Lifelong Learning Programme

Discover a New Working Field

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GUIDE ABOUT THE SECTORS and JOB AREAS RELATED TO RENEWABLE ENERGY

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RENEWABLE ENERGY CAREERS – SECTORS AND JOB AREAS

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C O N T E N T

FORWARD

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This guide is the result of a fruitful collaboration among several institutions partners within the LdV Partnership Project *Discover a new working field*, developed in the last 3 years.

As a product of an European partnership, we proposed to be useful for all those involved in this project, but especially for all those interested in the area of green energy, even if it's about wave, wind, solar, renewable, biomass energy, for all young people that intend to work in the area and to follow some training and education formations or to study in these fields.

Such a guide is always an instrument that could be used by anyone at any moment of his professional or forming life, also in the companies specialized in domain or in different areas of consuming.

The topic of the project was generous with all participants – people and organizations/ institutions, in offering us the opportunity to research, to choose, to work for realize a book that could offer rich and well documented information, sustained by sites or images that can be useful for all interested in domain, and can constitute a start point for open a business or a passioned activity that is a priority for our life and for our future.

The content of this guide was discussed by all partners in the project, and developed by three institutions, as it is mentioned above.

We started with a short description of what means renewable energy careers – sectors and job areas, with details about skills requirements, renewable energy jobs: status, prospects & policies, about working in the renewable energy sector and the world need for renewable energy. Also, we organized information for be useful for those that are intending to work in wind energy, wave energy, in solar energy, in green buildings, biofuels, in realizing a list of occupations in all these green energy areas, with some interesting and useful details about jobs, credentials, responsibilities, education and training, and so on.

In adding, we established this list of sectors and jobs in according with the criteria of presenting publically sectors and jobs in such a book as this guide is, and to give a set of information that can clarify and be opportune for all those that will read or use this guide.

Information included here were gathered, analyzed and synthetized, interpreted with more attention by all partners involved in elaborating this guide, after a good and intensive communication by emails, especially, and during project's meetings.

RENEWABLE ENERGY CAREERS – SECTORS AND JOB AREAS

SKILLS REQUIREMENTS:

A wide range of skills are required in the Renewable Energy sector. In order to achieve deployment targets and maximize job benefits, it is necessary to facilitate and increase education and training.

A large scale shift to Renewable Energy will require some skills similar to those needed in the conventional energy workforce and other skills that are to certain Renewable Technologies.

Many essential jobs in the Renewable industry require a skilled workforce. Industry surveys in Germany have suggested that on average Renewable Energy jobs are relatively high-skilled, across both fuel-free &fuel based Technologies. 82% employees in the industry have vocational qualifications and almost 40% of these have a university degree, compared to an average fort the whole industrial sector of %70 and % 10, respectively.

Nevertheless, a range of skilled and unskilled occupations are involved in all Renewable Energy Technologies, across their lifecycles.

For fuel – free technologies graduate level qualifications are necessary to fill positions in field such as engineering, meteorology, Project development and research & development.

By contrast, jobs in areas such as system design and installation or construction are more likely to require vocational qualifications.

A number of unskilled jobs may also be created in construction, as well as in indirect jobs, such as transport & administration.

RENEWABLE ENERGY JOBS: Renewable Energy jobs can be classified further into jobs related to fuel-free technologies and jobs related to fuel – based technologies, which involve two different employment patterns according to their value chain.

1. JOBS RELATED TO FUEL – FREE TECHNOLOGIES:

Fuel – free technologies such as solar or geothermal heat and power, wind, ocean and hydro power. These technologies typically involve jobs in the processing of raw materials. The manufacture of technology, Project design and management; installation and/or plant construction, operations and maintenance; and eventual decommissioning. Depending on the technology, this can draw on a range of occupations, and the share of jobs can fall across different parts of the value chain.

2. JOBS RELATED TO FUEL – BASED TECHNOLOGIES:

Fuel based Technologies such as biomass – based electricity and generation and liquid biofuels for transport require energy inputs that are not freely available, such as dedicated crops or bio-residues from various industries. For dedicated energy crops, agricultural jobs – such as farmers and seasonal labor – are required. Refining ethanol and the trans-esterification of biodiesel requires works such as chemists, machine operators and engineers, after which the biofuel can be distributed. Solid biomass fuel, for example, is used in some industries – such as paper and pulp, lumber producers, furniture manufacturers, agricultural industries - to produce heat and / or power on - site.

RENEWABLE ENERGY JOBS: STATUS, PROSPECTS & POLICIES

Jobs in Renewable Energy

Fuel-free technologies, such as solar or geothermal heat and power, wind, ocean and hydro power, typically involve the greatest number of jobs in the installation, manufacturing, and administration phase. Depending on the technology, this can draw on a range of occupations, and the share of jobs can fall across different parts of the value chain.

The various types of employment that will be needed. For solar PV, for example, engineers and technicians will be required to process raw materials and assemble system components. Project development needs qualified personnel to conduct resource assessments, as well as system designers, energy officers, business managers, financial analysts, as well as wholesalers. Construction workers, technical personnel and electricians will work on installation, while maintenance will involve technical staff. Finally, construction and materials recycling workers are needed for decommissioning.

Other technologies require different skill mixes. In fuel-based technologies, such as biofuels for transport, feedstock production and distribution of biofuels account for the largest share of jobs. Even though labour productivity evolves through time, studies have shown that renewable energy technologies are currently more labour intensive than fossil fuel technologies, with solar PV technology accounting for the highest number of job-years per GWh over the lifetime of the facility.

Job Distribution and Skills Levels

On average renewable energy jobs are relatively highly skilled, although unskilled workers are also needed. Graduates are needed to fill positions in fields such as engineering, meteorology, project development and research and development, while system design, installation or construction are more likely to require vocational qualifications. A number of unskilled jobs may be created in construction, transport and administration.

Existing Jobs

Estimated gross global renewable energy employment increased from 1.3 to more than 3.5 million jobs worldwide between 2004 and 2010. Most studies conclude that a high proportion of jobs are related to fuel-based technologies. The biofuels sector is estimated to account for about half of the jobs in the renewable energy industry (1.5 million in 2010). The largest number of jobs related to any one fuel-free technology was in the solar thermal sector (over 600,000 jobs in 2006).

Future Possibilities

The most studies show a positive future for jobs in renewable energy. One study suggests gross employment effects of up to 20 million jobs by 2030, with the highest job creation in the biofuel sector (up to 12 million) followed by solar (6.3 million) and wind (2.1 million).

Another study suggests that if countries remain dependent on fossil fuels, energy sector jobs will decline by 0.5 million by 2030 due to increasing labour productivity. By contrast, a wider deployment of renewable energy results in a net increase of two million jobs in the energy sector compared to 2010, to a total of 11.3 million, of which 6.9 million are renewable energy jobs.
Source Link:
http://www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Jobs_abstract.pdf

WORKING IN THE RENEWABLE ENERGY SECTOR

Renewable energy is a fast growing industry that has the potential to generate tens of thousands of jobs and offers long-term job security.
With rapid development already taking place in renewables, newcomers to the industry will have the opportunity to play a major part. In the UK alone over 600 companies engage in wind and marine energy related business activities. These range from large energy utility companies through to small organizations with only a handful of employees.

Careers in renewables tend to be challenging but there is huge potential for advancement.
"*Working environments vary depending on the area you specialize in. You could work outdoors on site, both on land and out at sea, in an office, or even in a laboratory,*" highlights Sophie Bennett, skills and employment policy officer at Renewable UK. "*Some roles, such as site or field engineers, could require extended periods working away from home, while other allow for more regular hours. Many roles involve travel and working in unique places.*"

Career Opportunities within the Renewable Energy Sector

The variety of career pathways and entry routes into the renewables sector is vast. A single project requires the contribution of many people employed in many different jobs, so individuals with a range of backgrounds and skill sets are needed. Jobs in the sector can be split into project development phases:

- Research, planning and development - e.g. data analysts, planners, software developers, GIS technicians, environmental analysts, oceanographers, ecologists, aerodynamics specialists, technical experts, scientists, mechanical and electrical engineers.
- Design and manufacture - e.g. procurement and selection of kit, technical designers, mechanical and electrical engineers, electrical and grid connection design, geophysicists, marine/technical experts.
- Construction and installation - e.g. project managers, contract managers, site management, cabling, civil engineers, and construction.
- Operations and maintenance - e.g. grid connection, electricity generation, physical inspection and maintenance, technician.
- Support services - e.g. business development, communication and public relations, human resources, finance, legal support, administration, facilities management.

Source Link: http://www.theiet.org/apprentices/area-engineering/renewable-energy.cfm

WORLD NEEDS STRONGER RENEWABLE ENERGY SECTOR

World needs more and more energy. Increase in population also increases demand for energy and world is always looking for new energetic solutions that would ensure adequate global energy supply. There are also times when global energy demand is experiencing decline (global financial crisis, global recession) but these are only temporary happenings, and once they finish hunger for more energy is even bigger than it was before these temporary situations.

World satisfies its energy needs mainly from non-renewable energy sources - fossil fuels, mostly coal, and then oil and natural gas. Not only that these energy sources are non-renewable which means that they cannot last for eternity, they are also not ecologically acceptable because they are not only responsible for different forms of pollution, but also for one of the biggest challenges in human history - climate change and global warming. Majority agrees that global warming phenomenon is mostly result of man-made activity due to excessive fossil fuels burning, and the only thing that can slow down the impact of global warming is drastic cut in CO_2 (carbon dioxide), and other greenhouse gas emissions. In order to do so we need to stop being so dependent on fossil fuels, because as long as coal, oil, and natural gas hold "top energy sources" spot world won't make that step forward that we so desperately need. This is where renewable energy sources should step in and make the difference. Can we really expect this in near future?

There are many reasons why fossil fuels are still dominant sources in so many countries worldwide. First of all these are traditional energy sources with very long history, and of course very strong lobbies that know how to dictate political will, and influence political leaders to support them. Second is their price, for instance many developing countries are only looking the cheapest energy solutions to revive their economies, and coal is one of the cheapest available energy sources. China and India, countries that have lately experienced big economy boom owe their success mainly to coal, and they have no plans to abandon coal in near future. Third reason is lack of adequate support from technology to renewable energy sector. This third reason is definitely making things very difficult for renewable energy sector to compete with fossil fuels. There are still not enough funds poured into renewable energy sector to become competitive on global scale, and without necessary funds it is really impossible to expect miracles overnight.

Many energy experts believe that fossil fuels prices need to skyrocket before we can see change because at the time when oil prices were constantly rising, and passed the $100 barrier there was lot of talk about the necessity for much stronger renewable energy sector since at that time renewables seemed as the economically acceptable solution. But as soon oil prices started falling due to global recession and decreased energy demand world started forgetting renewables and fossil fuels still remained No.1 energy sources. What renewable energy sources really need is to become price competitive with fossil fuels since economies are always on the lookout for the cheapest energy solutions, and renewable energy sources still have a long way to go before becoming price competitive with fossil fuels, especially if we do not see significant changes in funding in years to come.

The only thing that really has decent chance to boost renewable energy sector and make it dominant is climate change. Scientists are constantly warning world leaders how they should act as soon as possible and decrease greenhouse gas emissions, and fossil fuels use (or to be more precise fossil fuels burning) is the main factor responsible for these emissions. Though world leaders are planning significant cut in emissions this doesn't mean that world will be using less energy because of this, and this is the real chance for renewable energy sector.

Renewable energy sector has one very big advantage over fossil fuels, the fact that it is highly ecologically acceptable compared to "dirty" fossil fuels, because renewable energy sources release very little CO_2 emissions into atmosphere compared to fossil fuels as the convincingly biggest pollutants. Renewable energy sector should be heavily building on this big advantage to ensure energy dominance in years to come, and if the world leaders agree new climate change deal like they are talking they would (significant drop in emissions on global level), renewable energy sector will receive much more funding which could in the end result in the cost competitiveness with fossil fuels. However there is still lot of "ifs" involved, and we still need to see this new climate deal before we can talk about the actual chances for renewable energy sector to become dominant, and when exactly can we expect this dominance to happen.

There are many countries around the world that have given us a good example on big potential that renewable energy sources undoubtedly have, for instance Germany with their wind power sector, Iceland with their geothermal energy use, China with hydro energy, and even some U.S. states like Arizona and Florida with solar power projects. Potential is undoubtedly there, but renewable energy sector still needs support from technology in order to develop as much as possible and become much more affordable, and of course more efficient. With the adequate funding this can surely be achieved, the only question is how much time will be needed.

Even if the world accepts drastic cuts in CO_2 emissions and signs new climate deal this won't mean that we will be no longer using fossil fuels, this will only mean that there is a much stronger emphasis on renewable energy sector that will have to gradually replace fossil fuels, and become sufficient for satisfying world's demand for energy. This can be done successfully only if there is constant work on developing technologies, and constant growth of renewable energy projects worldwide. Worldwide use is key factor in the whole story because everything has to be done on global scale, with world leading countries giving right example to the rest of the world.

Of course we should also expect heavy resistance from fossil fuel sector because there are some pretty powerful lobbies and billions of dollars involved in the whole story, so things probably won't go smooth as many think they would. Some old energy titans will have to fall down before we see new world's energy policy, and this won't be easy to achieve. But still I expect renewables to become dominant energy sources by the end of this century because they offer best solution to climate change problem, and climate change problem is likely to haunt us for many centuries.

The important step forward to renewable energy sector is definitely new climate deal which should happen very soon, and there is really no reason why it shouldn't happen because not only world leaders can learn from Kyoto protocol mistakes but there is also strong political will (apparently) to make it happen.

Once this new climate deal is behind us then we can start talking about actual measures that would mean strengthening of renewable energy sector (like bigger taxes for non-renewable energy sources, more funds for renewables, and financial aid for developing countries so they can develop their own renewable energy sectors).

Rich countries have great responsibility, not only will they have to further develop their own renewable energy sector, but they will also have to share technologies and give enough money to poor developing countries so they can also start developing their own renewable energy sectors. This will by no means be an easy task, but it can be done if there's an agreement between rich countries. Without adequate funding and necessary technologies developing countries will still remain fateful to coal as the cheapest and the most available energy source with relatively easy implementation, and this won't change things on global

level. New energy policy is needed on global scale, not just in rich states, although at the end it is all in the hands of rich states, and their political will. Hopefully rich countries are aware of the fact that world needs to act globally on all-important questions, and new energy policy is definitely one of the most important questions.
The thing that worries the most is that politics always plays the key role in almost every aspect of life, and energy issues are sadly no exception. Energy experts, as well as the scientists can put lots of efforts and offer different logical solutions but if politics fail to do their part all their efforts are pretty much useless. Talk is one thing, and action something completely different and world definitely needs action to create new energy policy.
Renewable energy sector definitely deserves further development, and it needs to become much stronger in years to come.
Source
Link:http://www.our-energy.com/world_needs_stronger_renewable_energy_sector.html

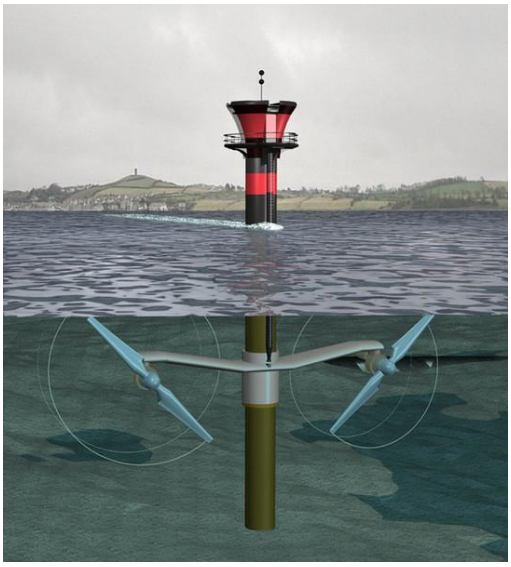
WIND ENERGY JOBS:

As the industry grows and matures, the demand for technical expertise is being extended to expertise in the softer areas such as PR, community liaison, environmental impact, etc. The sector offers capable and energetic individuals vast potential to succeed in an industry which is growing faster than any other. The international nature of the wind industry means that individuals with additional language skills are especially valued.

The successful implementation of wind energy projects tends to rely on a wide partnership of players, both large and small. Therefore, depending on personal preference, it is possible to choose a work with either small companies providing a specialist niche product or very large companies such as the international utility giants, which are now developing wind energy teams.

WAVE ENERGY - WAVE POWER JOBS:

Wave power is one of our largest renewable energy sources, but until very recently we have lacked the Technologies to harness such raw energy. There are now thousands of patents describing potential wave energy devices, but very few have been translated into working prototypes, and even less into devices with the survivability needed.



However, feed in tariffs for energy derived from marine sources are increased by certain governments ,many new designs are sure to leave the drawing board or CAD file- only time will tell which ones will form the backbone of the future industry.

SUSTAINABILITY: GREEN TRANSPORT

SOLAR: Solar vehicles are definitely an option for the future. A technical leap in the conversion rates of PV could allow %100 solar vehicles.

HYDROGEN:

If hydrogen is to power our future transportation, either through use of electrical motors, and fuel cell technology or improved internal combustion engines, the hydrogen must be sourced from non-fossils fuels.

Detractors point to the present expense of fuel cell technology and the difficulties of storing hydrogen on board at sufficient densities.

However progress is being made in all these areas, it is the challenge to source the actual hydrogen from renewable resources that is woefully behind schedule.

CARBON MANAGEMENT JOBS - OFFSETTING EMISSIONS:

By a rigorous process of carbon auditing, businesses can assess their existing carbon footprint, and the carbon offsets required in order to balance their green house gas emissions.

JOBS IN THE WATER INDUSTRY:

Opportunities exist in all areas of the industry, from senior Project leaders responsible for overseeing large civil engineering works to biological monitoring and water treatment roles within environmental health.

Water engineers with experience on the ground, and those with necessary skills for hydrological modelling are needed for every activity in the sector.

Chemical Engineer - engineer with a thorough knowledge of process design as well as troubleshooting experience in the same field.

Downstream Corrosion Engineer - join the Operations Support Division of the Consulting Services Department that provides with effective specialized engineering consultations, introduces viable technologies and maintains quality standards.

