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*Introduction*

With new innovations constantly entering the marketplace, the demand for energy has continued to soar. Think about all the things that you use on a regular basis that require energy – your computer, cell phone, iPod, car, and much more. On a larger scale, energy enables transportation, facilitates communication, runs businesses, and powers homes. Ensuring that supply continues to meet this demand presents exciting challenges for engineers.

Energy is produced in many ways, but in every case, natural resources are harvested one way or another. For example, companies extract and process crude oil and natural gas, harvest wind and water power, collect solar energy, and capture the energy released by nuclear reactions. Once converted into a useable form, that energy can be distributed and delivered to the consumer marketplace.

Oil companies and the oil service sector that supports it are central players in the energy field, heavily covered by the media and prominent in the public consciousness. But there are many other robust sectors in the industry. There are electrical utilities, nuclear fuel suppliers, natural gas companies, an expanding coal trade, EPC (Engineering, Procurement & Construction) companies developing large turnkey projects across the industry, and growing opportunities in the alternative energy field. With an industry as vast and diverse as this, you can bet that there are plenty of career opportunities for engineers.

Many energy companies have operations all over the world, especially companies like ExxonMobil, BP, and Royal Dutch Shell. In the U.S., many of the petroleum companies keep at least an office presence in major coastal cities and the oil services firms, companies that supply infrastructure and subcontract support to the major oil companies, tend to locate themselves near their primary clients. Coal producers tend to cluster in heavy coal-producing states, while electrical utilities are everywhere – more than 3,000

**Educational Goals:**

After completion of this module, you should:

- Be familiar with the energy industry and the opportunities it offers engineers
- Have a greater understanding of the operations and standards that are used in the energy industry
- Be familiar with resources that will help you take the next step in your career in the energy industry

utilities deliver power to homes and businesses across the U.S. With 104 nuclear generators currently in operation and infrastructure rebuilding underway, nuclear engineers will find careers opportunities across the country.

The energy industry also offers an international choice of job locations to choose from. Thanks to the global network of oil jobs and the re-emergence of coal as a market leader in developing economies, fossil fuel careers can take you almost anywhere in the world that you can imagine. Nuclear energy career paths can also be global in scope. You might consider places with well-established nuclear infrastructures like France – which uses nuclear energy to generate most of its electricity – or the nuclear expansion and construction in Japan, Korea, and South Africa may appeal to you. Those with an interest in working with alternative fuel sources might want to check out Brazil's robust ethanol production sector or Germany's growing commitment to solar and wind power. If China appeals to you, its booming economy and industrial growth are creating such a demand for greater and new energy supplies it's difficult to list just how many different energy-related opportunities you can find there.

So, let's break the industry down and take a closer look at some of the specific paths you might take in this expansive, evolving, global field.



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## Industry Scope

### Oil & Gas

Almost 50% of petroleum production in the U.S. goes toward gasoline, but oil and natural gas also cook our food, heat our homes, and generate our electricity. Because the industry provides the building blocks for so much of what surrounds us each day, it's no surprise that the sector and its major players – often referred to as Big Oil – are such an economic and political force that it's hard to imagine a world without them.

The oil & gas sector can be divided into roughly two segments. First is the "upstream sector" which involves exploration (the search for oil or gas fields) and extraction (the drilling and operation of wells that bring the raw materials to the surface). Second is the "downstream sector" which is focused on production and distribution. The downstream operators process, store, and transport the raw materials to the refineries and petrochemical plants, then distribute the resulting petroleum products - gasoline, diesel, jet fuel, heating oil, natural gas, and propane - to the consumer market. Many of the largest oil companies have extensive operations in both segments and are therefore referred to as "integrated oil companies".

Working closely with both the upstream and downstream components are the oil equipment and services companies that supply operational support to oil companies. These companies design, build, and supply oil rigs and pipeline equipment, conduct seismic testing, transport equipment for the upstream sector, and design plants, supply equipment, and delivery systems for the downstream sector. The success or failure of these auxiliary companies is tied to the rise and fall of the price of oil, since the price of oil will dictate increases or decreases in production. Most oil services jobs can be found in Texas, or internationally in places like London, Calgary, and the Middle East. In many ways, working for one of these support companies can feel like working directly for an oil company, given their close and interdependent relationships.



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## Industry Scope

### Coal

Coal is used in industrial manufacturing and in electricity generation. As developing countries industrialize and their demand for power grows with their expanding economies, worldwide demand for coal increases as well. In 2003, coal accounted for 24% of world energy consumption, and the U.S. Energy Information Administration expects coal use to double by 2030 to meet rising demand. A key reason for this dramatic rise is the staggering pace at which large countries such as China and India (both of which have large internal deposits of coal) are industrializing and developing, and the greater and greater quantities of coal they are consuming as a result. Other countries with substantial coal deposits – the U.S., Russia, and Australia – are also benefiting from the developing world's growing appetite for coal with export levels to China and India reaching new heights.



