table shows BLS data for the specialty trade occupations in this industry group for May 2010. The wages shown are median annual wages for the United States as a whole; wages vary by employer and location.

Selected occupations in the nonresidential building construction industry group	Median annual wages, 2010[1]
Carpenters	$43,980
Electricians	47,620
Heating, air conditioning, and refrigeration mechanics and installers	41,560
Plumbers, pipefitters, and steamfitters	51,490
Insulation workers, mechanical	37,100
Insulation workers, floor, ceiling, and wall	35,910
Painters, construction, and maintenance	35,050
Glaziers[2]	36,640
Roofers	31,360

[1] Occupational Employment Statistics data are available at **www.bls.gov/oes**. The data do not include benefits.

[2] Wage data for this occupation is not available in the nonresidential building construction industry group, so the dollar amount shown is the wage across all industries.

Conclusion

This article has examined the various occupations in green construction. If the growth of green construction continues, more buildings will be built to green standards. The benefits of this growth should be noticeable in the construction sector, which was hit particularly hard by the recent economic recession.

Green construction is able to provide jobs to people with a broad range of education and experience levels. Many of the occupations in green building design, such as architects and civil engineers, require at least a bachelor's degree, while many of the construction and trade occupations can be learned through on-the-job training or an apprenticeship.

As green construction becomes more widespread, new opportunities to contribute to the field will arise. A new market focused on sustainable construction techniques should build job prospects for many more future workers.

Notes

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[1] *Green Outlook 2011: Green Trends Driving Growth* (New York, McGraw-Hill Construction, 2010), on the Internet at **http://construction.com/market_research/**. (See p. 2.)

[2] Ibid.

[3] Ibid.

[4] U.S. Green Building Council, *Green Jobs Study* (McLean, VA, Booz Allen Hamilton, 2009), on the Internet at **http://www.usgbc.org/ShowFile.aspx?DocumentID=6435**. (See p. 6; visited May 24, 2011.) The estimate provided is the number of workers directly employed, displayed in Exhibit 2-5.

[5] "Construction," in Career Guide to Industries, 2010–11 Edition (Bureau of Labor Statistics, Dec. 3, 2010), on the Internet at **https://www.bls.gov/oco/cg/cgs003.htm** (visited March 18, 2011). BLS is currently collecting data on green jobs, and the data will be published in 2012.

[6] *2009 Greening of Corporate America* (New York, McGraw-Hill Construction, 2009), on the Internet at **http://www.mcgraw-hill-sales.com/2009_GreeningCorpAmerica.pdf**. (See p. 18.)

[7] *Buildings Energy Data Book* (U.S. Department of Energy, 2009), on the Internet at **http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.1.3** (visited Feb. 22, 2011).

[8] For more information about ENERGY STAR, see **http://www.energystar.gov**.