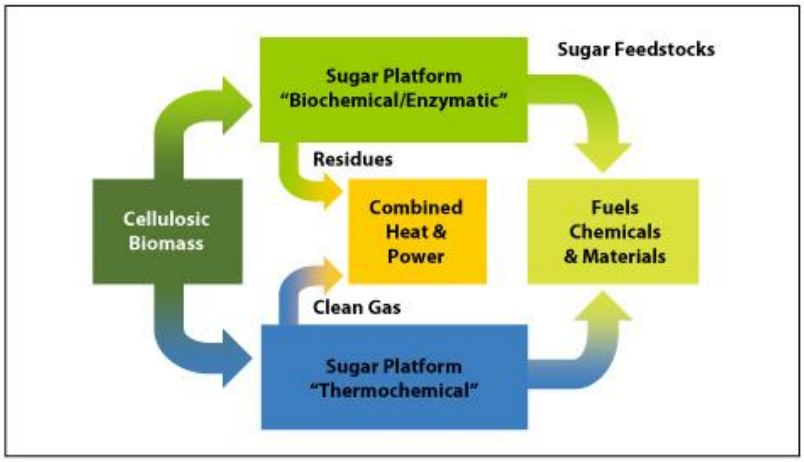
Environmental Jobs: Project Managers, EIA Consultants, Environmental Planners, Marine EIA Consultants, Marine Environmental Consultants, Marine Ecologists, Ecologists and Environmental Compliance Officers.

Waste Energy Jobs and Renewable Energy Jobs: Planning & Development, Design & Engineering, Construction, Operations & Maintenance, Commercial & Procurement, Business Development & Sales & Environmental.

Solar Jobs and Photovoltaic Energy: Planning & Development, Design & Engineering, Construction, Operations & Maintenance, Commercial & Procurement, Business Development & Sales & Environmental.

Bio Energy Jobs: Biomass Engineering Design **Responsibilities:** Build a high level of engineering solution design expertise within the team and the business for biomass energy systems; conduct detailed design exercises for biomass energy installations; Support the business development efforts by delivering the design and technical input to tenders for biomass heating and power installations, district heating and other bio-energy projects; build and manage the team of design engineers; run the services part of the business which includes remote monitoring services of existing installations with alerts provided to field staff when required.

Biomass and Biofuel Jobs: identify new sources of fuel.



Onshore Wind Jobs: Onshore Wind Farm Developer - site selection and evaluation, through project design and environmental assessment, submission of consent applications and into pre-construction; require to have an understanding of how the environmental, technical and

commercial aspects of each project interact; liaise and negotiate with landowners, planning authorities, statutory consults, stakeholder groups and the wider public; ensure resources are available and applied to support the efficient development of projects in such areas; manage environmental, technical and commercial interactions; liaising and negotiating with landowners on both development sites and access routes.

Commercial Analyst – Renewable: assist in setting up and maintaining sources of deal flow; assess investment opportunities and decide initial go-ahead; perform further investment opportunity analysis.

Onshore Wind Farm Development Manager: develop of wind farm sites. This will involve site screening and selection through to consenting and financial close of wind farm projects; deliver projects, including engineering and technical support, Environmental Impact Assessment studies, grid studies, consultants, commercial support and other stakeholders; formulate and implement project development plans and manage development budgets within the company strategy and business plan; having a degree in an environmental, engineering, planning or science based subject with experience of developing infrastructure projects.

Planning engineer – nuclear: having a degree in nuclear research sector, a specialty in the area.

Planning engineer – biomass conversion: graduate or professionally qualified engineer; with a chemical/process, mechanical or thermal background; expertise in the design and construction of process plant for industrial or utilities applications.

Planning Engineer – Green: engineering background in a relevant sector; experience in civil and/or process engineering; Technical/ engineering competence and appreciation: ability to recognize technical solutions benefits and deficiencies of supply chain also versus competitor offerings; engineering degree in one/ more of: mechanical, civil, process, chemical, renewable energy (or equivalent).

Metallurgical Engineering Specialist: knowledge in field operations upstream facilities, pipelines, refineries, gas plants and terminals; treatment procedures for operations; investigation studies; conduct metallurgical failure analyses to determine root causes and recommend corrective actions to prevent recurrence; provide material selection recommendations based on standards and technical information; perform materials testing, evaluation and selection; teach professional courses in materials Selection and failure analysis; bachelor's degree in materials engineering or related engineering degree from an accredited university in metallurgical and welding engineering, in oil and gas operations.

OCCUPATIONS IN SOLAR POWER

The solar power industry employs a wide range of occupations in a number of major industry segments:

- research and development,
- manufacturing of solar power materials,
- construction of solar power plants,
- operation of solar power plants,
- solar power installation and maintenance.

Sales occupations are also integral to the solar power products industry.

Following are descriptions of the most common jobs in the solar power industry; for each occupation, job duties are listed, along with the credentials needed for the occupation, including education, training, certification, or licensure. *Certification* demonstrates competency in a skill or set of skills, typically through work experience, training, the passage of an examination, or some combination of the three. *Licensing* is done by individual states, and typically requires the passage of an examination in addition to fulfillment of eligibility requirements, such as a minimum level of education, work experience, training, or the completion of an internship, residency, or apprenticeship.

The majority of the occupations listed here are not specific to the solar power industry—they exist in many other industries as well. Although many of these occupations require special skills unique to solar power, skills can be acquired in other industries in most cases. For many positions, experience in other industries is desired by employers in the solar power industry. For example, solar photovoltaic installers need to have specialized knowledge and training, but many installers have previous experience as roofers, electricians, or construction workers.

1. Occupations in Scientific Research

Solar power is still gaining popularity and acceptance, so research and development are key aspects of the industry. Continued research and increased returns to scale as production has increased have led to many developments that have decreased costs while increasing efficiency, reliability, and aesthetics. For example, new materials have been developed that allow for low-cost and lightweight thin-film solar panels that are less expensive to produce and easier to transport than glass- or laminate-coated solar panels.

Occupations in scientific research and development have become increasingly interdisciplinary, and as a result, it is common for physicists, chemists, materials scientists, and engineers to work together as part of a team. Most scientists in the solar industry work in an office or laboratory and also spend some time in manufacturing facilities with engineers and processing specialists.

Job Duties

Physicists observe, measure, interpret, and develop theories to explain physical phenomena using mathematics. In the solar power industry, physicists work with chemists, materials scientists, and engineers to improve the efficiency of solar panels. Physicists also find new materials to use for solar panel generation, such as the thin-film photovoltaic solar panels.

Chemists investigate the properties, composition, and structure of matter and the laws that govern the reactions of substances to each other. Using this knowledge, chemists in the solar power industry are able to improve on solar cell design, develop new materials for making solar cells, or improve existing materials. They typically focus on semiconducting materials, which are usually silicon-based materials or organic compounds, because most solar panels are made of semiconducting materials and some newer thin-film panels are made out of organic materials.

Materials scientists study the structures and chemical properties of various materials to develop new products or enhance existing ones. Current research in the solar power field is focused on developing new materials, especially thin-film cells, and decreasing the cost of photovoltaic panels. Materials scientists are also seeking to increase solar panel efficiency. Efficiency refers to the percentage of available energy that is actually harnessed by the solar cells. Most modern solar cells can only harvest about 10 to 15 percent of solar energy, with some types of panels capable of 25 to 30 percent efficiency. Finally, material scientists are seeking to create building-integrated solar energy technologies that address common complaints about solar panels taking away the aesthetic appeal of a building because of their large and bulky nature.

Credentials

A doctoral degree is a necessity for scientists that conduct original research and develop new products; however, some workers may enter the scientific fields with a bachelor's or master's degree. Computer skills are essential for scientists to perform data analysis, integration, modeling, and testing. Certification or licensure is not necessary for most of these scientists.

2. Occupations in Solar Power Engineering

Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between scientific research and commercial applications. Many engineers specify precise functional requirements, and then design, test, and integrate components to produce designs for new products. After the design phase, engineers are responsible for evaluating a design's effectiveness, cost, reliability, and safety. Engineers use computers extensively to produce and analyze designs, and for simulating and testing solar energy systems. Computers are also necessary for monitoring quality control processes. Computer software developers design the software and other systems needed to manufacture solar components, manage the production of solar panels, and control some solar generating systems.

Most engineers work in offices, laboratories, or industrial plants. Engineers are typically employed by manufacturers of solar equipment and may travel frequently to different worksites, including to plants in Asia and Europe.

Engineers are one of the most sought-after occupations by employers in the solar power industry. According to the Solar Foundation, 53 percent of manufacturing firms reported difficulty in hiring qualified engineers in 2010.

Job duties

Materials engineers are involved in the development, processing, and testing of the materials for use in products that must meet specialized design and performance specifications. In the solar industry, they work with semiconductors, metals, plastics, glass, and composites (mixtures of these materials) to create new materials that meet electrical and chemical requirements of solar cells. They create and study materials at an atomic level, using advanced processes to replicate the characteristics of those materials and their components using computer modeling programs.

Chemical engineers apply the principles of chemistry to design or improve equipment or to devise processes for manufacturing chemicals and products.

In the solar power industry, they design equipment and processes for large-scale manufacturing, plan and test methods of manufacturing solar cells, and supervise the production of solar cells. Chemical engineers in the solar industry typically focus on semiconductors or organic chemistry, since most solar panels are made of semiconducting materials and some newer thin-film panels are made out of organic materials.

Electrical engineers design, develop, test, and supervise the manufacture of electrical components. They are responsible for designing the electrical circuitry of solar panels and supporting devices for panels, such as inverters and wiring systems.
Industrial engineers determine the most effective ways to use the basic factors of production — people, machines, materials, information, and energy — to make a product or provide a service. In the solar power industry, they are concerned primarily with increasing productivity through the management of people, the use of technology, and the improvement of production methods of solar cells or mirrors. To maximize efficiency, industrial engineers study the product requirements carefully and design manufacturing and information systems with the help of mathematical models.

Mechanical engineers research, design, develop, manufacture, and test tools, engines, machines, and other mechanical devices. Engineers in the solar power industry work on the machines used in the manufacturing of solar panels. In the United States, solar photovoltaic manufacturing is highly automated. Machines do the majority of work: cutting semiconducting materials, such as crystalline silicon, into wafers, turning them into solar cells, and assembling the solar cells into solar panels. Besides machines, mechanical engineers also design and test the electric generators and pumps that are used in concentrating solar power plants.

Computer software developers are computer specialists who design and develop software used for a variety of purposes. In the solar power industry, computer software is used in forecasting weather and sunlight patterns to assess the feasibility and cost of generating solar power in a particular area. In power plants, software is used to monitor the equipment and to adjust the direction of mirrors or photovoltaic panels so that the maximum amount of energy is captured as the sun moves in the sky. Software developers are responsible for updating, repairing, expanding, and modifying existing programs.

Engineering technicians assist engineers with solving technical problems in research, development, manufacturing, construction, inspection, and maintenance. Their work is more narrowly focused and application-oriented than that of engineers or scientists. Engineering technicians who work in the research and development of solar panels or machines will build or set up equipment, prepare and conduct experiments, collect data, and calculate or record results. They may also help engineers or scientists to make prototypes of newly designed equipment or assist with computer-aided design and drafting (CADD) equipment.

Credentials

Engineers typically enter the solar industry with a bachelor's degree in engineering. However, because of the complexity of some systems, a significant number of jobs require a master's or doctoral degree. Engineers are expected to complete continuing education and keep up with rapidly changing technology.

Certifications are usually required and depend on the systems used by a particular manufacturer. Licensure as a professional engineer (PE) is desirable and often required, depending on an engineer's specialty.

Entry-level engineers may be hired as interns or junior team members and work under the close supervision of senior or supervisory engineers. As they gain experience, they are assigned more complex tasks and are given greater independence and leadership responsibilities.

Software developers typically have at least a bachelor's degree in computer science or a related discipline, combined with experience in computer programming and software design.

Engineering technicians typically have an associate's degree or certification from a community college or technical school. Technicians participate in on-the-job training and are closely supervised by engineers.

SOLAR ENEGY JOBS - PV:

Although traditionally expensive, the hard wearing, zero maintenance nature of PV already Powers the global satellite communication infrastructure, navigation lighting buoys and weather data logging instrumentation. Economies of scale promise to bring such technology within the pocket of the individual consumer and encourage the integration of PV systems into buildings.

BIOFUELS:

BIO-OILS: There are many useful varieties of plants and trees which yield high quantities of oil in their seeds and fruit such as sun flower or oil palm. In addition to processing seed oil, high temperature extraction and purification processes now allow oil to be obtained from less valuable material such as agricultural residues and waste biomass. Such oil can be combusted in its pure form, but requires additives to overcome the high gel point of pure plant oils such as soya, at which point it is termed biodiesel.

GREEN BUILDINGS - SUSTAINABILITY:

GREEN BUILDING

The adoption of micro-renewables, and software packages to aid the design and management of energy systems within buildings, has created new jobs opportunities .There is a demand to fill positions such as Energy Manager, Energy Control Systems, Engineer for individuals adept at computer modelling, or installing and commissioning of solar, wind and other micro-renewables technologies.

3. Occupations in Manufacturing for Solar Power

Manufacturing in the solar industry focuses on three technologies: concentrating solar power (CSP), photovoltaic solar power, and solar water heating. However, the vast majority of solar manufacturing firms focus mainly on photovoltaic solar power and producing photovoltaic panels. The production process for photovoltaic panels is more complex than for CSP components, and it involves complicated electronics. Making photovoltaic panels requires the work of many skilled workers, including semiconductor processors, computer-controlled machine tool operators, glaziers, and coating and painting workers. The manufacture of CSP mirrors includes many of the same occupations.

Job duties

Semiconductor processors are workers who oversee the manufacturing process of solar cells. Semiconductors are unique substances, which act as either conductors or insulators of electricity, depending on the conditions. Semiconductor processors turn semiconductors into photovoltaic cells. The process begins with the production of cylinders of silicon or other semiconducting materials, which are called ingots. The ingots are sliced into thin wafers using automated equipment, and are sometimes polished. The wafers are then connected to metal strips and placed into the cells. These cells are then arranged into larger solar panels.
The electrical circuitry of solar cells is very small, and microscopic contamination can render the cell useless. Because of this, most of the manufacturing processes are automated, and it is important to have workers to monitor the equipment and make adjustments as necessary.

They also perform necessary maintenance and repairs on equipment. Semiconductor processors test completed cells and perform diagnostic analyses. Workers are required to wear special lightweight outer garments known as "bunny suits" and spend most of their day working in clean rooms to prevent contamination of the cells and circuitry.

Computer-controlled machine tool operators are workers who run computer numerically controlled (CNC) machines, a machine tool that forms and shapes solar mirror or panel components. Some of the more highly trained CNC workers also program the machines to cut new pieces according to design schematics. CNC operators use machines to mass-produce components that require highly precise cutting. In the solar power industry, they manufacture precisely designed mirrors for CSP plants and many of the components of photovoltaic panels.

Welding, soldering, and brazing workers apply heat to metal pieces during the manufacturing process, melting and fusing them to form a permanent bond. Welders join two or more pieces of metal by melting them together. Soldering and brazing workers use a metal with a lower melting point than that of the original piece, so only the added metal is melted, preventing the piece from warping or distorting. Solar panels are made up of many small cells that are soldered to electric circuitry. This process may be automated, with workers monitoring the machines.

Glaziers are responsible for selecting, cutting, installing, replacing, and removing glass or glass-like materials. Photovoltaic panels are placed in an aluminum frame and are typically encased in glass or laminates to protect them from the elements. The glaziers are responsible for measuring and cutting the glass or laminate to cover the panel; securing it in place; and sealing it using rubber, vinyl, or silicone compounds. It is important to prevent the cover from cracking or scratching thereby reducing the efficiency of the solar panel.

CSP plants are made up of many highly reflective mirrors manufactured to exact specifications. Many of these plants use curved mirrors, which are challenging to produce. Glaziers are instrumental in the manufacturing, installation, and maintenance of these mirrors. Glaziers ensure the mirrors maintain maximum reflectivity in order to perform at desired levels. Because these mirrors are located outdoors and are expensive to make, glaziers must often refinish and refurbish them. Mirrors also break frequently, and glaziers produce the replacements.

Coating and painting machine setters, operators, and tenders apply coatings to solar panels, which can be a complicated process that must be done with a high level of precision. Mirrors in CSP plants are typically coated to protect them from the environment and to make them resistant to scratches and corrosion. Solar photovoltaic panels are also covered in protective coatings, and these coatings increase the efficiency of the panels. Special coatings, such as titanium oxide, make solar panels less reflective and therefore able to absorb more sunlight (or lose less sunlight.)

Before painting or coating a mirror or panel, workers prepare the surface by sanding or grinding away any imperfections. After preparing the surface, it is carefully cleaned to prevent any dust or dirt from becoming trapped under the coating. The coating is then applied by spraying it onto the panel. Many manufacturers apply coatings through an automated process. It is the workers' job to set up the systems, add solvents, monitor the equipment, and feed the pieces through the machines.

Coating and painting workers may be exposed to dangerous fumes from paint and coating solutions and other hazardous chemicals. Workers are usually required to wear masks and special suits to protect them from the fumes produced by paint, solvents, and other chemicals.
Electrical and electronics installers and repairers work on a number of the complex electronic equipment that the solar industry depends on for a variety of functions. Manufacturers use industrial controls to automatically monitor and direct production processes on the factory floor.

Electrical and electronic equipment assemblers put together the final products and the components that go into them. They are responsible for assembling the complex electrical circuitry in a photovoltaic panel, as well as assembling the components, such as inverters or controls, that connect to solar panels. Many of these assemblers operate automated systems to assemble small electronic parts that are too small or fragile for human assembly.
Industrial production managers plan, direct, and coordinate work on the factory floor. They determine which machines will be used, whether new machines need to be purchased, when overtime shifts are necessary, and how to improve the production process. They keep production runs on schedule, and are responsible for solving problems that could jeopardize the quality of the components.

Credentials

The level and type of training necessary for occupations in the solar power manufacturing process varies. Most production workers are trained on the job and gain expertise with experience. Workers in more skilled positions, such as computer-controlled machine tool operators, may attend formal training programs or apprenticeships. Experience working with electronics or semiconductors may be helpful for some of these occupations. Industrial production managers are typically required to have college degrees in business administration, management, industrial technology, or engineering.
Industrial production managers are typically required to have college degrees in business administration, management, industrial technology, or engineering.