Not coincidentally, such drastically increasing consumption is raising larger and larger environmental concerns. In the U.S., The Clean Air Act of 1990 sought to cut sulfur levels resulting from coal production, and there is a worldwide concern about global warming resulting from the burning of fossil fuels. Engineers are working on solutions to these concerns, designing new coal-fired plants and developing the air quality control systems that will result in cleaner coal-supplied power. Meanwhile, the continued growth and industrialization of two geopolitical giants means that coal consumption will remain high, new mining methods will be needed, and the demand for engineers to develop processes to reduce pollutants and contribute to a cleaner environment will remain strong.



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### Industry Scope

#### Nuclear Energy

With prices for oil and gas increasing all the time, and growing concern over the effects of greenhouse gases on the environment, nuclear power has become more attractive than ever. In 2005, 16 countries got more than 25% of their electricity from nuclear plants. Lithuania, France, Slovakia, and Belgium rely on nuclear power for more than 50% of their total electric power. Japan leads the way in Asia, with 53 nuclear generators - over twice as many as South Korea and 5 times as many as China. The U.S. and U.K. each generate nearly 20% of their total consumed electricity using nuclear sources.

[Source: U.S. Department of Energy, International Energy Outlook, 2006]

Nuclear power offers potential solutions to some of the current major environmental worries like global warming. These environmental incentives, together with engineering improvements in reactor design (reactors that are physically incapable of experiencing accidents like Three Mile Island or Chernobyl, for example) and safety procedures, have allayed many of the public's fears of the dangers of nuclear energy.

However, nuclear power brings new environmental concerns. All nations with nuclear power plants are still wrestling with the problem of nuclear waste disposal. Currently, most U.S. power plants store spent fuel onsite in huge pools of water, while other countries reprocess the fuel. But there is no question that more long-term engineering solutions are needed, and such solutions are still a matter of intense concern.

Overall, nuclear energy is expected to constitute a major slice of the energy pie in the future and engineers will find opportunities in building new plants (especially internationally), improving existing plants, and coming up with solutions for nuclear waste disposal.



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## Industry Scope

### Alternative Energy

Some of the most cutting-edge work in the industry is happening in the field of alternative fuels. In contrast to traditional fossil fuels, ethanol and other biofuels are produced with less environmental impact and from renewable resources. Solar and wind energy can be collected and converted directly or indirectly into other forms of energy, such as heat and electricity, with fewer pollution concerns.

In the broadest sense, alternative energy is defined as any technology that that does not harm the environment or deplete the Earth's natural resources. It reduces or eliminates the environmental impact of primary energy production, consumption, and generation. It's also sometimes called the "clean energy industry". For the most part, when people speak of clean energy, they mean solar energy, geothermal or wind power, and biofuels. The research and development of the equipment used in these processes is leading to breakthroughs at alternative energy companies all over the world.



*Industry Operations*

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**Overview**

The energy industry involves the mining and extraction of fossil fuels; the harnessing of nuclear power; the capturing of water, wind, and solar power; the production of secondary fuel sources like biofuels and ethanol; and the transmission and delivery of power. Each sector's unique process requires a wide array of specialized skills and knowledge that offer engineers from all disciplines a challenging and fulfilling career path.



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### Industry Operations

#### Mining & Extraction

Finding the raw materials, extracting them, processing them, and getting them to the marketplace takes the combined effort of teams of specialists, including engineers.

#### Coal Mining

Engineers are concerned not only with actual mining - the production and processing of coal itself - but with minimizing the environmental impact of the mining operation. As a result, you'll find geological, environmental, design, reclamation, and mining engineers working throughout the life cycle of most coal mining projects.



- **Site Analysis:** Engineers start with site analysis. They conduct preliminary surveys of deposits, making geological and topographical surveys; choosing methods of mining best suited to the character, type, and size of deposits. They also examine a wide range of elements beyond the coal itself. They look at growing conditions, climate, soil composition, vegetation, wildlife, etc. to create a full profile of the area. The results of these surveys are used to apply to state or federal authorities for a permit to mine and are used to design reclamation plans for implementation when the mining is complete.
- **Mining:** Engineers are onsite and involved with all aspects of the mining operation. They determine the most effective mining method for the site and type of deposit. They design the mining plan and facilities including waste management, site access routes, transportation and ventilation systems. They monitor production levels, check drainage efficiency, run air quality tests, and design and maintain safety devices.
- **Reclamation:** Even after the mining operation ceases, the engineers still have work to do. It is now standard practice in

the industry to reclaim the surface after mining is completed, returning the land to useful purposes, and over 2 million acres of previously mined land has been restored thus far. When the engineers involved in site analysis develop the mining plans, they include a reclamation plan as part of the permit application. Depending on the intended use of the land, the plans can address issues such as re-vegetation, water management, earthwork design, erosion control, and reintroduction of wildlife species.

### **Oil & Gas**

The circumstance of each site will dictate the exact process by which oil and gas are extracted but, the breakdown below gives a brief overview of the tasks and people regularly involved along the way.

- **Exploration:** A broad range of engineering disciplines are required to create and maintain the infrastructure required in the search for and development of drilling sites. Engineers will develop and refine drilling techniques for each unique location. They also work to create platforms, pumping systems, and support structures.
- **Production:** Once drilling has started, an engineering specialist calculates the amount of the resource at a site by gathering data on reservoir properties; oil, gas, and water levels; and thickness and area of coverage. They study information covering the reservoir's history, and that of other reservoirs in similar locations and circumstances, so they can forecast total material recovery. The reservoir engineer determines if the use of additional wells and secondary techniques would enhance productivity and profitability and be economically feasible.
- **Refining:** In order to transform raw materials into salable product (such as gasoline, jet fuel, or motor oil), engineers devise refineries and refining processes that will ensure high-quality products. Engineers also develop new or improved products through process innovations.
- **Transporting:** Pipelines and other supply lines move raw materials to refineries and take the final product to the end user. These complex systems are planned and run by design, operations, and process engineers who work with marketers, analysts, and trafficking professionals.



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**Industry Operations**

**Power Generation**

The overall process of getting a power plant planned, built, approved, and operational is fairly similar across different energy sources. However, each source presents slightly different considerations for engineers. Below, we will go through engineering roles in a nuclear power plant. Remember that most of these roles are similar in other types of plants, however, nuclear energy does require additional considerations (that may not apply to the other energy sources) such as additional levels of safety compliance.



***Plant Design and Development***

Engineers are key participants in the selection and design of new materials, components, and systems for a power facility. In addition to designing the overall facility itself, there are also decisions to be made about the design of individual fuel elements, reactors, reflectors, thermal and biological shields, instrumentation, and control and safety systems.

***Fuel Management***

Managing fuel from the beginning to the end of the process involves specifying procurement methods, transportation systems, handling procedures, and a management plan for the fuel throughout its reactor lifetime and beyond. The fuel does not cease to be an issue when the process of extracting the energy is done. Nuclear energy, for example, remains as radioactive waste. Engineers today are finding ways to reprocess used fuel to extract more energy and significantly reduce the amount of highly-radioactive waste material created.

***Operations and Safety***

Operation and process engineers are concerned with keeping the facility operating to the highest possible standards and with refining systems and procedures to maintain those standards; this may involve planning and procurement, construction supervision, and

component installation and manufacturing. They will also work closely with the safety and environmental engineers.

Safety in the nuclear sector needs to address not only the normal operating conditions of any large plant, but also special concerns regarding radiation safety. Safety and environmental engineers run simulated reactor accidents and analyze the results, and provide environmental-impact assessments on the possible consequences of nuclear accidents. All that information is used to devise plans and procedures meant to anticipate and prevent accidents, as well as mitigate the consequences of any that occur.



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### Industry Operations

#### Electrical Power Distribution

Before electrical power can make its way across the power grid to homes and business around the world, it starts at the power plant. At the center of all power plants is a generator, which may be a hydroelectric or gas turbine, but in most cases is a steam turbine. Of course, to drive a steam turbine you need steam, and for steam, you need a water source and a heat source. The heat source can vary from plant to plant – or even in the case of larger plants – from generator building to generator building. Some systems are designed to burn coal, oil, or natural gas, while the heat for others may come from a nuclear reactor. Each plant's operations will vary depending on the type of generator and the primary resource it uses.



#### Planning

In order to ensure the plant meets the needs of its consumer population while minimizing its environmental impact as much as possible, careful planning is needed. The local environment is examined, as are the logistics required to move the fuels into and out of the area. Because both fossil fuels and nuclear power have different harmful effects and risks associated with them, careful studies are needed to consider any alternatives available, anticipate problems, plan for solutions, and develop fuel management procedures. Design and environmental engineers, scientists, and other technicians work together from the beginning to plan and monitor construction of the facilities themselves, as well as specific key elements such as transformers, generators, motors, and other machinery.

#### Generation

In this phase, some primary resource – fossil fuels, hydropower, geothermal power, nuclear power, solar power, or wind power – is converted via the turbines into electrical power. Engineers can be found working on the operation and maintenance of equipment such as boilers, turbines, generators, diesels, pumps, condensers,

compressors, and pressure vessels. There are safety and environmental engineers at work in this phase as well, acting as inspectors, continuing environmental-impact assessment, and monitoring plant operations to ensure they are running in accordance with safety, environmental, and health standards.

### ***Transmission and Distribution***

The transmission encompasses not only moving the newly created electrical power from the power station where it originates to the end user, but also deals with connecting various power systems to each other across varying regions. Both of these phases involve complex systems requiring engineers to design, optimize, and maintain receiving and switching stations, as well as transmission lines and grid connections.

Another important task facing engineers in the energy industry today (as the power grid ages and power demands skyrocket) is the prevention of and recovery from power outages. Outages might be localized or system wide, but regardless of their size and location, engineering solutions (re-routing procedures, new relay switches and protection devices, and redundancy systems) are needed to maintain service, prevent disruption, and improve the grid performance as a whole.