4. Occupations in Solar Power Plant Development

Building a solar power plant is complex and site selection requires years of research and planning. The proposed site must meet several criteria: large, relatively flat site, adequate sunlight, and minimal environmental impact once built. Prior to beginning construction on a new solar plant, real estate brokers and scientists must ensure the site is suitable and that the proper federal, state, and local permits are obtained for construction of a power plant.

Job duties

Real estate brokers are instrumental in procuring land on which to build power plants. They are responsible for obtaining the land by purchasing or leasing it from land owners. Real estate brokers must work with local, state, and federal government agencies, community members and organizations, utility companies, and others that have a stake in the proposed power plant. They work alongside lawyers, accountants, and project managers. Real estate brokers also consult with atmospheric scientists to determine if the land is suitable for a solar power plant.

Real estate brokers in the solar industry must have specialized knowledge of property specifications for solar power plants and the regulations in place for obtaining the property. Currently, many large solar plants in the United States have been built on or are proposed to be built on federal lands, so brokers have to work with the Bureau of Land Management to obtain leases for these properties.

Atmospheric scientists (including meteorologists) study the atmosphere and weather patterns. In the solar power industry, they study particular areas being considered for development of a solar power plant. Because the efficiency of solar panels and concentrating solar power plants is highly dependent on the weather of a particular area, atmospheric scientists are needed to study atmospheric and weather conditions prior to the development of plants or large commercial solar projects. They can help determine if solar power will be a cost-effective way to generate energy in a particular area by studying past weather patterns and using computers to create models of expected weather activity. Although many atmospheric scientists work for companies that develop large-scale solar projects, some work for smaller consulting firms that provide these services to individual customers who are considering installing solar power in their homes or small businesses.

Environmental scientists ensure that environmental regulations and policies are followed and that sensitive parts of the ecosystem are protected. Many solar power plants are built in desert areas that have fragile ecosystems and numerous protected species. Construction and operation of plants must have minimal impact on the surrounding environment. Environmental scientists use their knowledge of the natural sciences to minimize hazards to the health of the environment and surrounding population.

Credentials

Real estate brokers typically have a bachelor's degree or a higher degree in business, real estate, law, engineering, or a related discipline. Experience with obtaining land permits and

an understanding of tax and accounting rules are necessary, as well as familiarity with local environmental and energy regulations. Experience working with relevant government agencies, such as the Bureau of Land Management, is also desirable. Companies typically hire people with experience in land acquisition and management and train them to their specific needs.

Atmospheric and environmental scientists typically need a bachelor's degree, but scientists with a master's or doctoral degree are preferred, depending on the scale of the projects they work on. Many of these scientists are hired on for the length of specific projects, and more education and experience makes them more attractive to hire full time. Atmospheric and environmental scientists may also need to be licensed, depending on local regulations.

5. Occupations in Solar Power Plant Construction

Once a site has been selected, civil engineers are responsible for the design of the power plant and related structures. When construction begins, workers are needed to build the actual plant. For a concentrating solar power (CSP) plant, large mirrors are arranged to catch and focus sunlight for power generation, therefore storage tanks, pipes, and

generators must be installed before the plant is connected to the electrical grid. Photovoltaic plants are less complex, requiring installation of arrays of photovoltaic panels before they are connected to transformers and the grid. Construction managers have the responsibility of managing the entire construction process.

Job duties

Construction managers oversee the construction of solar power plants, from site selection to the final construction of the plant. They supervise a team of diverse occupations, including engineers, scientists, construction workers, and heavy-equipment operators. Construction managers are employed by large construction companies, energy companies, or utilities companies and work under contract or as salaried employees. Because of the size of a power plant and the complexity of the construction, a project manager will typically oversee several construction managers, who then supervise individual aspects of the construction.

The construction manager's time is split between working at the construction site and an office, which may be located onsite or offsite. Primary office responsibilities include management of permits, contracts, and the budget. At the site, the construction manager monitors progress and performs inspections for quality control. Construction managers oversee the contracting process and manage various contractors and subcontractors. They are responsible for ensuring a safe work environment where workers adhere to strict site safety policies.

Civil engineers design and supervise the construction of power plants. Solar power plants can take a number of forms and sizes. CSP plants are more like typical power plants and require incorporating large steam turbines and storage tanks, plus a large, flat area for the solar array. Photovoltaic plants are less complex, but are a challenge for engineers to design because the panels are optimally configured to efficiently harvest solar power. Engineers ensure that the land is graded properly and is flat enough to support large arrays of mirrors or photovoltaic panels. Civil engineers are also responsible for designing necessary infrastructure, including roadways, support structures, foundations, and plumbing systems.

Construction laborers perform a wide range of construction-related tasks. Most construction laborers specialize in one component of construction, such as metalworking, concrete pouring and setting, assembly, or demolition. Laborers prepare the site for construction by removing trees and debris. They are also responsible for monitoring and repairing compressors, pumps, and generators, and for erecting scaffolding and other support structures, as well as loading, unloading, identifying, and distributing building materials in accordance with project plans.

Construction equipment operators use machinery to move construction materials, earth, and other heavy materials at a construction site. Many plants require flat, unobstructed ground in order to line up the solar panels or mirrors, and equipment operators operate machinery to clear and grade the land. They also operate cranes to lift and place heavy objects, such as photovoltaic arrays, large mirrors, and turbine generators. They set up and inspect their equipment, make adjustments to the equipment, and perform some maintenance and minor repairs.

Welders who work in solar power plant construction are important for both CSP and photovoltaic plants. In CSP plants, the work of welders includes joining structural beams together when constructing buildings, installing the structures that support the mirrors, and joining pipes together. At photovoltaic plants, welders are instrumental in building the solar panel mounting systems. Panels must be mounted on the ground or on a roof using metal beams, and welders are responsible for attaching these beams together to form the mounts.

Structural iron and steel workers use blueprints to place and install iron or steel girders, columns, and other structures to form the support structures for power plants. These workers also cut the structures to proper size, drill bolts for holes, and number them for onsite

assembly by construction workers or solar photovoltaic installers. The structures are then shipped to worksites where they will be erected by structural iron and steel workers on a construction site.

Credentials

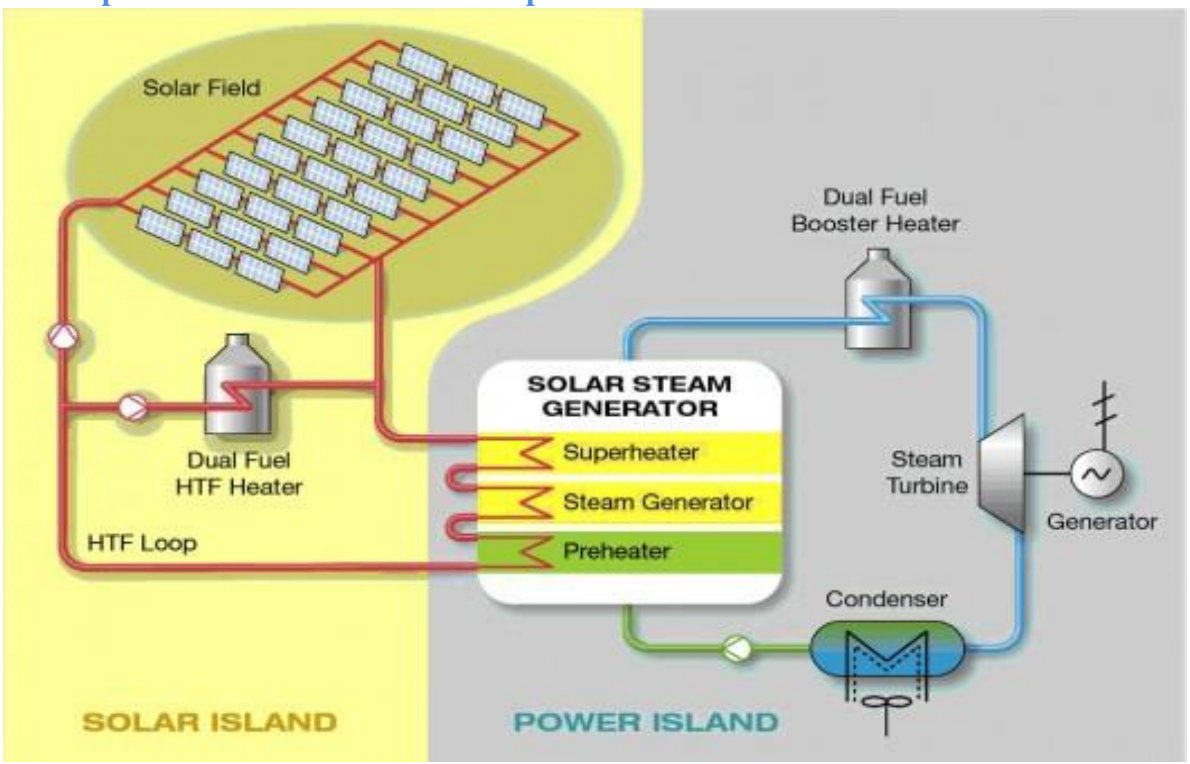
In most construction occupations, workers are trained on the job. Laborers typically work under supervisors, who direct them to complete tasks. As laborers gain more experience and prove their abilities, they may move up to become supervisors. Equipment operators often learn on the job or complete a formal training program, or a combination be certified, which involves some training and testing to ensure competence and safety.

Construction managers are typically educated in construction management, business management, or engineering, and usually have experience working in construction. Experience is important for construction managers, so it may be substituted for some educational requirements. Large, complex projects such as power plants, however, require specialized education. Workers with a degree in construction management or engineering, but without significant experience, may be hired as assistants to construction managers.

Civil engineers have at least a bachelor's degree in civil or structural engineering. Lead engineers on large projects, such as power plants, have specialized experience and typically have at least a master's degree. Licensure as a professional engineer (PE) may be required.

Welders usually learn their trade through on-the-job training or a formal apprenticeship program, or they may attend a formal training program at a trade school or community college. There are many different techniques that welders may use that also require additional training. Structural steel and iron workers are typically trained on the job and may complete additional specialized training.

6. Occupations in Solar Power Plant Operations



Workers at solar power plants install, operate, and maintain equipment. They also monitor the production process and correct any problems that arise during normal operation. Concentrating solar power (CSP) plants require more workers than photovoltaic plants; photovoltaic plants can sometimes even be run remotely.

Job duties

Power plant operators monitor power generation and distribution from control rooms at power plants. They monitor the solar arrays and generators and regulate output from the generators, and they monitor instruments to maintain voltage to regulate electricity flows from the plant. Power plant operators communicate with distribution centers to ensure that the proper amount of electricity is being generated based on demand. They also go on rounds through the plant to check that everything is operating correctly, keeping records of switching operations and loads on generators, lines, and transformers. Operators use computers to report unusual incidents or malfunctioning equipment, and to record maintenance performed during their shifts.

Some CSP plants have a secondary source of power generation, such as natural-gas powered turbines, that will generate power at night or when the weather doesn't allow for sufficient solar power generation. Power plant operators are responsible for monitoring this equipment and deciding when to switch from solar generation to the secondary source.

Pump operators tend, control, and operate pump and manifold systems that transfer oil, water, and other materials throughout the CSP plant. CSP plants use mirrors to heat fluids like molten salt or synthetic oil, which are pumped through the solar heating devices and into a heat-transfer device to produce steam.

Pump operators maintain the equipment and regulate the flow of materials according to a schedule set up by the plant engineers or production supervisors. The work tends to be repetitive and physically demanding. Workers may lift and carry heavy objects and stoop, kneel, crouch, or crawl in awkward positions. Some work at great heights, and most work is done outdoors.

Electricians are responsible for installing and maintaining the electrical equipment and wiring that connects the plant to the electrical grid. Electricians in power plants work with heavy equipment, including generators, inverters, and transformers. They must be familiar with computer systems that regulate the flow of electricity, and they must be comfortable with high-voltage systems.

*Plumbers, pipefitters, and steamfitter*s install, maintain, and repair pipe systems. Pipe systems in power plants carry the heat-transfer material — synthetic oil or molten salt — throughout the plant and into special heat containment units. Other pipes carry steam from the heaters to the turbines that generate electricity. These pipes often carry materials at both high temperatures and high pressure. The workers monitor, regulate, and control flow through the popes using automatic controls.

Plumbers, pipefitters, and steamfitters need physical strength and stamina. They must frequently lift heavy pipes, stand for long periods of time, and work in uncomfortable and cramped positions. They often must work outdoors and in inclement weather conditions. In addition, they are subject to possible injuries brought on by falls from ladders, cuts from sharp objects, and burns from hot pipes or soldering equipment.

Electrical and electronics installers and repairers use electronic power equipment to operate and control generating plants, substations, and monitoring equipment. They install, maintain, and repair these complex systems.

Electrical engineers are responsible for controlling electrical generation and monitoring transmission devices used by electric utilities in power plants.

Credentials

Power plant workers generally need a combination of education, on-the-job training, and experience. Strong mechanical, technical, and computer skills are needed to operate a power plant. Certification by the North American Energy Reliability Corporation (NERC) is necessary for positions that could affect the power grid. Companies also require a strong

math and science background for workers seeking highly technical jobs. Knowledge of these subjects can be obtained through specialized training courses.
Because of security concerns, many power plant operators are subject to background investigations and must have a clean criminal record. They must also be willing to submit to random drug testing. Electricians and pipefitters and steamfitters must be trained on the specific systems on which they work. They attend specialized training programs and undergo extensive on-the-job training.

Selected occupations in the electric power generation, transmission, and distribution industry group
Power plant operators
Pump operators, except wellhead pumpers
Electricians
Plumbers, pipefitters, and steamfitters
Electrical and electronics repairers, powerhouse, substation, and relay

7. Solar Photovoltaic installers

Solar photovoltaic installers are the key to the process of solar panel installation and maintenance. They use specialized skills to install residential and commercial solar projects. They are responsible for safely attaching the panels to the roofs of houses or other buildings and ensuring that the systems work. Solar photovoltaic installers must be able to work with power tools and hand tools at great heights, and possess in-depth knowledge of electrical wiring as well as basic math skills. When necessary, installers must be problem solvers, able to repair damaged systems or replace malfunctioning components. Safety is a priority when installing solar panels because installers run the risk of falling from a roof or being electrocuted by high voltage.
Solar photovoltaic installers are often self-employed as general contractors or employed by solar panel manufacturers or installation companies. Installation companies typically specialize in installing certain types of panels and provide some maintenance and repair services. When a solar panel system is purchased, manufacturers may provide the buyer with installation services or maintenance and repair work. Self-employed installers typically have training and experience with installing solar power systems and are hired directly by the property owners or by a construction firm.

Job duties

The main component of a solar installer's job is the preparation of the installation site. Before the installation process begins, a full audit of a structure is conducted, including a survey of the existing electrical system and developing safety procedures. The job is then designed based on the characteristics of the structure and the type of system being installed. After the layout and equipment are finalized, the permits are obtained from the relevant governments

(local, state, federal, or a combination). If the installers do not do these preparations themselves, they must familiarize themselves with the site before they begin working on it.

Once installation begins, the proper safety equipment, such as a rope and anchor system, must be set up to prevent falls from the rooftop. Often, the building will have to be upgraded to support the solar panels; this may involve reinforcing the roof, replacing rafters, or installing supports to handle the added weight of the panels. The roof must be marked to show where the arrays will be placed, and holes are drilled in the roof to attach the mounting system. After the mounting system is in place, the solar panels can be installed. Workers use caution during installation because the panels are fragile, expensive, and weigh at least 40 pounds each. If the panels are damaged during the installation process, the company has to cover the cost of repair or replacement.

Credentials

Solar photovoltaic installers typically have a background in construction or as electricians. There is no formal training standard for installers, but courses are offered by a variety of institutions, such as trade schools, apprenticeship programs, or by photovoltaic module manufacturers. Training programs vary widely and can range from 1 day to several weeks. Many solar installers are licensed as general contractors. Certification, while not necessary, can improve the job prospects of installers, and many larger projects require workers to be certified.

Solar installers may work alongside roofers, electricians, and plumbers in order to learn the variety of skills needed to complete an installation. Many installers enter the field with previous experience in one or more of these fields. Because of the high skill level required, clients may also ask that both lead installers and those installers who work independently obtain a general contractor's license, depending on regulations of the localities and states where they work.

8. Other Occupations in Solar Panel installation and Maintenance

Other occupations in solar installation and maintenance are site assessors, electricians, plumbers, and roofers. These workers are involved in the installation process but are not classified as solar photovoltaic installers. However, solar photovoltaic installers possess many of the same skills as these occupations and often have work experience in these fields.

Job duties

Site assessors determine how much energy can be harvested at a particular location and then make recommendations based on that assessment. Site assessors help determine the best type, size, and layout of solar panels, and help draw up plans for installation crews. Assessors may take readings of sunlight at a proposed location, review weather patterns, and calculate potential costs and savings. Site assessors are usually hired for commercial projects by companies that are making substantial investments in solar power and therefore want to ensure maximum benefits from the project. Some site assessors may consult with homeowners or solar installation companies on residential projects.

Electricians install and maintain all of the electrical and power systems in a home or business. They install and maintain the wiring and control the equipment through which electricity flows. Electricians are responsible for connecting the solar panels, inverter, and other equipment to a building's power supply. Electricians may or may not specialize in solar installation; however, most electricians that work with solar panels have some experience or training on solar power equipment. If a new building or house is being constructed with a solar power generating system, electricians may be responsible for installing the solar power system along with the electrical wiring system, or they may be responsible for simply connecting the solar equipment.

Plumbers install solar water heating systems. These systems replace or augment a conventional water heater and must be connected to a house's or building's plumbing. To install these systems, plumbers require specialized training to work with solar water heater equipment.

Roofers install and repair roofs, and they ensure that any cuts or holes made in the roof during the installation of solar panels and mounting racks are properly repaired and sealed. They may also assist with the installation of mounting systems and structural supports. Roofers typically work with a variety of materials including tar, asphalt, gravel, rubber, thermoplastic, metal, and shingles. Roofing work is very strenuous. It requires workers to be on hot roofs for long periods of time, and it carries the risk of falls and other injuries.

Credentials

Site assessors generally have past experience with electrical or roofing work or experience as solar photovoltaic installers. They receive on-the-job training as well as specialized training in the equipment and techniques used to assess a site for a potential solar project. Some formal educational programs are available that teach basic site assessment including how to gauge the feasibility of solar generation, estimate costs, and determine which products to use.