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## Industry Operations

### Industry Tools

The impact of technological advances in the "engineering tool kit" cannot be overstated. Computer modeling tools like AutoCAD are used by design engineers to create virtual prototypes in remarkable detail, while corrosion and safety engineers can get more precise readings from computer simulations faster than ever before. Fluid and material engineers can create flow simulations to design and test pipelines, while drilling engineers and geoscience specialists can build and study virtual cross sections of the earth before the first drill bit touches the ground.

Aerial and satellite imagery is also now being used as an analysis tool throughout the complete lifecycle of many energy company projects. New GIS mapping software and high-resolution digital imagery is being used to design better site-access plans based upon elevations, soil erosion, and flooding potential, and can facilitate more thorough collection of data for environmental impact assessments, watershed analysis, and ground-water management. These studies are critical in order for an organization to maintain regulatory compliance.

Engineering analysis tools are constantly evolving. Engineers are not only using these tools but improving them as well. They refine them, make them faster and more accurate, and expand the tool capabilities. The energy industry's need for additional energy sources is being driven by innovation and a lot of that innovation happens thanks to the engineer's toolkit.



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### Industry Operations

#### Industry Standards & Regulations

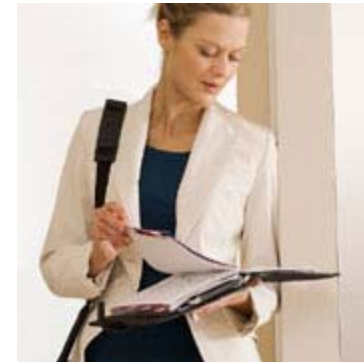
Each sector of the energy industry has standards to which it adheres and that provide guidance and direction to engineers in those fields. These standards are written by experts with knowledge and expertise in the field and may run from just a few paragraphs to hundreds of pages. Standards are not unique to this industry, of course. They promote safety, reliability, productivity, and efficiency in almost every industry that relies on engineering components or equipment.

Some of the organizations providing standards to the engineers in the energy industry include:

- [American Nuclear Society \(ANS\)](#)
- [American National Standards Institute \(ANSI\)](#)
- [Institute of Electrical and Electronics Engineers \(IEEE\)](#)
- [American Gas Association \(AGA\)](#)
- [American Society of Mechanical Engineers \(ASME\)](#)
- [American Petroleum Institute \(API\)](#)

The energy infrastructure of a country is critical to the country's well being, security, and prosperity. It should come as no surprise then to discover that all aspects of the energy industry are overseen or regulated by a number of governmental bodies and agencies. Some of the bodies involved worldwide include:

- [Department of Energy \(DOE\), USA](#)
- [Federal Energy Regulatory Commission, USA](#)
- [Energy Information Administration \(EIA\), USA](#)
- [Nuclear Regulatory Commission \(NRC\), USA](#)
- [Office of Fossil Energy, USA](#)
- [Environmental Protection Agency, USA](#)
- [Minerals Management Service, USA](#)
- [National Nuclear Energy Commission \(CNEN\), Brazil](#)
- [Radiation and Nuclear Safety Authority \(STUK\), Finland](#)



- Nuclear Safety Directorate, Great Britain
- Slovenian Nuclear Safety Administration (SNSA), Slovenia
- Swiss Federal Nuclear Safety Inspectorate (HSK), Switzerland
- National Electricity Regulation Agency (ENRE), Argentina
- National Energy Board, Canada
- Norwegian Water Resources and Energy Directorate (NVE), Norway

In the United States, there are additional layers of regulatory bodies at the state and municipal level, while another layer of regulation is now in place in Europe at the EU level.



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### Companies

#### Private Sector

This list represents many of the key players in the industry, but it is by no means meant to be a comprehensive list of employers in the energy field.

#### Integrated Oil & Gas, Exploration and Production

[Anadarko Petroleum](#)  
[Apache Corp](#)  
[BP](#)  
[Canadian Natural Resources](#)  
[Chesapeake Energy Corp](#)  
[Chevron Corp](#)  
[China Petroleum & Chemical](#)  
[CNOOC](#)  
[ConocoPhillips](#)  
[Devon Energy Corp](#)  
[EnCana Corp](#)  
[ENI](#)  
[EOG Resources Inc](#)  
[ExxonMobil Corp](#)  
[Gazprom](#)  
[Hess Corporation](#)  
[Indian Oil Corporation](#)  
[Inpex Holdings Inc](#)  
[Japex](#)  
[Kerr-McGee Corp](#)  
[LUKoil](#)  
[Marathon Oil Corporation](#)  
[Nexen](#)  
[Noble Energy](#)  
[Norsk Hydro](#)  
[Occidental Petroleum](#)  
[OMV Aktiengesellschaft](#)

#### Oilfield Services, Refinery and Pipeline Operators

[Baker Hughes](#)  
[Cosmo Oil Co](#)  
[El Paso Corp](#)  
[Enbridge Energy Partner](#)  
[Energy Transfer](#)  
[Formosa Petrochemical](#)  
[GASCO](#)  
[Halliburton](#)  
[Indian Oil Corp](#)  
[Kinder Morgan Energy LP](#)  
[Neste Oil](#)  
[Nippon Oil Corp](#)  
[Plains All American Pipeline](#)  
[Reliance Industries](#)  
[Schlumberger](#)  
[Showa Shell Sekiyu KK](#)  
[SK Corp](#)  
[Smith International Inc.](#)  
[S-Oil Corp](#)  
[Sumitomo Chemical](#)  
[Sunoco Inc](#)  
[TransCanada Corp](#)  
[Valero Energy Corporation](#)  
[Western Gas Resources](#)

#### EPC Companies

[Bechtel](#)



Petrobras Brasileiro  
Petrochina Co  
PTT Exploration  
Royal Dutch Shell  
Sasol Ltd  
Statoil  
Talisman Energy  
Total ELF  
Woodside Petroleum  
XTO Energy

**Coal, Mining and Production**

Drummond Company  
CONSOL Energy  
Peabody Energy Corp  
Yanzhou Coal Mining  
Cameco Corp  
Rio Tinto Energy America, Inc  
Arch Coal, Inc  
Foundation Coal Corp  
AT Massey Coal Co  
North American Coal Corp  
Westmoreland Coal Co  
BHP Minerals Group  
Alpha Natural Resources  
Magnum Coal Co  
Pittsburg & Midway Coal  
National Mining Association  
PacifiCorp  
James River Coal Co  
Kiewit Energy

**Alternative Fuel**

American Ethanol  
Green Fuel Technologies  
Evergreen Solar Inc  
Vestas Wind Systems  
FuelCell Energy  
DayStar Technologies Inc  
Archer Daniels Midland  
Pacific Ethanol

KBR  
Fluor  
Foster Wheeler  
JGC Corporation  
Technip  
Doosan Babcock  
Zachry  
Jacobs Engineering Group  
Black and Veatch

**Nuclear Plant & Utility Operators**

AES Corp.  
American Electric Power  
AREVA  
CenterPoint Energy  
Cleco Corp  
Consolidated Edison  
Constellation Energy Group  
Dominion  
Duke Energy  
Edison International  
Entergy Corp  
Excelon  
FirstEnergy  
GE Energy, Nuclear  
NiSource  
Pacific Gas & Electric Co  
PPL Corporation  
Progress Energy  
Questar Corp  
Reliant Energy  
Southern Co.  
Tennessee Valley Authority  
TXU Corp  
Washington Group International  
Energy Agency  
Westinghouse Electric  
Xcel Energy Inc  
Southern California Edison Co  
Florida Power & Light Co.  
Commonwealth Edison Co  
Virginia Electric & Power Co  
Public Service Elec & Gas Co



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## Companies

### Government

A full spectrum of engineering careers can be found in public service. Some of the department and agencies dealing directly with energy include:

#### ***The Department of Energy***

This agency's mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of nuclear weapons. The Department is also the nation's top sponsor of research and development in alternate fuel vehicles and energy efficiency.

The Department is a large agency that oversees a number of smaller operational units, including The Energy Information Administration, The National Nuclear Security Administration, The Federal Energy Regulatory Commission, and four regional Power Marketing Administrations (Bonneville, Southeastern, Southwestern, and Western). All of these organizations – as well as the DOE itself - utilize engineers from many disciplines working on projects including developing emergency action plans, providing guidance and supervision for alternative energy initiatives, and developing fuel management procedures for the nation's nuclear weapons and energy systems. For information on specific positions at any of these agencies, go directly to the [DOE page at USAJobs](#).

In addition to full-time and contract positions, the DOE is also reaching out to student and intern applicants. The DOE has developed student employment and career internship programs. If you want to discuss this with a DOE representative, contact your career counseling office or check the [DOE website](#). They publish their recruiting calendar, updated regularly on their website so you can see where they will be and when you can meet with them.



### ***Minerals Management Service***

This agency is part of the U.S. Department of the Interior and manages the nation's natural gas, oil, and other mineral resources on the outer continental shelf (OCS). The Minerals Revenue Management program is headquartered in Washington, D.C., but operationally based in Denver, Colorado. As with other government agencies, information on job opportunities can be accessed via USA Jobs, however [the Service also has internship program information on their own site.](#)

### ***Nuclear Regulatory Commission (NRC)***

This independent agency regulates commercial nuclear power plants (and other uses of nuclear materials) through licensing, inspection, and enforcement of its requirements. There are career opportunities at the NRC for nuclear, mechanical, chemical, structural, electrical, environmental, materials, and software engineers. Current job listings can be found, as with other government positions, at the USA Jobs website. They also have student program information on their own [departmental website.](#)

### ***National Laboratories***

In addition to many job opportunities in the federal government agencies, engineering positions are also to be found at National Laboratories. These facilities are funded by the government and government agencies but operated by non-governmental private firms or universities.