Plumbers and electricians receive training through supervised apprenticeships administered by technical schools or community colleges. Apprenticeships usually consist of 4 or 5 years of paid on-the-job training and at least 144 hours of related classroom instruction per year. Most states require plumbers and electricians to be licensed. Licensing requirements vary, but it is common for states to require between 2 and 5 years of experience, followed by an examination that tests knowledge of trade and local codes. Applicants for apprenticeships must be at least 18 years old and in good physical condition. Drug tests may be required, and most apprenticeship programs ask that applicants have at least a high school diploma or equivalent.

Plumbers and electricians working on solar installation projects must also have specialized training on the systems that they will be installing, or they must work under the supervision of a qualified solar photovoltaic installer.

Roofers typically have on-the-job training and may participate in 3-year apprenticeship program. Many roofers in the solar industry educate themselves through additional training, or they gain experience to become solar photovoltaic installers.

9. Occupations Supporting the Solar Power Industry

The advancement of the solar power industry has led to job creation in a number of other occupations as well. Many of these jobs do not concentrate on solar power, but they provide support

to solar energy production and contribute to the industry as a whole. For instance, the solar power supply chain consists of many different manufacturers of varying sizes. Foundry workers are an important part of this supply chain; they cast metal, plastics, and composites out of raw materials into individual components for solar energy production.

Solar manufacturers need trained salespeople to sell their products to customers. Sales representatives, sales engineers, and sales managers are instrumental in matching a company's products to consumers' needs. They are responsible for making their products known and generating interest in the products. Sales professionals may work directly for manufacturers, distributers, installers, or consulting services. A salesperson must stay abreast of new products and the changing needs of customers. They attend trade shows at which new products and technologies are showcased.

Conclusion

Clean energy such as solar power is expected to be a key piece of the growing "green economy," and jobs in solar power show great potential for new employment opportunities. Jobs are expected to grow in all the major sectors of the solar power industry: manufacturing, project development, construction, operation and maintenance, and installation. This growth in the solar power industry is evidenced by the rapid increase in solar capacity over the past several years, leading to the increased the demand for skilled workers. Jobs in this industry are located in many states and cover a wide variety of occupations. As solar technology evolves and new uses for solar power are discovered, occupations in the industry will continue to grow and develop.

JOB AREAS:

Business & Financial
Solar Thermal
Domestic Hot water
Solar cooking
Passive solar
Solar pumps
PV systems
Grid tied inverters
Battery systems
System Design
Building integration
PV Installers
Solar Powered
Vehicles
Aircraft
Consumer goods
Buildings
Communities
Non-technical
Sales
Communications
Marketing
Public Relations
Human Resources

OCCUPATIONS IN BIOFUELS

The biofuels industry employs a wide range of workers in a variety of occupations. Scientists and engineers conduct research and development; construction workers build plants and update infrastructure; agricultural workers grow and harvest feedstocks; plant workers process feedstocks into fuel; and sales workers sell the biofuels.

There are workers in other industries that help to bring biofuels to market, too. For example, scientists and engineers who work on biofuels are often employed by scientific research and development or engineering services firms, so they are included in data for those industries.
Following are descriptions of some of the most common jobs in the biofuels industry, along with information on the duties associated with the jobs and the credentials needed to attain a job in the field. Wage data also are included in the occupation descriptions. Wage data do not include benefits or other compensation.

1. Occupations in Scientific Research

Scientists work to find the best, most cost-effective way of turning feedstocks into fuel. They conduct experiments, document their results, and maintain various instruments in a laboratory setting. Scientists and researchers often work for a wide variety of organizations, such as colleges, private and nonprofit companies, and government agencies. Scientists generally work in offices or laboratories, though some may work in a production plant.
Biochemists and biophysicists study the chemical and physical principles of living things and biological processes. Those who work in alternative fuels may research various technologies that can be used to break down feedstocks into fuel.
Chemical or laboratory technicians use special instruments and techniques to assist scientists and engineers in researching, developing, and producing chemical products and processes. They conduct research, test for quality control, and perform analyses based on their experiments. Technicians may blend various chemicals for processing or to test the quality of a batch of fuel.
Chemists study the properties, structures, compositions, and reactions of matter. They study various chemical processes that can be used to more efficiently produce biofuels. Chemists blend various compounds to see what inputs yield the best quality blends of fuel at a

reasonable cost. Based on their findings, they develop new protocols for blending fuels to ensure quality control.

Microbiologists study the growth, structure, development, and characteristics of microscopic organisms, such as bacteria, algae, or plant cells. They may use their knowledge of various forms of bacteria to improve the fermentation process used to make ethanol or to develop new ways of cultivating algae to use as a feedstock.

Soil and plant scientists conduct research on soil, crops, and other agricultural products to find new and improved ways to use various agricultural products for fuel. A plant scientist may test several types of perennial grasses to see which can be most efficiently broken down into simple sugars. Plant scientists also work to improve crop yields by using techniques that could enhance feedstock production efforts.

Credentials

Most scientist positions require a bachelor's degree from a program that includes both coursework and laboratory hours. A scientist who is leading a research team or conducting independent research may need a master's or doctoral degree to do so. Biochemists and biophysicists typically need a doctoral degree to enter the occupation. It is common for scientists to pursue a specialized degree in a subfield, such as bacteriology or toxicology.

Although some lab technician jobs typically require an associate's degree or 2 years of postsecondary training, a bachelor's degree in science is sometimes preferred. Technician jobs generally require some laboratory experience and a strong background in math and science.

Analytical skills are important for those conducting experiments and determining an outcome or a reasonable way to continue an experiment. Scientists and technicians also need oral and written communication skills because they often work as part of a team and must effectively communicate the results of their analysis to others. In addition, scientists and technicians must be detail-oriented when conducting experiments and recording data.

2. Occupations in Engineering

Engineers use scientific and technological research to develop commercial applications and economic solutions. They design and test various products and machinery. In the biofuels industry, many engineers are involved in much of the same work as scientists, evaluating both existing and potential feedstocks, and examining which sources provide the best energy at a reasonable cost. However, they also may work on processing facility design and be familiar with industrial equipment.

Engineers develop project plans and establish budgets. At processing plants, engineers work to ensure quality control and a steady flow of materials. They also ensure that federal, state, and local safety regulations are met and company standard operating procedures are followed.

Agricultural engineers apply technological advances to farming. These engineers are experts in agriculture and horticulture, and they study existing and potential feedstocks to determine which plants can be best used to produce fuel. They must consider the best time of year for various feedstocks to be grown and the best location to cultivate them, as well as the waste products that will be generated in their production. Agricultural engineers also may design processing plants and other structures involved in storing and processing feedstocks.

Chemical engineers apply the principles of chemistry, biology, and physics to solve problems. They design plant equipment and establish various processes and protocols for manufacturing biofuels as well as the chemicals that are used to convert raw materials into fuel.

Some chemical engineers receive additional training or education to become biochemical engineers. In addition to the basic chemical engineering principles, biochemical engineers

have in-depth knowledge of biological systems, such as the production of specific products using enzymes or microorganisms. Chemical engineers and biochemical engineers often work together in a biofuel production facility. For instance, biochemical engineers develop and implement a fermentation process for production of ethanol from sugars, and chemical engineers distill and purify the compound.

Civil engineers design and supervise the construction of biofuel processing plants. When designing a plant, they consider a number of factors, including costs, government regulations, potential environmental hazards, and proximity to feedstocks. They may need to retrofit an existing petroleum plant or convert a biofuel plant so that it can process additional types of feedstocks.

Electrical engineers research, design, develop, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, or scientific use. Within a biofuel plant, electrical engineers may work with various motors, power generation equipment, lighting, or any electrical controls for industrial equipment that are needed for the plant to run.

Environmental engineers use the principles of engineering, soil science, biology, and chemistry to develop solutions to environmental problems. They work to improve waste treatments and water systems, and to find ways to limit emissions from fuel processing. For instance, an environmental engineer may work to minimize the natural gases that are released while burning materials at a plant, thereby preventing or reducing the degradation of the atmosphere or local soil and water systems.

Industrial engineers find ways to eliminate wastefulness in production processes. They may work to determine the most efficient way to use workers, machines, materials, information, and energy to make biofuels using a given feedstock or chemical process.

Mechanical engineers research, design, develop, build, and test mechanical devices, including tools, engines, and machines used in a processing plant. They also may oversee installation, maintenance, and repair of equipment. Mechanical engineers often provide a plan for the layout of equipment at a new plant, or they provide suggested plans for implementing new equipment. For instance, a mechanical engineer may work on developing precursor equipment that can begin the process of breaking feedstocks down into sugar before they are transported to a processing plant.

Credentials

Engineering jobs typically require a bachelor's degree in a related engineering field. However, some jobs, particularly those involved in research and development or those at the managerial level may require advanced degrees or work experience. Many engineer jobs also require a professional engineer (PE) license, which requires a degree, work experience, and passing written exams. Civil engineers who exercise direct control of a project or those who supervise other engineers must have a license.

Engineers should enjoy problem solving because they must constantly look for new and improved ways to develop a product or process. Communication skills are also critical for

engineers because they must be able to clearly explain their instructions to production staff to avoid costly mistakes.
Selected engineering occupations:
- agricultural engineers;
- chemical engineers;
- civil engineers;
- electrical engineers;
- environmental engineers;
- industrial engineers;
- mechanical engineers.

3. Occupations in Constructions

Construction workers build the processing plants where biofuels are made. Much of the future construction needs from the biofuels industry will be driven by cellulosic technology, using nonfood biomass to create biofuels. The advances in processing additional feedstocks have created demand for processing plants that can convert multiple crops into fuel. Construction workers are also needed to convert existing infrastructure at gas stations so that they can support higher blends of fuel. There may also be career opportunities in the design and construction of feedstock pre-processing facilities to condense biomass feedstocks before transportation to fuel production plants.
Construction managers plan, coordinate, budget, and supervise construction projects from early development to completion. They oversee new construction of biofuel and feedstock processing plants as well as the retrofitting of existing plants. Construction managers work with various specialists, such as architects and engineers, to get the plant built on time and within a budget.
Construction laborers perform tasks that require physical labor on construction sites, many of which are physically demanding. They build new biofuel plants and convert existing plants so that they can also produce fuel using cellulosic feedstocks. And as more ethanol blend fuels are made available, these workers will build new tanks to hold them or install blender pumps to existing tanks.
Construction equipment operators drive, maneuver, or control the heavy machinery used in construction. They operate various types of equipment, such as bulldozers, forklifts, and cranes. They use these machines to build processing plants and to install new fuel tanks at gas stations.

Credentials

Most construction managers have a bachelor's degree in construction science, construction management, architecture, or engineering. However, a combination of work experience and an associate's degree may meet the qualifications of some employers. Managers must have time-management skills and decision-making skills to ensure that each task involved in a project is assigned to the appropriate party and that each task is completed on time.
Most employers hiring construction laborers do not have a formal education requirement. The majority of laborers learn their skills through on-the-job-training, either informally or through an apprenticeship program. Construction workers must have strength and stamina for lifting heavy objects and performing other strenuous tasks throughout the day.
Construction equipment operators may learn the skills needed for their job through on-the-job training, an apprenticeship, or at a trade school. A high school diploma and a commercial driver's license may be required. They should have good eye-hand-foot coordination because they control powerful machinery.

4. Occupations in Agriculture

Farms are needed to grow corn, soybeans, and the other feedstocks used in making biofuels. These crops must be planted and cultivated before they are harvested and transported to grain elevators and processing plants.

Farmers and other agricultural managers, sometimes called growers, run establishments that produce crops that are used to make fuel. They supervise work being done by laborers and make decisions about where and when to plant various crops. They oversee the day-to-day operations of the farm or agricultural establishment.

Agricultural laborers maintain the quality of farms and crops by doing manual labor under the supervision of agricultural managers. They plant, cultivate, and harvest crops, which are used as fuel feedstocks.

Agricultural equipment operators operate farm equipment, such as tractors and combines, to sow seeds, and maintain and harvest crops.

Credentials

Farmers and agricultural managers typically need a high school diploma or equivalent, although some may have a degree from an agricultural college. Prospective farmers and agricultural managers typically train and gain experience under more experienced workers. Those farmers and agricultural managers who don't have any postsecondary education may take a longer time to learn some aspects of the job.

Most agricultural laborer and equipment operator positions do not have a formal education requirement. Workers typically learn through on-the-job training. It is important for these workers to have strength and stamina because the work can be physically demanding. Good hand-eye coordination is often needed to harvest crops and operate farm machinery.

5. Occupations in Plant Operations

Managers and technicians at processing plants convert feedstock into fuel through various technologies. They perform a wide variety of tasks, from blending chemicals to operating industrial equipment to testing fuel quality. Workers must follow a number of standard operating procedures and abide by all safety protocols. Staff may keep records or logs during each shift, noting any plant activities and reporting any problems to supervisory staff.

Plant managers, also known as industrial production managers, run daily operations at the plant. Managers coordinate and plan the activities needed to create biofuels. They supervise employees in completing their tasks and provide feedback on employees' job performances. They ensure compliance with all federal, state, and local laws and safety requirements. Managers must be able to solve problems quickly, adjust procedures when issues arise, and maintain detailed records on processing plant production.

Plant operators, also known as fuel makers, are chemical equipment operators and tenders. They operate or tend equipment that controls chemical changes or reactions in the processing of industrial or consumer products.

In addition to operating industrial equipment, plant operators may also inspect tanks, clean pumps and other equipment, and dispose of waste products. Some plant workers may conduct

quality control checks, testing samples from a batch of fuel. Others may be involved in shipping and receiving materials at the plant. They must follow all safety procedures, including reporting any problems to supervisory staff.

Industrial machinery mechanics test, maintain, and repair plant equipment and other industrial machinery, such as conveying systems, production machinery, and packaging equipment. When malfunctions occur, they need to disable a piece of equipment, locate and fix the broken piece, and reassemble the machine.

Credentials

Plant manager positions often require a bachelor's degree in a related science, engineering, or business administration. Many manager positions require between 1 and 5 years of work experience, while others may require up to 10 years of related experience. In addition, some employers want their managers to have previous experience as a supervisor. Most production managers must complete company-specific training. Many managers opt to earn various certifications to show a higher level of competency in their field.

Most plant operators need to have a high school diploma, and many employers prefer workers with a degree from a college or vocational school. Many employers value strong math and science skills and related work experience. Moderate on-the-job training is necessary because of the complex equipment and specific safety procedures of each company.

Industrial machinery mechanics generally need at least a high school diploma, though many employers prefer to hire candidates who have completed postsecondary training in industrial technology. Mechanics who have not taken postsecondary courses may need a year or more of on-the-job training to learn the necessary mechanical and technical skills.

Most plant employees work in shifts, as plants operate around the clock. They usually must wear safety equipment, such as gloves or goggles. Work in a plant can be physically demanding because workers may have to lift heavy objects and control large machinery. Individuals working in a plant must complete training to learn all of a company's standard operating and safety procedures.

6. Occupations in sales

Once the biofuels have been produced, sales workers are needed to keep supply chains running. Sales workers establish contracts so that goods can be bought and sold, and they help to keep biofuel production on schedule.

Purchasing agents buy farm products for further processing or for resale. They evaluate suppliers, negotiate contracts, review product quality, and monitor inventories. Purchasing agents develop budgets based on when and how much of a given feedstock is needed at a plant. They also establish contracts with suppliers, to ensure a steady flow of a given feedstock is transported to the plant to keep production on schedule.

Wholesale and manufacturing sales representatives sell goods — such as fuel, by-products from fuel production, or industrial equipment — for wholesalers or manufacturers to businesses, government agencies, and other organizations. They ensure that there are customers to buy the fuel, negotiate prices of these sales, and prepare contracts. They are often very knowledgeable about the products that they sell, but they may also work with an engineer who has more expertise.

Credentials

Some purchasing agent jobs may only require a high school diploma. However, jobs at large-scale commercial plants generally require a bachelor's degree. Some positions, especially those at the managerial level, may require advanced degrees. Degrees related to engineering,

business, economics, or applied sciences are preferred. On-the-job training may take up to 1 year.

Wholesale and manufacturing sales representatives generally need a bachelor's degree, though some positions may only require a high school diploma. Most companies have on-the-job training programs that a sales representative must complete; these programs usually include time spent shadowing a more experienced employee as they complete day-to-day work. Sales representatives may also choose to earn a certification.

Jobs in Biofuels

Feedstocks

- Farmers
- Seasonal workers
- Tree farm workers
- Mechanical engineers
- Harvesting equipment mechanics
- Equipment production workers
- Chemical engineers
- Chemical application specialists
- Chemical production workers
- Biochemists
- Agricultural engineers
- Genetic engineers and scientists
- Storage facility operators

Conversion

- Microbiologists
- Clean room technicians
- Industrial engineers
- Chemical & mechanical engineers
- Plant operators

End Use

- Station workers
- Construction workers
- Codes & standards developers
- Regulation compliance workers
- Consultants
- Chemists

Transport of Feedstocks & Biofuels

- Truck drivers
- Truck filling station worker
- Pipeline operators
- Barge operators
- Railcar operators
- Train station operators

OCCUPATIONS IN WIND POWER

For the purposes of this guide, occupations in wind power are separated into three phases: manufacturing, project development, and operation and maintenance. However, occupations are not always limited to one phase. For example, engineers are used in both manufacturing and project development, but in this report they are discussed in the manufacturing section. Wind turbine service technicians work in all three phases, but are listed here under operation and maintenance.

Most of the occupations detailed in this section are not specific to the wind power industry. Although many of these jobs require special skills unique to wind power, in most cases, skills can be acquired in other industries. For most positions, the wind companies hire people with experience in other industries and give them wind-specific training.

The primary exception to this trend is the wind turbine service technician. Currently, a large portion of these technicians learn on the job or through apprenticeship programs. However, as more vocational training programs are developed and training is standardized, technicians will be expected to have formal training and a certificate or degree.

Research and development is a key aspect of any industry, but because wind power is a relatively new industry in the United States, it is vital for manufacturers to invest in new technologies and processes. There are hundreds of companies involved in manufacturing turbines and turbine components, and because of the competition in the industry, each firm must find innovative ways to make turbines more powerful, efficient, and reliable—without significantly increasing costs.

Key careers in wind turbine research and development are those of scientists, engineers, and engineering technicians. Scientists involved in include atmospheric scientists and materials scientists, who must design components that can efficiently generate the most power and withstand environmental stresses. The three major pieces of a wind turbine — the blades, the tower and the nacelle — are all difficult to produce. Contained within the nacelle are the turbine's drive train and generator, and other mechanical and electrical components. All of these pieces must be manufactured to meet design specifications. Workers in many different occupations, including machinists, computer-controlled machine tool operators, assemblers, welders, quality-control inspectors, and industrial production managers, are involved in manufacturing the turbine components.

1. Research and Development Jobs

Engineers in the wind power industry are involved in the design and development of wind turbines. In addition, they also work in testing, production, and maintenance. Engineers may also supervise production in factories, test manufactured products to maintain quality, and troubleshoot design or component problems. They also estimate the time and cost required to complete projects and look for ways to make production processes more efficient. Supervisory engineers are responsible for major components or entire projects and typically lead a team of engineers and technicians.

Engineers use computers extensively to produce and analyze designs, generate specifications for parts, monitor product quality, and simulate and test how a turbine or component operates. Because of the complexity of wind turbines, several types of engineers are employed by the industry. The following is a partial list of the types of engineers employed in the wind power industry: aerospace engineers, civil engineers, computer engineers, electrical engineers, environmental engineers, health and safety engineers, industrial engineers, materials engineers, and mechanical engineers.

Job Duties

Engineers in the wind power industry work in offices, laboratories, and industrial plants. Some may spend time at working wind farms and those under development. Many are expected to travel frequently to oversee manufacturing processes or turbine installation, and travel abroad is often required since many of the largest turbine manufacturers are based overseas. The nature of engineers' work depends largely on their specialties.

Aerospace engineers design, test, and supervise the manufacture of turbine blades and rotors, and conduct aerodynamics assessments. They are frequently involved in site selection, working closely with meteorologists to determine the optimal configuration of turbines at a wind farm site.

Civil engineers design and supervise the construction of many parts of wind farms, including roads, support buildings, and other structures such as the tower and foundation portions of the wind turbine. Because of the scale of wind turbines, these engineers must deal with some atypical problems, such as designing roads that can withstand very heavy loads as well as trailers that are up to 100 feet long. Since many wind farms are located in the Midwest and western States in USA, they have to consider potential hazards ranging from extreme winds and cold temperatures to earthquakes. Civil engineers in wind power typically specialize in structural, transportation, construction, and geotechnical engineering.

Electrical engineers design, develop, test, and supervise the manufacture of turbines' electrical components, including electric motors, machinery controls, lighting and wiring, generators, communications systems, and electricity transmission systems.

Electronics engineers are responsible for systems that use electricity to control turbine systems or signal processes. Whereas electrical engineers work primarily with power generation and distribution, electronics engineers deal with the complex electronic systems used to operate the turbine.

Environmental engineers deal with the potential environmental impacts of wind turbines. Although wind power is one of the most environmentally friendly sources of electricity, there are still some environmental concerns that engineers must consider. These include noise, visual impact, and the impact on local species, interference with radar and telecommunications, and electric and magnetic fields caused by electricity-generating equipment.

Health and safety engineers identify and measure potential hazards of wind turbines, and implement systems that ensure safe manufacture and operation. They usually recommend appropriate loss-prevention measures according to the probability of harm or damage.

Industrial engineers determine the most effective ways to use the basic factors of production to make components of wind turbines. They are concerned primarily with increasing productivity and minimizing costs in the manufacture of turbine systems and components. Industrial engineers study product requirements and design manufacturing and information systems to meet those requirements with the help of mathematical models. They also aid in financial planning, cost analysis, and the design of production processes and control systems.

Materials engineers develop, process, and test materials used to construct wind turbines. Wind turbines consist of thousands of parts, and each must be designed to exacting specifications because of the stresses involved in generating wind power. Materials engineers must work with metals, ceramics, plastics, semiconductors, and composites that meet certain mechanical and electrical requirements.

Mechanical engineers work on a variety of machines and other mechanical devices. They research, design, develop, and test tools and mechanical devices. These engineers work on wind turbine components, wind turbine systems, or the machinery that is used to manufacture and test the turbines. Many of these engineers also supervise manufacturing processes.

Engineering technicians assist engineers and scientists, especially in research and development and in the manufacturing process. Some work in quality control, inspections, and data collection. They assist with design by use of computer-aided design and drafting equipment, collect data, and calculate or record results. Engineering technicians are also responsible for operating and maintaining design and test equipment.

Education and Training

Engineers typically enter the wind power industry with at least a bachelor's degree in an engineering specialty. However, a significant number of jobs require more education, such as a master's or doctoral degree. In addition, engineers typically are licensed and are expected to complete continuing education to keep current with rapidly changing technology.

Wind turbine manufacturers prefer to hire engineers with 3–5 years of experience in their respective field and knowledge of commonly used systems and processes. Engineers are then given additional training lasting several weeks or months prior to assignment, and then they undergo extensive on-the-job training.

Entry-level engineers may also 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.

Certifications are usually required, depending on the systems used by a particular manufacturer. Licensure as a professional engineer (PE) is desirable, but is not required for many wind turbine manufacturers. Engineering technicians typically have an associate's degree or a certificate from a community college or technical school.

2. General Manufacturing Jobs

Producing turbine components that match design specifications is the responsibility of manufacturing workers. The wind-energy supply chain requires the skills of many different production occupations, including machinists, computer-controlled machine tool operators, assemblers, welders, quality-control inspectors, and industrial production managers. The job duties, skills, and training backgrounds of these workers are similar to those of manufacturing employees in other industries.

Job Duties

Machinists use many different tools to produce precision metal and plastic pieces in numbers too small to be manufactured with automated machinery. They use their technical knowledge to review blueprints and ensure that pieces are machined to the specifications of engineers in the field. Machinists may also finish parts that were made by automated machinery.

Before beginning to cut, machinists must plan how to position and feed the materials into the machine. And during the machining process, machinists must constantly monitor the feed rate and speed of the machine while keeping an eye out for any potential problems.

Computer-controlled machine tool operator Computer-controlled machine tool operators run computer numerically controlled (CNC) machines, which use the machine tool to form and shape turbine components. CNC machines use the same techniques as many other mechanical manufacturing machines but are controlled by a central computer instead of a human operator or electric switchboard. Some highly trained CNC workers also program the machines to cut new pieces according to designers' schematics.

CNC operators usually use machines to mass-produce components that require cutting with a high level of precision. In the wind-turbine supply chain, they manufacture many of the finely cut pieces, including those which are part of the generator or drive train.

Assemblers are responsible for putting the components together into a larger product. Despite increased automation, many parts still have to be put together and fastened by hand. After determining how parts should connect, assemblers use hand or power tools to trim, shim, cut, and make other adjustments to align and fit components. Once the parts are properly aligned, they connect them with bolts and screws or by welding or soldering pieces together.

Assemblers are used extensively in the production of all turbine components. Manufacturing blades, for example, is extremely labor intensive. Making the casings requires assemblers to interlace layers of fabrics and resins. Blades are usually made in two separate halves, which assemblers join together with an adhesive. After the blade has been formed, they sand and cover it with a protective coating.

Welders apply heat to metal pieces, melting and fusing them to form a permanent bond. The types of equipment welders use are dependent on the job they are performing and material with which they are working. Some welding is done by manually using a rod and heat to join metals, whereas other welding is semiautomatic, meaning that a wire-feed welding machine is used to bond materials. In the wind industry, welders work on many diverse components; for example, they weld together cylinders of rolled steel to form turbine tower segments.

Quality-control inspectors are responsible for verifying that parts fit, move correctly, and are properly lubricated. Some jobs involve only a quick visual inspection; others require a longer, detailed one. Inspectors are also responsible for recording the results of their examinations and must regularly submit quality-control reports.

Because wind turbine components are so large and expensive, it is extremely important that no mistakes be made and that design specifications be followed precisely. Inspectors are integral to maintaining the quality of the manufacturing process.

Industrial production managers plan, direct, and coordinate the work on the factory floor. They may determine which machines will be used, whether new machines need to be purchased, whether overtime or extra shifts are necessary, and how best to improve production processes. Industrial production managers also monitor the production run to make sure that it stays on schedule.

Industrial production managers are also responsible for solving any problems that could jeopardize the quality of their company's components. If the problem relates to the quality of work performed in the plant, the manager may implement better training programs or reorganize the manufacturing process. If the cause is substandard materials or parts from outside suppliers, the industrial production manager may work with the supplier to improve quality.

Education And Training

The type of training necessary for these production occupations varies. Many workers are trained on the job and gain expertise with experience. However, some workers in more skilled positions, such as computer-controlled machine tool operators, may be required to attend formal training programs or apprenticeships. A strong mechanical background is necessary to succeed in all of these occupations.

Many industrial production managers have a college degree in business administration, management, industrial technology, or industrial engineering. After they graduate, they usually spend a few months in corporate training, learning company policies and production methods for wind turbine components. Others become industrial production managers by working their way up through the ranks, starting as production workers and then advancing to supervisory positions before being selected for management.

Because of the relative youth of the wind energy industry, it can be difficult to find workers with a background in wind power; many turbine component manufacturers will hire almost any qualified applicants with a related technical background. Experience in the manufacture of large machines can be especially helpful. Workers from other backgrounds can be taught on the job how to apply their manufacturing skills to turbine components.

3. Occupations Relevant to Project Development

Worker on phone at wind farm Building a wind farm is a complex process. Site selection alone requires years of research and planning. And the proposed site must meet several criteria, such as developable land, adequate wind, suitable terrain, and public acceptance. In addition, wind turbines must be deemed safe for local wildlife, particularly birds, and be sited away from populated areas because of noise and safety concerns. Scientists, land acquisition specialists, asset managers, lawyers, financers, and engineers are needed to ensure the site is suitable for wind farm development.

After the site is selected and construction begins, workers are needed to install the turbines and support structures. This requires the work of many skilled people, including construction workers, crane operators, wind turbine service technicians, and truck drivers.

Land Acquisition, Asset Management, and Logistics

Land acquisition specialists and asset managers are responsible for obtaining the land for new wind development, as well as administering the land once it has been purchased or leased. They coordinate the efforts of permitting specialists, lawyers, engineers, and scientists to ensure that the wind farm is built on time and within budget. Typically, they are employed by a wind development company or the company that owns and operates the wind farm.

After land has been obtained and wind turbines have been manufactured, the turbines need to be delivered to the wind farm. Because of the extremely large size of turbine components, transporting them is no easy feat. Most wind farms are in relatively remote areas of the country; it takes a great deal of planning to transport the turbine parts there in a cost-efficient, timely manner. Getting wind turbine components from the factory to the construction site requires the hard work of teams of logisticians, heavy-load truck drivers, and, occasionally, rail and water freight movers.

In the wind energy industry, some OEMs handle their own logistics and transportation. Others contract these services out to third-party companies, many of which have extensive experience at moving heavy freight in other industries.

Job Duties

Land acquisition specialists are responsible for designing and implementing land acquisition plans for new wind development sites. Land acquisition specialists work closely with landowners, local governments, and community organizations to gain support for proposed wind projects. They also work with lawyers, permitting specialists, engineers, and scientists to determine whether sites are suitable for wind farm development and to lead the process of purchasing or leasing the land.

Asset managers are responsible for representing owner interests, especially by maximizing profits, in wind-farm projects. They ensure that the land is used in the most efficient way possible and oversee the project's finances, budget, and contractual requirements.

Logisticians are responsible for keeping transportation as efficient as possible. Because wind farm projects are expensive and run on tight schedules, any time spent waiting for delayed turbine components costs money. Logisticians have to work extensively with both the manufacturer and construction team to develop an optimized schedule for delivering turbine components.

One difficulty logisticians face is the differing regulations individual States have for trucking heavy freight within their borders. Some require State trooper escorts, and others do not even allow trucks over a certain tonnage over their State lines. Logisticians must consider these varied regulations when planning routes. They must also take mechanical considerations, such as a truck's turning radius into account when mapping routes.

Education and Training

Land acquisition specialists and asset managers are expected to have a bachelor's degree or higher in business, real estate, law, engineering, or a related discipline. Experience and familiarity with the permitting process and an understanding of tax and accounting rules is desirable. Companies will typically hire people with experience in land acquisition and management and train them to their specific needs. Experience in the energy industry is helpful.

Most logisticians have a bachelor's degree, usually in a field like engineering, business, or economics. Typically they also attend postgraduate programs in logistics or supply chain management. Additionally, many logisticians receive on-the-job training to learn about supply chain issues unique to the wind energy industry.

4. Scientists

Woman with computer in front of wind turbine Wind energy is one of the most environmentally friendly sources of power generation available today. However, turbines, like any large construction project, have an impact on the environment. The permitting process requires that environmental impact studies be conducted before work begins on a wind farm. In addition, scientific research is necessary to ensure that a site is suitable for erecting turbines and that the turbines are configured to maximize electricity in varying wind conditions.

Scientists in the wind industry may be employed by a development company or contracted for a specific project. Some contractors work for companies that specialize in environmental consulting for wind power projects. Scientists travel frequently, spend substantial amounts of time at proposed wind-farm sites, and work with local, State, and Federal regulators throughout the permitting study process.

Wind farm development requires the work of scientists in various specialties, including atmospheric scientists, biologists, geologists, and environmental scientists. They work along with engineers, technicians, and project managers to ensure that the site is suitable for the development of a wind farm.

Job Duties

Scientists employed by the wind power industry spend a large part of their time in the field. Typically, the scientists are used as experts to ensure that a site is suitable for a proposed wind farm. They often start with a site visit to gather preliminary data and conduct desktop studies by use of computer models and other techniques. Field studies are necessary to ensure that the wind turbines will have little impact on the surrounding environment and can safely generate enough electricity to be profitable.

Atmospheric scientists, often referred to as meteorologists, monitor the atmosphere around a potential project to ensure that there is adequate wind to produce electricity. They also assess whether the wind or other weather conditions may be too extreme for viable wind development. These scientists take wind measurements over a period of months or years and use computer models to judge whether the wind is adequate for turbine operation. In addition, they help decide the placement of turbines at the site to ensure that the greatest possible amount of energy is obtained from the wind. Atmospheric scientists in the wind industry are in relatively high demand, although they are a small segment of the wind-energy workforce.

Wildlife biologists evaluate the wind farm's effect on local animal life. Although wind turbines do not take up a lot of space, construction can be disruptive to the natural environment. Operational turbines also are a serious threat to local and migrating bird and bat populations. Biologists must make sure that the impact on these populations is minimal. They spend a great deal of their time outdoors at the site, cataloging the surrounding wildlife and making recommendations on how to avoid interfering with local ecosystems. Formal permitting processes exist at the Federal and State levels. Wildlife biologists supervise the development of reports on environmental impact.

Geologists spend a large part of their time in the field, identifying and examining the underlying topography of a proposed wind farm. Because of the size and weight of modern turbines, geologists must ensure that the ground at the site can support such structures. They study the ground, make recommendations on where to place the turbines, and provide guidance on how to construct the foundations.

Environmental scientists work with wind farm developers to help them comply with environmental regulations and policies and to ensure that sensitive parts of the ecosystem are protected. They use their knowledge of the natural sciences to minimize hazards to the health of the environment and the population. These scientists are heavily involved in the study and permitting phases of development.

Education and Training

Although a master's degree is often preferred, a bachelor's degree, depending on the specialty, typically is sufficient for an entry-level position. A Ph.D. is desirable for scientists in certain fields who oversee environmental impact and site suitability studies and provide expert guidance to ensure that wind turbines are constructed for optimal efficiency and minimal environmental impact.

Computer skills are essential for the majority of these positions because scientists use them for data analysis and integration, digital mapping, remote sensing, and construction of computer models. Scientists in certain specialties, such as atmospheric scientists, geologists, environmental scientists, are usually certified or licensed by a State licensing board.

Occupation
Atmospheric and space scientists
Zoologist and wildlife biologists
Geoscientists, except hydrologists and geographers
Environmental scientists and specialists, including health

5. Construction Occupations

Construction of a wind turbine Erecting wind turbines requires the efforts of many skilled construction workers. The work begins before the turbine components arrive on site: construction laborers and construction equipment operators are responsible for building local access roads and the foundations that support the turbines.

After the turbine components arrive, crane operators set the first tower segment vertically onto the ground, where other workers secure it to the foundation. The remaining tower segments are then stacked atop one another and fastened together. When the tower has been erected, crane operators carefully lift the nacelle and the blades. The nacelle is placed on the top of the tower, and the blades are attached to the turbine's hub.

Job Duties

Construction laborers often work on wind farms as contractors and are responsible for preparing the site and building the surrounding infrastructure. Their work includes clearing trees and debris from the wind farm, cleaning machines, and helping to break up the ground on which the turbine will rest.

Construction workers employed by companies that specialize in developing wind farms are sometimes in supervisory roles. They might work under the project manager to direct local contractors and confirm that all on-site work is performed safely and correctly. These workers might also be trained as wind turbine service technicians.

Construction equipment operators, with the help of construction laborers, are responsible for building accessible roads directly to the construction site, helping ensure that the wind turbine components can arrive without damage or delay. They use bulldozers, road graders, and other equipment to set up the construction site.

Crane operators are necessary in building a wind farm because the components are so large. They use their cranes to lift the pieces of the turbine off the trucks as they arrive. Crane operators are integral to the actual construction job, as well. For example, they operate cranes to stack the tower segments and lift the blades to the hub.

Electricians are needed to get the energy from the turbine's generator to the power grid on the ground. They wire the turbine to connect its electrical system to the power grid. When installing wiring, electricians use hand tools such as conduit benders, screwdrivers, pliers, knives, hacksaws, and wire strippers, as well as power tools such as drills and saws.

Education and Training

Although some construction laborer jobs have no specific education or training requirements, some construction workers receive more formal training in the form of apprenticeships. These programs consist of several years of classroom and on-the-job training. High school classes in English, mathematics, physics, mechanical drawing, blueprint reading, welding, and general shop can be helpful to prepare for the apprenticeships. Many construction laborers' skills are learned on-the-job and by assisting more experienced workers.