- Argonne National Laboratory
- Brookhaven National Laboratory
- Fermi National Accelerator Laboratory
- Idaho National Laboratory
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- National Renewable Energy Laboratory
- National Energy Technology Laboratory
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory
- Princeton Plasma Physics Laboratory
- Sandia National Laboratories
- Thomas Jefferson National Accelerator Facility



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**Industry Outlook**

**Overview**

There is a high demand for engineers in the energy industry and there are several trends that indicate that this will be the case for some time to come.

First is growth, not only of the global population, but also the population's increasing thirst for energy of all kinds. As demand grows, current supplies of oil and gas will be pushed to the limit. Oil companies' exploration and production budgets are rising as they gear up to try and find untapped sources of fossil fuels, and as a result the petroleum engineering job market is on the rise. Supplementing the current supply (either by better production or additional exploration and discovery) will not be sufficient. New sources and forms of energy will be needed. It will take time, money, and most of all engineering and technical skills to develop and refine these energy sources to a point where they are both economically feasible and socially acceptable.

According to the Bureau of Labor Statistics, engineering employment overall is expected to grow about as fast as the average for all occupations over the 2004-14 period, while engineering opportunities in energy-related fields like nuclear and environmental engineering will experience a slightly faster-than-average growth. In addition, few industries offer engineers quite as many opportunities to work anywhere in the world.

The electrical utilities present a promising picture for engineering job hunters. Deregulation has meant the expansion of these companies and the opening up of brand-new opportunities. With many utilities diversifying into telecommunications and other industries, the sector is hiring not only more engineers than before but also a hiring a wider range of engineering specialists.



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### Industry Outlook

#### Industry Trends

##### **Control of Oil Supplies**

There are many countries in the world – most of them among the top crude oil producers – where the state owns and controls the country's oil assets, either through nationalization of those assets or through partially state-owned companies. In fact, as more overseas oil assets have come under local state control, major oil companies in the West have been left controlling less than 10% of the world's oil and gas. That type of shift in ownership and control can have a significant effect on the international energy markets – affecting current wholesale and retail prices, as well as where and when exploration and extraction will be conducted. That impacts not only the oil supply today but tomorrow as well.

A body with significant influence on the global oil supply is the Organization of Petroleum Exporting Countries (OPEC). The Western oil companies have been interested in diversifying their operations, as well as enhancing supply security by strengthening ties with the emerging national oil companies and entities like OPEC, but strategic alliances have been difficult to form. The interaction between emerging national oil companies, major oil producing countries, and Western consumer countries will have a large impact on the question of energy security and the stability of the oil and gas markets.

##### **Peak Oil and Declining Supply**

There are constant questions about whether we, as a planet, are running out of oil. Oil is expected to be the dominant energy source for decades to come. But the challenge will be managing rising energy consumption across the globe. Projections estimate that global energy consumption will rise by 71% percent by the year 2030.

[Source: 2007 International Energy Report, U.S. Energy Information Agency]



However, oil is a finite, non-renewable resource and "peak oil" is a way to describe the time when we have extracted half of the total existing known supply. From that point onwards, the supply can only deplete and there will be no more. When exactly that point will be reached is a topic of fierce debate: Some peak oil theorists claim we have already reached it, while others think we still have some time to go. No matter which side is right in predicting the timing of it, that point will eventually come, and the energy and utility companies are going to need to invest heavily in technology and in workers who can create innovative solutions to what could be a serious energy consumption crisis. Whether they search out new supplies of oil, establish wind farms, produce cheaper solar cells, develop next-generation nuclear energy facilities, or focus on alternative energy sources – engineers will be at the heart of one of the closest-watched trends in the industry for the near future.



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### Industry Outlook

#### Politics & Environment

##### **Political Issues**

The energy industry is always at the center of economic and political concerns – now more than ever, with high prices at the gas pump, instability in the Middle East, and increasing awareness of environmental concerns. Price will always be a concern, and sadly the instability in the Middle East that affects it is not new nor likely to cease any time soon.

Environmental concerns, somewhat dismissed a few decades previously by the industry and by political power brokers, have become much more of a force to be reckoned with. A good illustration of this is the current state of refineries: The last oil refinery built in the U.S. was completed in 1976, and though just a few more could lower gas prices significantly, the risks and controversy surrounding their construction have prevented any plans from moving forward.

##### **Clean Energy**

The clean energy sector offers some enticing career possibilities. Wind energy is becoming more commercially viable and its use has risen dramatically over the past 10 years. The production of ethanol, already booming, is expected to double by 2010 to over 10 billion gallons of production per year. As more production facilities are built, the job outlook for biofuels is expected to expand. Solar power also has a lot to offer job hunters at this time – especially in the traditionally high-tech communities where improvements in fuel cells and computer chips are underway.