Local contractors may or may not have worked with wind turbines before. However, construction workers and wind turbine service technicians employed by companies

specializing in wind farm development handle the more technical operations and usually have extensive experience in the wind industry.
Construction equipment operators and crane operators learn their skills through on-the-job training, apprenticeships, or, for some, union instruction. In addition, the operators are expected to be certified to operate their equipment. Crane operators need to be highly skilled, especially when handling large, expensive cargo like wind turbine components.
Most electricians learn their trade through apprenticeship programs that combine on-the-job training with related classroom instruction. Apprenticeship programs usually last 4 years, and, in them, electricians learn skills such as electrical theory, blueprint reading, electrical code requirements, and soldering. Depending on the State, electricians might have to pass an examination that tests their knowledge of electrical theory, the National Electrical Code, and local and State electrical and building codes.

Occupation
Construction laborers
Operating engineers and other construction equipment operators
Crane and tower operators
Electricians

6. Project Managers

It takes a large number of people to build a wind farm, and managing the project can be a difficult task. Project managers oversee the construction of the wind farm from site selection to the final installation of turbines. A project manager will oversee a diverse team, including engineers, construction workers, truck drivers, crane operators, and wind technicians. Project managers must have excellent attention to detail and be good at time and resource management.
Project managers usually have experience in construction and management or in engineering. They must be familiar with all aspects of wind farm development: from budgeting, site selection, site studies, and permitting processes and safety policies to construction and transportation of wind turbines.

Job Duties

Project managers are employed by larger construction companies, energy companies, or land owners and work under contract or as salaried employees. Because of the size and complexity of some wind farms, project managers may manage portions of the construction, such as site clearing, foundation construction, or tower erection. These managers report to a senior project manager or site manager.
Project managers split their time between the wind farm site and their office, which may be located onsite or offsite. Primary office responsibilities include managing permitting, contracting, and the budget. At the construction site, the project manager monitors progress and performs inspections for quality control. Project managers oversee the contracting process and manage various contractors and subcontractors. They are responsible for promoting a safe work environment and ensuring strict adherence to site safety policies.

Education and Training

Experience in construction, particularly wind farm construction, is vital for project managers. Most managers have experience working on several wind farm projects before they are selected to manage one. 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 an MBA, are becoming more common.
Because experience is so important for these positions, years of experience may substitute for some educational requirements. However, this is becoming increasingly rare, as projects

grow more complex and employers place more emphasis on specialized education. New graduates from construction management or engineering programs may be hired as assistants to project managers to gain experience.

7. Occupations Relevant to Operation and Maintenance

The reliability of the turbine system is essential to a power project. Because of the complexity and expense of the equipment, operation and maintenance services are critical to keeping the turbine functioning properly. Safety also is a primary concern: the large size and speed of turbine blades can present hazards to nearby turbines or people who are in the area. Operating a turbine requires someone to schedule site personnel, observe turbine operation, and deal with equipment failure. Maintaining it requires periodic equipment inspections, sensor calibration, cleaning, and unscheduled repairs of malfunctioning components. These tasks are performed by wind turbine service technicians, who must climb the towers and ensure that the wind turbines continue to operate reliably.

Wind Turbine Service Technicians

Woman with blueprints in front of wind turbine Wind turbines are extremely complex machines, made up of many different components. If any part fails, the wind turbine has to be shut down until repairs can be performed, and this lost operating time costs the owner money. To prevent these stoppages, wind turbine service technicians, also known as wind techs, are employed to inspect turbines and provide regular maintenance. Wind techs are capable of diagnosing and fixing any problem that could require the turbine to be shut down.

Many different companies employ wind turbine service technicians. The companies that design and manufacture the turbines offer warranties on their turbines usually lasting anywhere from 2 to 5 years. They employ wind techs to perform maintenance and address problems during the warranty period. There are also many companies that specialize in performing turbine maintenance and employ wind techs to provide this service to wind farm owners.

Most wind farms are located away from populated areas, so technicians must be prepared to travel frequently or to live in remote locations for extended periods. Wind turbine service technicians may work at several different sites and travel among the sites to perform maintenance as needed.

Job Duties

Wind techs are responsible for both regular maintenance and performing complicated repairs of wind turbines. The average workday is spent climbing and inspecting multiple turbines. Technicians work a schedule that rotates which turbines need to be inspected or maintained. Any problems they notice during the examination are reported and scheduled for repair.

Wind turbine service technicians do much of their daily maintenance work in the nacelle, where the gears and sensitive electronics are housed. Nacelles, however, are built very compactly, and wind techs must be able to work with little operating room. Inside the nacelle,

turbine technicians regularly clean and lubricate shafts, bearings, gears, and other machinery. They also use handheld power tools and electrical measuring instruments to troubleshoot any faults in the generator.

Sometimes wind techs have to work outside, on the top of the nacelle. They might, for example, have to replace the instruments that measure wind speed and direction. When outside, turbine technicians can be hundreds of feet in the air and need to be extremely safety conscious. They wear harnesses that are attached to rings on the nacelle and move cautiously while working.

When performing repairs, wind techs might need a new component to replace the broken one. If so, they must drive to the wind farm's parts storage facility and pick up a new component or have another worker deliver it to the turbine site. The turbine technician sometimes has to carry the new piece while climbing up to where it is installed.

Wind turbine service technicians are also responsible for administration of the site. These technicians may be responsible for anywhere from one turbine to hundreds of turbines on a large farm. They are responsible for ordering spare parts, and ensuring there is a proper inventory of parts available for needed repairs.

Education and Training

Worker inside wind turbine nacelle The wind energy industry in the United States is relatively young, so there is no one way to be trained as a wind tech. Wind techs need to have mechanical skills and the aptitude to understand how a turbine functions, so some wind techs come from technician jobs in other industries. Experience or training as an electrician also is beneficial.

As formal training programs are developed, employers are placing more emphasis on wind-specific education. Educational institutions - specifically, community colleges and technical schools - are beginning to offer 1-year certificate and 2-year degree programs in wind turbine maintenance. In certificate programs, students take classes in basic turbine design, diagnostics, control and monitoring systems, and basic turbine repair. For a 2-year associate degree, students complete the aforementioned types of classes in addition to general-education courses. Some programs also give students hands-on training and practice on school-owned turbines and machinery.

In addition to having technical knowledge, wind techs must be physically fit. Climbing up and down the ladders inside turbine towers, even with load-bearing harnesses, can be extremely strenuous. Wind turbine service technicians will often climb several towers during the course of a typical workday, and their bodies, especially their shoulders, must able to withstand this strain.

8. Occupations Supporting Wind Power

The growth of the wind power industry nowadays presents many opportunities for job creation. Jobs in this industry are located in more countries and cover a wide variety of occupations. This report has highlighted occupations in manufacturing, project development, and operation and maintenance, but the wind industry employs people in many other occupations as well. As with any complex project, support staff is necessary to ensure success.

The wind turbine supply chain consists of many different manufacturers of varying sizes. Although many of the companies in the supply chain do not concentrate on wind power, wind-power-related jobs in these companies do contribute to the industry. The process starts with the raw materials that are made into individual turbine components. Foundry workers are the first part of the wind turbine supply chain, casting metal, plastics, and composites out of raw materials.

Professional and administrative positions are vital to supporting wind power. Jobs in these fields include secretaries and receptionists, human resources specialists, accountants and auditors, lawyers, and managers of many different types. People in these jobs ensure that companies involved in the wind energy industry run smoothly by taking care of personnel, budget, and legal issues.

For facilities to be properly secured and maintained, it is necessary to have janitors, maintenance workers, and security guards. Janitors and custodians are responsible for the cleaning and upkeep of facilities; security guards ensure that the facilities are free of unauthorized people and that problems are reported as soon as they occur. Maintenance workers make sure that machinery and equipment are kept in safe operating condition and repair broken equipment.

Conclusion

Jobs related to wind power are a potential source of new employment opportunities. Renewable energy is a key piece of the "green economy," and wind power, which supplies thousands of jobs, is the fastest growing sector in renewable energy.

This report examined the three major phases of a wind power project: manufacturing, project development, and operation and maintenance. All three are expected to experience rapid growth for the foreseeable future, as wind becomes a more common source of electricity generation for people in the world. The benefits of this expansion will be noticeable in the manufacturing and construction sectors, which have been hit particularly hard by the recent economic recession. Jobs in the wind industry will be available to people with a broad range of education and experience levels.

The industry's growth should increase demand for skilled workers. Companies employ wind energy workers in most states: manufacturing occurs in areas where wind power is not feasible, and construction and operations jobs are available in areas where wind is abundant. In addition to the occupations covered in this report, the future holds opportunities for more types of occupations. And, as offshore wind projects are started and people begin to take advantage of "small wind" projects, even more jobs could be created.

Wind Energy Related Employment

Financial & Legal
CEOs
Finance Directors
Senior Accountants
Business Development
Legal Advisors
Investment advisor
Wind Farm Development
Wind Farm Development Managers
Off-shore expertise
Project Mangers
Technical Directors
Engineering
Grid Connection
Wind Resources
Resource Analysis
Micrositing
Wind Farm Software modelling

Planning Consents
Policy
EIAs
Environmental Monitoring
Planning Regulations
Community Relations
Turbine Manufacture
Turbine R&D
Towers and Nacelles
Control Systems
Quality Control
Non-technical
Sales
Communications
Marketing
Public Relations
Human Resources

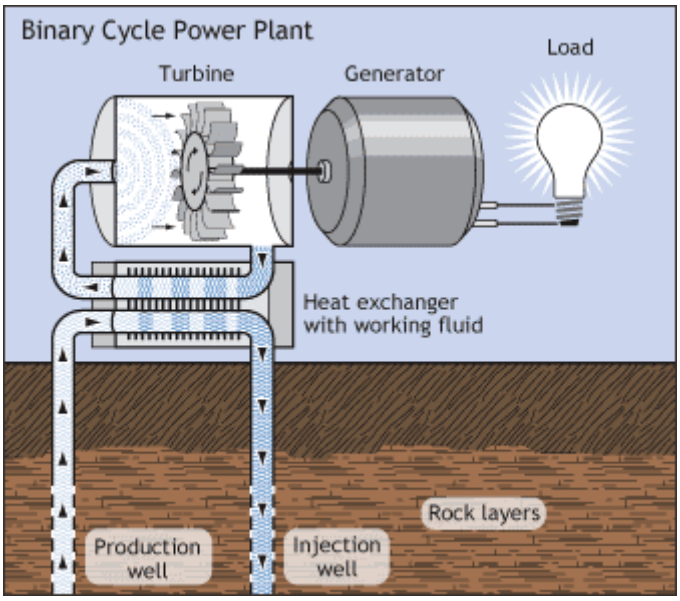
OCCUPATIONS IN GEOTHERMAL ENERGY

It requires many workers to get a geothermal plant up and running. Different workers are needed for each phase of a geothermal plant's development.
The occupations detailed in this section are not specific to the geothermal industry. For many occupations, workers' experiences in industries other than geothermal can be applied to geothermal projects.

1. Science occupations

Scientific research is an important component of geothermal development. Because drilling wells is extremely expensive, it's important that scientists select drilling sites most likely to support geothermal power.
Scientists work in offices where they study charts and maps of geothermal resources. They might also travel to the field to examine proposed geothermal sites. Scientists work on teams with other scientists in various disciplines. Geothermal companies employ some scientists full-time, while others are hired as consultants.
Environmental scientists work with geothermal plant developers to help them comply with environmental regulations and policies and to ensure that sensitive parts of the ecosystem are protected. They use their knowledge of the natural sciences to minimize hazards to the health of the environment and the nearby population. These scientists produce environmental impact studies necessary for a geothermal project to earn its building permits.
Geologists spend a large part of their time in the field, identifying and examining the topography and geologic makeup of a geothermal site. Geologists also study maps and charts to ensure that a site will be able to supply adequate geothermal energy. Geologists use their knowledge of different kinds of rock to make recommendations on the most cost-effective areas to drill. Some specialized geologists might help to monitor a plant's location for seismic activity and attempt to predict the threat of earthquakes.
Hydrologists study water and the water cycle. They study the movement, distribution, and other properties of water, and analyze how these properties influence the surrounding environment. Hydrologists use their expertise to solve problems concerning water quality and

availability. On geothermal projects, hydrologists study the water below the earth's surface. They help decide where to drill wells and analyze the groundwater that is pumped from the underground reservoirs to the surface.



Wildlife biologists evaluate a geothermal plant's effect on local animal life. Although geothermal plants are not inherently destructive, construction of the related infrastructure, such as plants, roads, and transmission towers, can be disruptive to the natural environment. Biologists ensure that the plant's impact on local animal populations is minimal. They spend a great deal of their time outdoors at the site, cataloging the surrounding wildlife and making recommendations on how to avoid interfering with local ecosystems.

Credentials

Although a master's degree is often preferred, a bachelor's degree, depending on the specialty, is typically sufficient for an entry-level position for geologists, environmental scientists, and wildlife biologists. Hydrologists typically enter the occupation with a master's degree. A Ph.D. is desirable for scientists who oversee environmental impact and site suitability studies. Most scientists must have excellent computer skills because they use computers frequently for data analysis, digital mapping, remote sensing, and computer modeling. Scientists in certain specialties, such as geologists, are usually certified or licensed by a state licensing board.

2. Engineering Occupations

Designing geothermal plants or new drilling equipment requires the work of many engineers. Most work in offices, laboratories, or industrial plants, but some engineers work outdoors at construction sites, where they monitor or direct operations or solve onsite problems.

Engineering occupations

Civil engineers design geothermal plants and supervise the construction phase. Many geothermal plants are built in rocky, difficult terrain, which require special procedures. Civil engineers also have to consider potential hazards such as earthquakes, and build plants to withstand them. These engineers are also responsible for designing access roads that lead to the plants.

Electrical engineers design, develop, test, and supervise the manufacture of geothermal plants' electrical components, including machinery controls, lighting and wiring, generators, communications systems, and electricity transmission systems.

Electronics engineers are responsible for systems that control plant systems or signal processes. Electrical engineers work primarily with power generation and distribution; electronics engineers develop the complex electronic systems used to operate the geothermal plant.
Environmental engineers deal with the potential environmental impacts of geothermal plants. Although geothermal energy is an environmentally friendly source of electricity, environmental engineers must consider a site's potential impact on local plants and wildlife.
Mechanical engineers research, design, develop, and test tools and a variety of machines and mechanical devices. Many of these engineers supervise the manufacturing processes of drilling equipment or various generator or turbine components.

Credentials

Engineers typically have at least a bachelor's degree in an engineering specialty. However, some jobs require more education, such as a master's degree or doctoral degree. Additionally, an engineer typically must be licensed as a professional engineer (PE) and is expected to complete continuing education to keep current with new technologies.

Entry-level engineers may also 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.
Engineers are usually required to be certified as competent to carry out specific work, depending on the systems used by a particular geothermal power company.

3. Drilling Occupations

To reach hot water far below the earth's surface, geothermal plants use wells that descend thousands of feet into underground reservoirs. Drilling these wells requires specialized machinery and workers. Drilling crews first drill exploratory wells to confirm the locations of underground reservoirs. After discovering the best locations, they drill the geothermal plant's main well.
Drilling crews typically use a derrick, a large, metal framed crane hanging over a well, to guide drilling equipment. Because drilling equipment is so heavy, derricks are necessary to control and maneuver drilling bits, pipes, and other equipment. Drilling fluids that help to break up the rock are pumped into the well through a pipe connected to the drill bit. The pipe also carries debris and mud out of the well and to the surface, where it can be disposed of. As the well gets deeper, new pipe sections are connected to those already in the ground, and the drill continues until it taps the underground reservoir.

Drilling occupations

Depending on a project's location and the type of rock that needs to be drilled through, drilling crews will use different drill bits and drill fluid mixtures.
In addition to the workers who drill the wells, drilling crews might include some support personnel, such as workers who transport the drilling rigs and fuel to project sites.
Derrick operators control and inspect drilling derricks. These workers can raise or lower the drill bits and pipes into or out of the well. Derrick operators are also responsible for maintaining their machinery and ensuring that it operates correctly.
Rotary driller operators control the drill itself. They determine a drill's pressure and speed as it penetrates rock. To keep drill sites safe, rotary driller operators use gauges that monitor drill pump pressure and other data, such as how much drill mud and debris are being pumped from the well. Rotary drill operators also keep records of where they've drilled and how many layers of rock they've penetrated.
Roustabouts do much of the basic labor on drilling sites. They clean equipment and keep work areas free of the debris and drilling mud that the drill pipes carry up from the wells. Roustabouts also install new pipe sections that allow the drill to reach deeper underground.

Credentials

There are few formal education requirements for drilling crew workers. Although drilling crew workers are not required to have a high school diploma, some employers might prefer to hire workers who do. While in school, drilling crew workers can learn skills such as basic mechanics, welding, and heavy equipment operations through vocational programs.
Most drilling crew workers start as helpers to experienced workers and are trained on the job. However, formal training is becoming more common as new and more advanced machinery and methods are used. Drilling crew workers usually must be at least 18 years old, be in good physical condition, and pass a drug test.

4. Construction Occupations

Construction workers build the geothermal power plant and necessary supporting infrastructure, such as roads and transmission lines. During the construction phase, crews have to build around the geothermal well and drilling operations. Depending on where a plant is located, construction crews might operate specialized equipment to build plants in rocky, difficult terrain.
Carpenters build, install, and repair any fixtures made from wood or other materials, including plastic, fiberglass, and drywall, on geothermal construction sites. Following construction drawings, carpenters measure, mark, and arrange their materials. They use hand and power tools, such as planes, saws, and drills, to cut and shape the materials, which are frequently joined together with nails, screws, or other fasteners. After completing an installation, carpenters check the accuracy of their work with instruments, such as levels or rulers, before making any necessary adjustments.
Construction equipment operators use machinery to clear earth, trees, and rocks at geothermal plant construction sites. They also use machines to grade the land and build roads prior to construction. Construction equipment operators use their machinery to hoist heavy construction materials for other workers to use.
Construction laborers perform a wide range of tasks on geothermal plant construction sites. They use a variety of equipment, including 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, such as carpenters and electricians.
Construction managers plan, direct, coordinate, and budget geothermal projects. They may supervise an entire project or, depending on the size of a plant, just part of one. As

coordinators of all design and construction processes, construction managers select, hire, and oversee specialty trade contractors, such as carpenters and electricians.
Construction managers are involved in a plant's development from its original conceptual designs through its final construction. They help to ensure that geothermal plants are built on time and within budget. Construction managers often meet with engineers, architects, and any other workers building the plant.
Electricians do both installation and maintenance work on the energy systems of geothermal plants. When constructing plants, 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 systems such as circuit breakers, transformers, and outlets.
Electricians also install the electrical equipment and wiring that connects the geothermal plant to the electrical grid. They must be familiar with computer systems that regulate the flow of electricity and be experienced working with high-voltage systems.
Plumbers, pipefitters, and steamfitters install, maintain, and repair the pipe systems in geothermal plants that carry hot, high-pressure fluids from the well and into low-pressure tanks. They also are responsible for a plant's other pipes, including those that carry steam from the tanks to the turbines.
Plumbers, pipefitters, and steamfitters must frequently lift heavy pipes, stand for long periods of time, and work in uncomfortable and cramped positions. In their work, they face a number of possible hazards, including falls from ladders, cuts from sharp objects, and burns from hot pipes or soldering equipment.