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### Mapping Your Career

#### Educational Preparation

##### **College/University Coursework**

The majority of engineering programs—regardless of specialty—include core curriculums that will enable the recent graduate to work in any of the job functions discussed in previous sections. If, however, you want to start pursuing an energy-industry career path right away, consult with your academic advisors and consider coursework related to the field such as:

- Advanced Mechanics of Materials
- Automation & Robotics
- Combustion
- Design Principles of Reactor Systems
- Energy & Environment
- Energy Conservation
- Energy Conversion
- Energy Design
- Fuel Cell Technology
- Oil Recovery Methods
- Power System Analysis
- Quantitative Analysis in Earth Sciences
- Reactor Physics and Design
- Reliability & Risk Concepts in Design
- Renewable Energy
- Rock & Fluid Properties
- Thermodynamics
- Well Testing & Evaluation

##### **Internships & Co-ops**

Workplace experience is one of the best ways to prepare for a career in the energy and power industries. You'll learn not only about the companies themselves, but also about how the industry works and what roles engineers play in it. You'll see how different segments of development and production work together, and what kinds of non-



engineering skills you will need to be a productive member of the industry workforce.

In addition to looking for leads on campus, you may want to look at opportunities offered directly by employers. Many of the major players in the industry have programs in place designed to bring students at all levels into the workplace and give them real-world experience. Among the companies with such programs:

- [Pacific Gas & Electric Company](#) has engineering internships in Avila Beach, CA, at their Diablo Canyon Nuclear Power Plant.
- [Dominion](#), one of the nation's largest producers of energy, has several established student programs offering internships and co-ops in many of their facilities across Virginia.
- [American Electric Power](#) offers Michigan-based internships at the Donald C. Cook Nuclear Power Plant, as well as other student opportunities in their operations in 11 states (Michigan, Indiana, Ohio, Kentucky, Virginia, West Virginia, Tennessee, Arkansas, Oklahoma, Texas, and Louisiana).
- [Duke Energy](#) offers co-ops and internships in many of its locations, including North and South Carolina, Ohio, and Indiana.
- In Idaho Falls, the [Idaho National Laboratory](#) has a number of nuclear engineering internships.
- [Westinghouse Engineering](#) lists its internships on their company's page in the career section. They also host an annual intern café and regularly participate in active campus recruiting. Internships are located at many of Westinghouse's locations including, but not limited to, Pennsylvania, Connecticut, and Utah.
- [American Council On Renewable Energy \(ACORE\)](#) Internships are available through their Washington, D.C.,-based headquarters.

[The Nuclear Energy Institute](#) (a nuclear energy industry group providing information on the nuclear industry to members, policymakers, the news media, and the public, and serving as the industry's unified voice when lobbying Congress) has information on internships in nuclear energy. In addition, many industry employers have co-op and internship information available on their web sites alongside their regular job listings.



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### Mapping Your Career

#### Finding the Right Job

A job search actually starts long before you send the first resume. It starts with a decision on what areas of the industry to focus on. Then you focus on companies and opportunities in those areas. How do you make that decision? With research.

#### Research

Get to know the industry—the trends and current events—and get to know more about the key players and firms in the field. Which companies have merged or announced new innovations in alternative fuels? Have there been any new federal regulations or legislation announced that would influence the industry? Who is opening a new plant or closing a refinery?

The energy and power sectors are major economic forces and occupy a prime position in the business section of the major news outlets. Begin by scanning your local newspaper's business section as well as the *Wall Street Journal* and the websites of other major dailies.

The next set of publications you should review regularly are the industry trade magazines, such as *Electric Light & Power*, *Power Engineering*, and *Utility Automation & Engineering T&D*. Publications like these report on all aspects of the industry and can help focus your search and help you target specific companies. More industry news sources can be found in the [Industry Resources](#) section in this module.

Once you have your industry sources established, you can start researching the companies you intend to target. Don't forget that one of the best sources of information about a company is the company itself. Most companies have Web sites that include not only information on product lines but also company history and links for employment opportunities. For a list of leading companies in the industry, check out the [Companies](#) section in this module. For more



information on researching companies and identifying targets for your search, review our [Career Planning](#) module.

### ***On-campus Recruiting***

Many companies visit campus for recruiting purposes. Your university Career Services Office should be able to tell you what companies are coming and when. They might also be able to provide information and contacts related to internships. For more information on using these on-campus options, review our [Career Planning](#) module.

### ***Networking***

Many people dismiss networking as simply "asking around" but it's much more than that—it can be the key to getting in the door and standing out from the crowd. You might hear of job openings not yet advertised or about people who plan to leave a job in the near future. Another advantage is that being able to associate yourself with someone known to the hiring manager means you will have an edge in your first interview over an applicant who is just one of many names on a list. For tips and suggestions on effective networking, review our [Career Planning](#) module.

### ***On-Line Job Listing Sites***

You can certainly find industry jobs on the large, general job-listing sites like Monster.com or careerbuilder.com, but winnowing down the list to the jobs in areas you want to focus on can be time consuming. Still, these resources are very comprehensive and it's worth looking at them—if only to get a sense of the range of engineering positions available at any given time.