Credentials

Construction managers have typically completed an associate's degree or higher in construction management, business management, or engineering. They also usually have previous experience working on construction projects. Because experience is so important for construction managers, in some cases, it may be substituted for educational requirements. However, large, complex projects such as a geothermal plant require specialized education. Workers with degrees in construction management or engineering, but without significant experience, may be hired as assistants to project managers.
Most construction laborers are trained on the job. Laborers typically work under a foreman, who gives them instructions. As they gain more experience and prove their abilities, laborers may become foremen themselves.
Equipment operators typically enter the occupation with a high school diploma or equivalent. They may learn on the job, complete a formal training program, or a combination of both. Certain equipment requires operators to be certified, which involves some training and testing to ensure competence and safety.
Electricians, carpenters, plumbers, pipefitters, and steamfitters typically enter the occupation with a high school diploma or equivalent. They are usually trained through apprenticeship programs, which typically last 3 or 4 years for electricians and carpenters and 4 or 5 years for plumbers, pipefitters, and steamfitters. Electricians, carpenters, plumbers, pipefitters, and steamfitters may also attend specialized training programs on the specific systems with which they work.

5. Plant Operators

After a geothermal plant is completed and running, some staff are needed to operate and monitor the plant. They prevent or resolve any problems that would stop the plant from operating correctly.

Power plant operators work in control rooms to monitor power generation and distribution at a geothermal plant. They monitor the geothermal plant's pipes, generators, and instruments that regulate voltage and electricity flows. Power plant operators communicate with electrical distribution centers on the regional power grid to match production with system load. They go on inspection rounds to confirm that everything in the plant is operating correctly and keep records of switching operations as well as loads on generators, lines, and transformers. Power plant operators use computers to report unusual incidents, malfunctioning equipment, or maintenance performed during their shifts.

Credentials

Power plant operators typically need a high school diploma or equivalent and on-the-job training. Previous work experience, such as a line worker or a laborer in a power plant, can be helpful in getting a job. Strong mechanical, technical, and computer skills are needed to operate a power plant. Companies also require individuals seeking highly technical jobs to have a strong math and science background.

Conclusion

Geothermal jobs of all kinds will be most prevalent in the world, where geothermal projects are most common. If the geothermal industry continues to grow, opportunities should arise for workers in a wide variety of occupations with different education and training requirements, from doctoral scientists to roustabouts. Some occupations, such as those in construction, typically require workers to have completed an apprenticeship, and others have less formal on-the-job training. As the demand for clean energy grows, jobs in geothermal energy will be a small but growing potential source of new employment opportunities.

OCCUPATIONS IN RECYCLING

Getting recyclables from waste bins to manufacturers requires different types of workers. Drivers collect the recyclables and transport them to a specialized centre, at which sorters, plant managers, and technicians and mechanics work. Skilled personnel in support roles, such as sales and logistics, are also essential to the recycling industry. Larger recycling firms also employ workers in many other occupations, including management and human resources, but these occupations are not covered in this report.

For each of the occupations discussed in this section, the job duties, necessary credentials, and wage data are presented. Unless otherwise specified, the wages for each occupation are median annual wages within the remediation and other waste services industry group, which includes recycling.

1. Drivers

Recycling companies or local governments offering home pickup services employ drivers, also called recyclable material collectors, to pick up and transport recyclables to a specialized center.

Job duties

Several drivers usually work together as a team to collect recyclables. One drives the truck, stopping alongside each recycling bin, while the other workers ride inside the cabin or hold onto the side of the truck. At each stop, at least one worker exits the vehicle, grabs the curbside recycling bin, and empties it into the bed of the truck. When the truck finishes its assigned route, the workers return to the center where the recyclables are unloaded.

Depending on the type of truck used, workers might have to lift and empty the recyclables from the bin themselves. Other vehicles have hydraulic lifting mechanisms — in either the rear or front of the truck — that can be used to empty the bins automatically. To protect themselves from accidents around the trucks and lift systems, drivers follow detailed safety procedures.

Drivers are required to collect recyclables year-round and in all weather conditions. And, in order to pick up recyclables along long routes, some workers begin shifts as early as 5 or 6 a.m.

Recycling companies that offer services to construction firms pick up recyclable materials from construction sites. Because of the high volume and large size of construction waste, these workers might drive roll-off trucks, which can haul the large dumpsters used on construction sites back to special construction and demolition debris facilities.

Drivers are responsible for inspecting their vehicles at both the beginning and end of every workday. They inspect the tire pressure, fluid levels, safety equipment, and all gauges and controls.

Credentials

Drivers should have at least a high school education. To be certified to handle large recycling trucks, drivers must have a Class A or B Commercial Driver's License with airbrake endorsement. Recycling companies prefer drivers who have several years of experience with large commercial trucks.

Drivers need to pass drug screening and background checks. They should have clean driving records. Drivers must also be physically capable of lifting, pushing, and pulling full recycling bins repeatedly throughout the day.

2. Sorters

In single-stream recycling systems, many different kinds of recyclables are collected together. Sorters separate the various types of recyclables so they can be processed.

Job duties

Sorters work along conveyer belts in centers. As waste materials come down the conveyer belt, sorters pull out any items that cannot be recycled and should be disposed of. They sometimes work as quality control inspectors and remove unwanted materials from a single stream. For example, they might remove paper products from a stream of plastic containers.

At older centers, sorters are also responsible for separating all the different types of recyclables by material type. Such centers are increasingly relying on automated equipment as a faster way to sort recyclables. Even in these plants, however, sorters are necessary to ensure that no stray recyclables fall into the wrong group. Sorters also monitor the waste stream before it reaches the automated equipment to pull items that could damage the machinery, such as garden hoses, from the conveyer belt.

Credentials

There are no specific education requirements for sorters. Many companies conduct drug tests and background checks on prospective employees. Sorters need to be physically capable of working on their feet for the entire day. They also need strong backs to handle repeatedly bending over to pick items off the conveyor belts. Sorters must have excellent vision to spot items as they come down the conveyer belt.

3. Mechanics, technicians, and machinery maintenance workers

Recycling operations rely on various kinds of mechanics, technicians, and machinery maintenance workers to inspect and repair the automated equipment in centers and to maintain recycling trucks.

Job duties

Mechanics and technicians monitor and operate the machines in centers, including balers (compactors) that shape the recyclables into a form to simplify shipping to and use by manufacturers. They also regularly inspect the machinery and diagnose and repair any problems with the electrical or hydraulic systems of the compactors. They record their work in detailed logs.

Other mechanics, technicians, and maintenance workers are needed to repair and maintain the recycling trucks. They run inspections and diagnostic tests and perform preventative maintenance and vehicular repairs. Truck technicians also document vehicular part usage and repair times. They may be required to make emergency roadside calls if recycling trucks experience problems while out on collection.

Credentials

Whether they work on machinery or recycling trucks, mechanics and technicians should have at least a high school education. They should also have at least a year of formal education and experience performing repairs on machines or vehicles. Workers can learn these technical skills through vocational training programs or apprenticeships. While mechanics used to specialize in one area, many now have knowledge of multiple disciplines, including electricity, electronics, hydraulics, and computer programming. Machinery maintenance workers usually receive on-the-job training that lasts for a few months or a year.

Mechanics and technicians are required to pass drug tests and background checks.

4. Material recovery facility managers

Keeping a constant flow of recyclables collected, sorted, processed, and sold requires a proficient staff - and experienced center managers to supervise it.

Job duties

Centers managers are also responsible for recruiting, hiring, and training employees. They evaluate employees' performances and offer feedback to senior managers on how to reward and compensate employees. Finally, because heavy machinery and large vehicles at a such center can pose a risk to employees, a substantial part of this center managers' jobs concerns workplace safety, such as providing employees with regular safety briefings and reviewing technicians' inspection and maintenance reports.

Credentials

Management experience, especially in the waste industry, can sometimes be substituted for education. A combination of a graduate degree and several years of experience is ideal.

5. Route managers

To collect recyclables in the most efficient way possible, route managers plan routes and schedules for recycling trucks to follow.

Job duties

Using maps and customer data, route managers choose the best schedule and routes for collecting recyclables from customers. They determine the most efficient routes and assign them to drivers. Route managers monitor drivers' routes and might solicit their feedback before making changes. They record statistics, including the length of each route, the time it takes to run each route, number of homes serviced, and the amount of recyclables collected. If the recycling service changes its collection plan — such as the day on which recyclables are collected — route managers inform customers of this change through the customer service department.

Credentials

Route managers need at least a high school diploma. Many have associate's degrees and several years of experience in transportation, logistics, or waste management. They also use communication skills to interact with recycling truck workers.

6. Sales representatives

Sales representatives, also called account managers, are responsible for finding purchasers for both recycling services and processed recyclables.

Job duties

Companies selling recycling services use sales representatives to sell their services to either an entire municipality or individual consumers. The sales representatives need to know what services their company offers: collection services, sorting and processing services at a center, or both. Sales workers are the point of contact between the community and the recycling company. If there are any changes or problems with the recycling service, sales workers need to explain these issues to their clients.

Sales workers also sell recyclables — after they have been sorted and processed at a center of collecting — to manufacturers to be used as the raw material in new products. To find new clients, sales representatives might have to make sales pitches over the phone or perform in-person presentations. They research their potential clients and devise ways to convince them to use recycled materials in their products. Depending on the recycling contractor, these sales workers might be the same as or different from the sales workers who sell recycling services.

Credentials

Sales representatives are usually required to have at least a bachelor's degree. Experience in sales, especially waste management sales, is very useful. Communication skills are also extremely important for sales workers. They must be able to find clients and negotiate with them effectively.

Conclusion

As recycling continues to grow, more workers will be needed to collect, sort, and process recyclables. Recycling jobs require people with a broad range of skill levels. For example, becoming a sorter has few specific skill requirements, but mechanics and technicians in the recycling industry are highly skilled. Route managers usually have at least a bachelor's degree. But whether driving large vehicles or operating a such center, prior work experience — particularly in other areas of waste management — is helpful for those seeking to make a career in the recycling industry.

OCCUPATIONS IN GREEN CONSTRUCTION

Many organizations, both national and local, offer training for green construction trades. 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, 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.

1. 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.

Two men reviewing blueprints 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.
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 constructions. 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.

2. 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.
Two men operating construction equipment 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.
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 or other international language, 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.

Selected occupations in the nonresidential building construction industry group
Construction managers
Construction laborers
Operating engineers and other construction equipment operators

3. 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.

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 steam pipe, 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.
Man fastening insulation to a wall 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.

Man installing solar panels on a roof: 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.

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. 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 installers to be licensed. Licensing requirements vary, but workers typically must have several years of experience and pass an examination that tests their general knowledge and familiarity with local building codes.

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FITTER OF RENEWABLE ENERGY DEVICES

1. Tasks and operational requirements.

The aim of the work of the fitter of renewable energy devices is to perform assembly and disassembly of equipment such as solar panels, heat pumps, photovoltaic panels and other renewable energy equipment through a series of construction projects that use solar energy, hydro, wind, geothermal and hydrogen.

The main tasks which can be specified in the fitter job are to organize, to perform, to maintenance and to repair of equipment and renewable energy systems.

By organizing the assembly shall mean the following professional tasks:

• preparation of working places,

• installation of security against threats and accidents,

• preparation of appropriate work tools addicted to the type of job installation,

To perform the assembling is dependent on the devices that the fitter must install and is associated with the following professional tasks:

• selection of tools, materials and equipment for the assembly of a biomass boiler, heat pump, solar collector, photovoltaic cells, the assembly,

• ongoing supervision and control of work,

• preparation of equipment for the reception,

• provide information to users about the proper use of mounted devices.

Maintenance and repair of renewable energy systems involves the ability to take care of the proper functioning of equipment, cleaning and maintenance as well as the indication of emerging defects, replacement of worn parts, and repair and removal of such installations and devices.

Additional tasks may include preparing cost estimates, contracts or tenders associated with installation in / on equipment and control of their work.

Assembling of these devices is performed on the basis of drawings and projects therefore an important task of the fitter of renewable energy devices will be the correct reading of the drawing and making installation in accordance with the guidelines, according to a specific technology.

An important skill of all professional fitters is efficient use of different assembling tools. These include, among other things: keys, screwdrivers, tools for cutting, bending, straightening, and drilling. During the work of the fitter of renewable energy devices it is also necessary to use the devices for the measurement of electrical parameters, and tools and equipment to perform the soldered, threaded and welded connections.

2. Working environment.

1) The material environment.

The working place can be very varied and depends on the ordered assembly. They may be residential buildings during renovation or construction, open spaces, factories and other facilities. Especially a lot of such systems appear in tourist resorts and estates of detached houses in cities.

The tasks performed require reliable and conscientious work, and strictly comply with the principles of occupational health and safety. The job of the fitter of renewable energy devices may be associated with working at height is therefore necessary to have permission to work at heights.

2) Social conditions.

The work of fitter can be of independent in carrying out small installation works, maintenance or dismantling of renewable energy devices. This requires the total knowledge of issues related to the installation of the facilities, their operation and maintenance. But mostly he will work rather in the team of people especially when installing large orders. Contacts with people are then often and rely on issuing commands and listening, agreeing, communicating with other employees. It is therefore required the ability to collaborate with others, exchange of information and sharing tasks.

3) Organizational conditions.

Working time of the fitter is substantially 8 hours a day. Work can be a shift or shifts. It also happens so that the working time is extended due to the established terms, dependence of some work on weather or the work of other teams. The work is performed mostly during the day; it is rare that the time is moved to the night hours. The work of the fitter is not a routine work. It requires focus on the activities and tasks performed.

Very important information is that a lot of installations can take place outside the place of residence of workers. This affects the willingness and necessity trips.

Work installer requires the establishment of protective clothing.

3. Terms to work in the profession.

The profession of the fitter of renewable energy devices can be earned in non-school system and qualification courses. Their completion allows you to take the exam and after obtaining a certificate of passing this qualification. In addition, it will be necessary to have the knowledge and certificates to work with electric devices up to 1 kV. This profession can be obtained also after some technical school.
In addition, the profession defines various specialized skills, which may include:
hydropower, wind, geothermal and hydrogen. This enables candidates to specialize in a particular area, for which there is demand in the local or regional labour market.

4. Ability to work by adults.

Adults who have completed a vocational education should first acquire a secondary education (finish secondary school) also extramural without matriculation exam. This will open the way to qualification courses, and later examinations for skills: installation of equipment and systems and the exploitation of renewable energy equipment and renewable energy systems.

It's easier for people who have completed secondary school in another profession, because it is enough to only pass the qualifying course and passed the examinations. These courses can organize by public and private schools and other institutions, including vocational training centres.

5. Employers.

The fitter of renewable energy devices is a profession of the future. Increasingly, individuals use biomass boilers, heat pumps and solar collectors. Especially a lot of such installations already appeared in tourist resorts and estates of detached houses in cities. Qualified personnel are needed for mounting and installation of these devices. This creates an opportunity to create a small service companies. In addition, it gives the opportunity to work in:

• companies involved in the design and installation of ecological boilers,

• companies involved in the installation and production of solar panels, photovoltaic cells, heat pumps, biomass boilers and other renewable energy equipment,

• maintenance of these devices,

• wholesalers of sanitary equipment,

• centres of ecological heating systems.

TECHNICIAN OF RENEWABLE ENERGY DEVICES

1. Tasks and operational requirements.

Technician of equipment and renewable energy systems during his work performs the following professional tasks:
a) determines the conditions of the location of the equipment used for the production of thermal energy, mechanical and electrical;
b) plans of works related to assembly of the facilities using the renewable energy;
c) organizes and supervises the work related to the installation of equipment used in renewable energy systems;
d) performs the installation of equipment used for renewable energy production;
e) controls the operation of the equipment and installation, and operation of renewable energy systems;
f) calculates the cost of materials and installation works;
g) he is fluent in a foreign technical language implemented in his profession;
h) cooperates with national and international organizations, enterprises and institutions in the field of renewable energy;
i) performs quality control of the works;
j) prepares estimates and tenders and contracts for equipment and renewable energy systems.

2. Working environment.

1) The material environment.

Technician of equipment and renewable energy systems often have to endure the inconvenience of the weather, because it works in the open air, regardless of weather conditions, for example, mounting solar collectors.

A person who is hired for this position may suffer from colds, as well as diseases associated with skeletal system. Field work also promotes respiratory diseases and allergies. The reason for this may be also the tasks regarding installation work where the air is often polluted with dust, the lighting may be too strong or too weak, high noise levels, variable thermal conditions. Therefore, working conditions, of technician of equipment and renewable energy systems expose him also to diseases of the eye, ear, inflammation of the mucous membranes of the nose, larynx and pharynx.

2) Social conditions.

Technician of equipment and renewable energy systems almost always work in a team. Its size depends on the size and type of task.

During the task, a person working in this position collaborates with other assemblers and their superiors. Technician of equipment and renewable energy systems must also contact the owners and users of the work that it performs. It is necessary to be able to make any comments, and then respond to them, and when it exceeds his competence - pass it to his superiors.

3) Organizational conditions.

For most of the year, the working hours of technician of equipment and renewable energy systems are generally fixed and range from 6 to 9 hours a day, but because of the needs and weather conditions can be set according to specific needs. Works during the high season can also be held on Saturdays in order to take advantage of the weather. Technician of equipment and renewable energy systems also spends a lot of time in the car, reaching and implementing professional tasks.

At work a comfortable, lightweight dress is preferred, with an emphasis on protective clothing (rubber boots, helmets, raincoats).