If you want to give your search more focus, you can check out these sites specifically aimed at those looking for positions in the industry:

- [Energy Careers](#)
- [Energy Jobs Network](#)
- [Energy Job Search](#)
- [NSPE Job Board](#)
- [Oil Career Center](#)
- [Penn Energy Jobs](#)
- [Petroleum Engineer](#)
- [Power Plant Jobs](#)
- [Professional Energy Jobs](#)
- [Quest Technical](#)
- [World Wide Worker](#)



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**Staying Current**

***Continuing Education***

Success is more than showing up regularly and doing your job consistently. You must continually strive to improve your performance and expand your knowledge. So, how can you keep your edge and stay ahead of the curve? Staying apprised of the latest industry news, as mentioned previously, is important, but another important channel for improvement and success is through continuing education options like online classes, seminars, and conferences. Participation in professional societies like the ASME offers great opportunities to find resources like these.

- [ASME Continuing Education Institute](#)
- [ASME Professional Practice Curriculum](#)
- [NSPE's virtual classroom](#)
- [Association of Energy Engineers Seminars](#)
- [American Society of Civil Engineers](#)
- [American Institute of Chemical Engineers](#)

More professional development options can be found through some of the places listed in our [Industry Resources](#) section.

***Networking as an Ongoing Practice***

Networking is a valuable career development tool that can help you move up the career ladder. If you have the opportunity to participate in your company's rotation program or to attend industry meetings and conferences, take advantage of it.



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### Industry Resources

#### **Reading: Magazines, Journals, and Websites**

- [Electric Energy Online](#)
- [Electric Light & Power](#)
- [Energy Bulletin](#)
- [Energy Business Daily](#)
- [Energy Tech](#)
- [Hydrocarbons Processing](#)
- [Nuclear News](#)
- [Pipeline & Gas Journal](#)
- [Platt's Global Power Report](#)
- [Power Engineering](#)
- [Power Finance & Risk](#)
- [Renewable Energy World](#)
- [Utility Automation & Engineering T&D](#)



#### **Professional Societies and Associations**

Professional organizations offer the opportunity to meet, network and exchange technical information with other industry professionals. These activities keep engineers connected to the latest technological advances and also aid in their professional advancement. Professional societies also offer information on careers, industry information, and events that can be invaluable, not only as you start your job search, but later on as you seek to take your career to new levels. Some you might want to check out include:

- [American Council On Renewable Energy](#)
- [American Association of Drilling Engineers](#)
- [American Gas Association](#)
- [American Public Power Association \(APPA\)](#)
- [Association of Energy Engineers \(AEE\)](#)
- [American Wind Energy Association](#)
- [Electric Power Supply Association \(EPSA\)](#)
- [Energy Council of the Northeast](#)
- [Energy Information Administration \(EIA\)](#)

- [Federal Energy Regulatory Commission](#)
- [National Assoc. of Power Engineers \(NAPE\)](#)
- [Power Engineering Society \(IEEE\)](#)
- [Power Marketing Association](#)
- [Society of Exploration Geophysicists](#)
- [Solar Electric Power Association](#)
- [Solar Energy Industry Association \(SEIA\)](#)
- [Society of Petroleum Engineers](#)

In addition, ASME has five technical divisions directly related to the energy industry: the [Nuclear Engineering Division](#), the [Power Division](#), the [Advanced Energy Systems Division](#), the [Solar Energy Division](#), and the [Internal Combustion Engine Division](#).



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### Summary

The size, scope, and state of the energy industry is constantly being examined and discussed by the industry itself, by government agencies, by the public, and by the media. It's an important factor in economic and environmental public policies, in domestic and foreign affairs, and in the overall employment sector. Few industries are as truly global as the energy industry. In every corner of the world, there are energy companies searching for oil, developing fuel cells, harnessing wind power, extracting coal, and generating electricity. In all those corners, in all those sectors, and working on all those tasks are engineers.

Because of the broad scope and global nature of the industry, engineers who pursue an energy career have a wide variety of locations and job functions to choose from. There are geological and drilling engineers working in the Arctic developing new extraction methods for previously untapped fuel supplies; at the same time robotics engineers are out in the oceans developing remote-operated systems designed to explore waters too deep for divers or manned vehicles. Other engineers can be found analyzing data and making recommendations to government agencies on public policy issues, to public utilities on ensuring efficiency and expansion of the distribution grid, and to private companies on ways to optimize their production and minimize transportation costs.

The energy industry is facing growing concerns about world fuel supply, rising demand across expanding markets, and environmental impact. Addressing these concerns presents an enormous and long-term challenge, and engineers - who have been so critical to the success of the industry from its earliest days - will continue to play key roles in meeting that challenge and in creating a stable, secure energy future.

The energy industry is developing new technologies all the time and thrives on innovation. The field offers a staggering breadth of choices and specialties for engineers, and the opportunities it presents are



some of the most exciting and challenging you will ever find.

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