Tasks and functions depend on the size of the operation of the company itself. Technician of equipment and renewable energy systems before work receives a project of the tasks. During his work he collaborates with superiors, colleagues and technical supervision. Technician of equipment and renewable energy systems can also set up his own business.

4. Terms to work in the profession.

Technician of equipment and renewable energy systems should have a high school education. Workers who have experience in the job and the certificates that allow to manage the works are mostly employed by employers (firms of installation that specialize in designing and manufacturing related to: hydropower, wind energy, geothermal energy, hydrogen energy, solar energy, energy-saving construction, wind technology, as well as in companies dealing with the law and standards concerning environmental protection) [4]. In case of technicians of equipment and renewable energy systems who work in the administration it will be useful ability to use computer programs and office equipment.

Schools that educate the technicians of equipment and renewable energy systems usually have a 4 - year cycle of training. The curriculum takes into account such issues as: the base energy, renewable energy systems, technical documentation, environmental issues (significant because of the adjustment of Polish legislation to the requirements of the European Union) and the computerization of work. For the profession of technician of equipment and renewable energy systems it is also included links to general education. [5] A graduate of the profession of technician of equipment and renewable energy systems can continue his education at any university.
Due to field work in different locations and the need to go the distance in this profession it is required to have a driving license.

5. Ability to work by adults.

Age restrictions in the profession of technician of equipment and renewable energy systems generally do not occur. Anyone who has specific knowledge and has a professional background has the opportunity to get a job in this profession. However, working as a

technician of equipment and renewable energy systems is associated with good physical condition, which is useful when performing the tasks.

6. Employers.

Technician of equipment and renewable energy systems may find employment in positions related to the installation of equipment and renewable energy systems, as well as the positions of technical supervision, which rely on maintaining the proper functioning of the installation of renewable energy. People who work in positions of technician of equipment and renewable energy systems usually work in the construction and energy sectors, as well as energy consulting (dealing with the possibilities of the use of renewable energy sources). If you take a job in the administration, the positions could be of technical supervision and services for investment associated with the use of renewable energy sources, particularly in the construction industry.

People can create their own entrepreneurial companies (especially small).

FITTER OF THERMAL INSULATION

1. Tasks and operational requirements.

Fitter of thermal insulation performs thermal insulation of buildings. Its task is adequately protecting wooden buildings, concrete or brick against extreme temperatures atmospheric environment. Disclaimer residential building and industrial require a certain temperature in the place occupied by people, to achieve the desired quality of life and work.

The tasks of the professional fitter of thermal insulation should be:

1) analyzing the working drawings and determine on the basis of the scope and type of insulation works, necessary materials, tools, equipment and machinery

2) matching and evaluate the quality and use of materials for insulation system

3) organization of the workplace and transportation of materials

4) perform basic carpentry works, locksmith

5) preparation of substrates for the type of insulation

6) external insulation of building walls using the selected system

7) preserving, repairing, renovating and removing insulation systems.

After proper training, the fitter of thermal insulation can perform insulation fungicides, fireproof and the dry wall of the building.

Fitter of thermal insulation use the appropriate materials, tools and equipment.

Thermal insulation of building walls is related to the works at height using different kinds of scaffolding and hydraulic platforms and elevators. For installation of scaffolding some training is required. Performed activities include: mechanical drilling holes in the wall, shooting-steel pins, mounting the bearing elements and mount them trim-to-size panels of expanded polystyrene, mineral wool, etc.

The fitter also assembles the cover elements if required by technology, usually in the form of profiled metal enamel. So he performs additional tasks when cutting sheet metal to size and their assembly.

In carrying out the thermal insulation inside the building within the scope of its activities includes joinery and carpentry works involving the execution and assembled walls and wooden scaffolding skeleton constituting the thermal partition.

The work of fitter of thermal insulation is performed at the end of the construction of buildings, often even when the building is in use or after many years of use in order to improve the insulation or replace system in the new technology.

2. Working environment.

1) The material environment

Workplaces of the fitter of thermal insulation are moving and changing due to processes occurring in the construction industry. Most often are organized directly on the site, often at high altitude and changeable weather conditions. There is a very serious risk of accidents associated with working at heights. This requires the employee to take particular care and precautions for use protective equipment against falls from a height.

During operation, the fitter also meets hazards common to other construction professions. These are the risk of electric shock when using electrical hand tools. Especially dangerous is the floating dust from the cleaned shells and splinters of discs and pieces of wire with wire brushes used to clean the surface.

2) Social conditions

The fitter of thermal insulation almost always works in a team of people and works with his superiors. The size of the team depends on the tasks to perform. The fitter job is usually performed under the direction of foreman and works manager.

The fitter can work in a specialized brigade implementing large investment projects or a small team. In both cases he collaborates with colleagues of the same level of education, professional abilities, and similar areas of activity.

3) Organizational conditions.

The working hours of fitter are fixed, however, due to the seasonality of the work and work-related nuisance occurring with variable weather conditions, eg. rain, snow, extreme temperatures, wind, work in the summer can be conducted in two shifts.

In the case of small businesses, as well as for the intensity of seasonal work, are often adopted different standards of time allowed by the legal system.

3. Terms to work in the profession.

In this profession can work only adult males. To be allowed to work is finding a qualified medical practitioner about the absence of contraindications as well as the obligation in terms of initial training on topics related to their work. Sufficient education is the completion of vocational school of general construction profile.

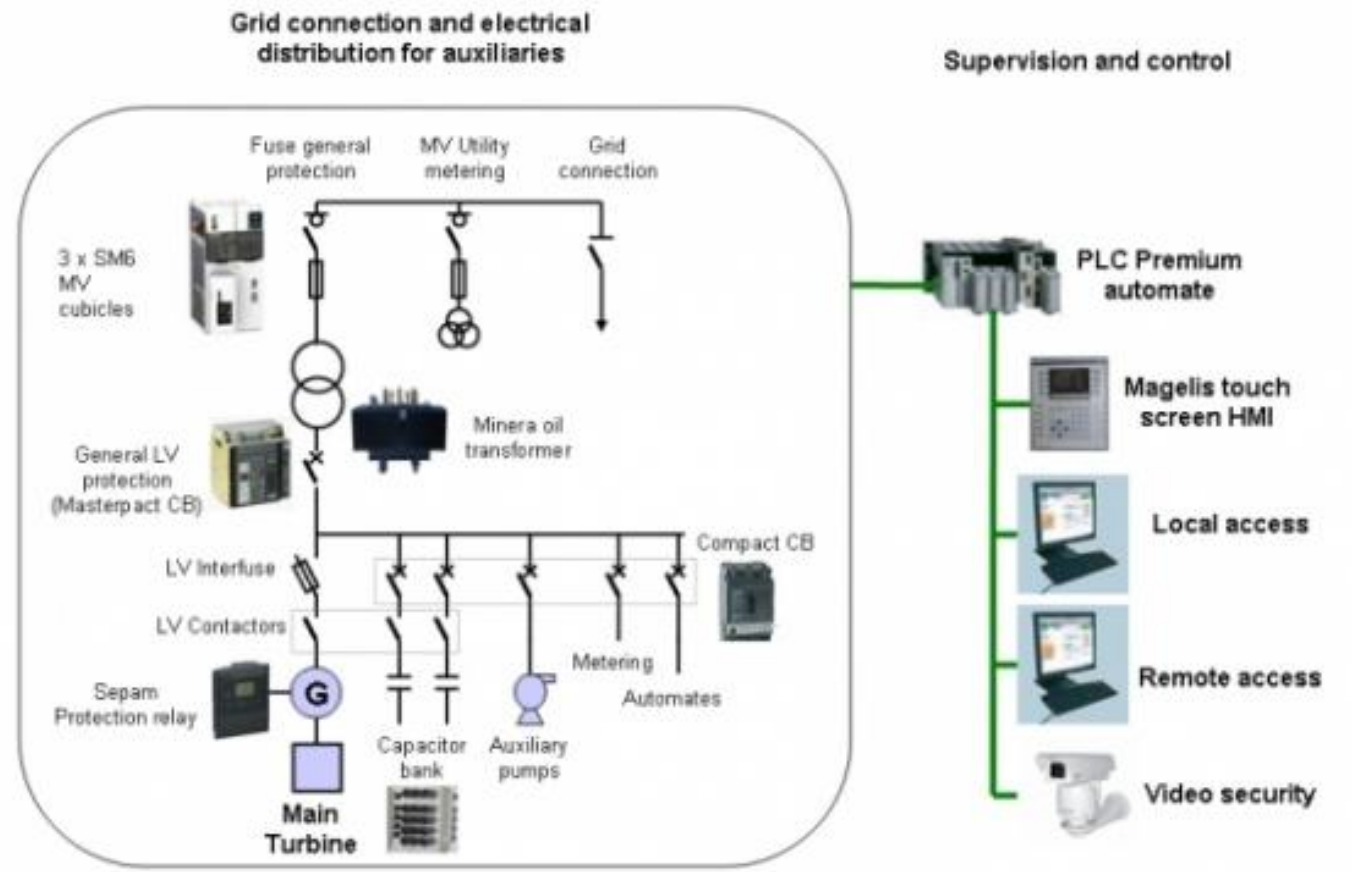
4. Ability to work by adults.

The only barrier to access to the profession for adults is their age. It can be specified for 50 years and is associated with high requirements of the health and physical condition.

5. Employers.

The fitters of thermal insulation are working mostly in construction companies. They can also set up their own company.

1. Tasks and operational requirements.



Electrician continuously monitors the status of equipment, in particular hydropower generators. The tasks of the people working in this profession are:

- switch on and off of hydrogenerators,
- supervision over their work and auxiliary equipment,
- perform maintenance and repair of electrical equipment in motion and when parked.
- control the operation of switchboard of high and low voltage,

• control over the work of transformers,
• supervision over the work of hydraulic equipment, such as locks, weirs, fish pass and a water reservoir (in particular during low and high water levels),
• supervision of auxiliary power equipment such as rechargeable batteries, compressed air systems, backup power, etc.
• make measurements of insulation resistance, current and power consumption by power equipment,
• in the case of electrical power failure he takes crucial decisions: to switch off the defective unit (replacing it with a backup), or to reduce its energy load by changing the setting switches or repair - that is, to restore them to full efficiency.

The tasks of the people working in this profession may also include:
• determining the causes of malfunction of electrical equipment,
• locating faults,
• removing them from their own or with the necessary specialists,
• overseeing the efficiency of back-up systems,
• monitoring the compliance with emergency procedures in the event of failure,
• carrying out periodic maintenance,
• performing readings indicated by measuring equipments,
• keeping a log book and work book of machines according to the low requirements,
• use safe work practices,
• compliance with health and safety regulations and fire.
Additional tasks which can take a person working in this profession is acting as a dispatcher of small hydropower plants, dams and intakes.

2. Working environment.

1) The material environment.

The workplace of electrician is, of course, the space of hydropower plant, in which he was engaged. It could be a plant with significant power in the energy balance of the country or small hydroelectric power plants of local significance. Hydroelectric power plants are closely related to hydrological structures: dam, water reservoir, water supply system and drainage system.

3) Social conditions.

Employees of large hydroelectric power plants work in large teams. Contacts between individual employees are direct and by using modern technology.

In small hydro power plants - these are smaller groups of people or individual work.

4) Organizational conditions.

Persons employed in maintenance departments of power work in continuous operation. Work is in shifts and then seven days a week (including public holidays). In large hydroelectric power plants - direct supervision is usually limited, but there is continuous supervision resulting from the collaboration of different teams. Electricians working in large hydropower plants - in repair and maintenance - usually work in one shift. They can, however, be required to availability outside of working hours - in case of serious failures of power systems.

3. Terms to work in the profession.

The first and most important requirement, which is located among the most common expectations of potential employers is a matter of education possessed by the candidate - are preferred persons, possess a higher technical education, acquired in the direction of electric power. Experience from working in a position involving the handling power will be for a potential employer an advantage, as the ability of analytical thinking, self-organization of work and personal qualities such as responsibility or involvement in the performance of duties. The obvious issue is the need to have knowledge of the operation and maintenance of equipment, occurring in the plant.
Although there are people working in this profession and having a basic vocational education, is due to the development of technology is increasingly demanded of candidates for the job of higher qualifications. The minimum condition for that job is the completion of higher vocational school. Desirable is to complete higher studies in this field.
Additional qualifications of persons who work in the profession of electrician of hydropower plants are special energy certificates, according to the current legislation in this area.

4. Ability to work by adults.

Persons with current knowledge and skills are preferred in this industry. They are also required good health - which often disqualifies a person over 50 years of age (also because of the often outdated knowledge and the need for expensive training). But these are not absolute requirements - a person with a directional education - 50 years of age, with experience in the industry, enjoying good health and ready to supplement the professional qualifications - has a chance to work in this profession.

5. Employers.

Hydropower sector are small and large hydropower plants. It is predicted that in the future the development of hydroenergy will be mainly based on the modernization of old power plants with a large production capacity, as well as small hydropower plants with a capacity of 5 MW. Electrician can work in each of this hydropower plants category.

ECOLOGICAL AUDITOR

1. Tasks and operational requirements.

Ecological audit is one of the basic tools of surveillance of environmental and ecological assessment. According to the definition of the International Chamber of Commerce (ICC) “ecological inspection is a systematic, documented, periodic and deliberately carried out the assessment of the organization, business or

enterprise of its management system and processes designed to protect the environment". To perform it is required so called “local view" of a given company or organizational unit where you make an inventory and assessment of the technical condition of the equipment and obtain environmental data, which sometimes requires the execution of independent measurements: soil, water, radiation, noise etc. The ecological auditor checks the commitment of the company towards environmental regulations and shall examine the conformity of the actions of the unit with the generally applicable legislation. If the unit is large, the control may relate only to its internal organizational units, ie. branches, offices, departments, etc. Inspection consists of a careful and thorough examination of the documentation. The auditor also conducts talks with the controlled entity, its managers and employees, gaining additional information that allow getting a complete picture of the operations of the unit. Ecological audit may be partial (selected environmental aspects) or full (all environmental aspects). The work of the auditor is to check the environmental activities of companies and various institutions for compliance with the standards for the protection of the environment. It specifies that the requirements are fulfilled and which are not, and gives guidelines for the company in order not to exceed the required standards and pay the lowest possible fees for commercial use of the environment. In addition to the tasks of the environmental auditor may include laboratory testing in the field of environmental quality, forecast the environmental impact of projects, plans and socio-economic strategies, participation in the ecological certification. It can help in preparing of different reports for local authorities.
At the end of audit the auditor prepares the protocol and report on the inspection together with the conclusions and recommendations. In this protocol there are specified matters (issues) that are subject to inspection, the irregularities and misconduct. The auditor determines the level of adaptation of inspected unit according to guidelines of BAT (Best Available Techniques) and determines how to obtain financing for the plant to adapt to functioning in accordance with BAT. The auditor may also carry out an analysis of strengths and weaknesses of the individual in terms of environmental management. This analysis provides the basis for an action plan according to the EMAS Regulation.

2. Working environment.

1) The material environment.

Ecological auditor works in offices generally well equipped with office furniture and office equipment, ie. computer, phone, fax, etc. Making eco-audit profession involves working mostly sitting. Since the basic function is to read the documents and track data on a computer screen, the auditor is exposed to electromagnetic radiation and eye diseases.

2) Social conditions.

Ecological auditor works individually or in a team. Often this profession involves an individual analysis of each batch of documents and the team (most often with two or three people) to discuss and develop the whole material. In addition, ecological auditor has enough often contacts with people, because not only interviews with the management of the audited organizational unit or business, but also to its employees, and then presents the results of control of the principal.

Since the purpose of the audit is to control the unit, the result of which may be an indication of deficiencies or errors, so it happens that the presence of the auditor is not received with enthusiasm, but rather raises reluctance, anxiety and fear. Ecological auditors in their work

use a variety of methods of communication - writing, verbally or through communication devices.

3) Organizational conditions.

Ecological auditor usually operates at fixed hours of work, usually in line with the opening hours of controlled entity. The work lasts 8 hours a day. In exceptional cases, is also working on days off from work, but then it is also rewarded. Ecological auditor moves within the city, especially when the individual organizational units audited are not in the same building, but are distributed in different parts of the city. It happens also that he must go to another city and stay there as long as it takes control of local branches. The operation of ecological auditor is subject only to the general supervision – only the type, place and date of inspection are determined, but he has a large autonomy in organizing the work, ie. the sequence of operations performed, conducted interviews and document analysis. Often ecological auditor conducts his own business, doing the job for local governments, financial institutions, investors and companies.

3. Terms to work in the profession.

From people employed in this occupation employers generally expect theoretical and practical knowledge in the field of environmental protection, management, law or economics and professional experience in the work of a similar nature. Education needed to carry out the environmental audit profession can earn at universities, academies of agricultural or non-state universities under full-time study or part-time. It is advisable to supplement their knowledge in postgraduate direction „Ecological Auditing". It is also necessary a constant update their knowledge by monitoring regulatory changes and participation in a variety of specialized training, including in the field of environmental management, eco-auditing, environmental impact assessments, rights or sustainable development. Attaches great importance also to the analytical capacity of the candidate and personal characteristics (verified by testing and interview) and English language proficiency. It is useful to have a driving license.

4. Ability to work by adults.

Often, in order to find employment in the position of the ecological auditor is required experience from working in the industry related to ecology or environmental protection. Rarely are admitted to the profession of people right after school or after graduation. Therefore the greatest chances to work in this profession are those who crossed 30 years of age and have a few years' professional experience. Persons aged 40-50 years are likely employed, provided that they have the appropriate knowledge, they are willing to fairly frequent trips outside the residence, and the general state of their health is good.

5. Employers.

The ecological auditor may take employment in the following institutions:
- bodies of state administration and self-government,
- representative bodies at international organizations dealing with the environment,
- environmental institutions,
- non-governmental organizations and foundations involved in ecology,
- departments of environmental protection in the companies,
- consulting firms related to environmental protection,

- scientific and research institutions,
- sanitary and epidemiological stations,
- institutions seeking to get funds for the purposes of environmental protection from the European Union.

CONCLUSION

This guide has examined the various occupations in green construction, but especially in using and producing renewable energy. 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 .If the world will have such specialists, it will be easy to find the possibilities and the opportunities to find and use new sources and resources for energy, and to develop our future, and our life.