

Industry Guidebook: Energy Extraction



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**Produced for the WEIC Task Force of the Colorado Workforce Development Council by
Corporation for a Skilled Workforce**

Purpose of This Guidebook

This Energy Extraction Industry guidebook was developed as a resource for workforce practitioners and intermediaries, and their partners, as they design and implement sector initiatives in their regions. Sector strategies, or regionally targeted industry strategies as they are sometimes known, have become a well established and effective strategy to enhance the economic competitiveness of regions and states. The intent of this guidebook is to provide data, information, resources and trends about the industry sector at the national and state levels; so that public partners can gain a more in depth knowledge of the sector. It is not intended to be a comprehensive listing of all Colorado resources and organizations, but rather a starting point for more research at the state and regional level. Users are encouraged to spend time reviewing this guide and exploring the links to state level reports, industry web sites and other resources. The links are rich with data and industry information, and many change over time as sector trends and issues change. Successful intermediaries and sector public partners should strive to be as knowledgeable as possible about the target industry and its challenges so that they can more effectively communicate with their business partners and better understand the needs of the industry. This guidebook is intended to provide a strong foundation to start you on this journey of sector knowledge acquisition.

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Overview of Industry

Did You Know?

- Oil and natural gas industry employees in Colorado earn an average of \$85,134 (direct and indirect) –more than twice the state’s average earnings of \$40,813.
- Energy production is an 80-year tradition in Colorado; the state produces enough oil to fuel almost 700,000 cars and heat 300,000 homes a day and enough natural gas to heat 12 million homes a day.
- In a June 2008 article, the Denver Business Journal stated: “Barely six months after Colorado ranked as the No. 1 place on the planet that oil and gas companies wanted to invest money and explore for oil and natural gas, the state has fallen to No. 52 out of 81 locations.”
- Colorado is home to the nationally renowned Colorado School of Mines - a public research university devoted to engineering and applied science; and one of a very few institutions in the world having broad expertise in resource exploration, extraction, production and utilization.
- Employment in US oil and gas extraction rose 20% from the end of 2006 to mid-2008, and competition for workers has led to a 26% increase in average hourly wages.
- There is a specific challenge in recruiting and housing drilling rig staff, who often live onsite and work 8- or 12-hour shifts until the well is completed.

By the Numbers: Energy Extraction Employment in Colorado

There were 25,032 people employed in the energy extraction industry in Colorado in 2007, an increase of 91% since 2003, which is 10 times the state’s overall employment growth rate of 9%.

Support Activities for Mining

12,432 workers – 50% of energy extraction employment in Colorado (0.5% of total employment)

Average weekly wage of \$1,421

Projected growth of 27.4% through 2016 (compared to 18% across all industries)

Oil and Gas Extraction

6,907 workers - 28% of energy extraction employment in Colorado (0.3% of total employment)

Average weekly wage of \$2,428

Projected growth of 63.7% through 2016 (compared to 18% across all industries)

Mining (Except Oil and Gas)

5,693 workers – 23% of energy extraction employment in Colorado (0.2% of total employment)

Average weekly wage of \$1,336

Projected growth of 35.5% through 2016 (compared to 18% across all industries)

Source: Office of Labor Market Information of the Colorado Department of Labor and Employment

Colorado Energy Extraction Industry

The Colorado Energy Extraction (mining) industry includes about 950 companies with combined annual revenue of \$5.3 billion. The mining industry employs approximately 13,400 with an annual payroll of \$686 million. Large mining sub-sectors include oil and gas extraction (valued at \$3.7 billion); coal and nonmetallic minerals (\$1.1 billion); and support activities for industry (\$551 million). The industry contributes \$11 billion to Colorado's gross state product, representing 5% of the state's total gross state product. Colorado mining industry annual exports total about \$254 million. Crude oil production in Colorado rose nearly 66% to 6 million barrels in Q1 2008 from the previous year, while total US production decreased a slight 0.1%.¹

Energy production is an 80-year tradition in Colorado; the state produces enough oil to fuel almost 700,000 cars and heat 300,000 homes a day and enough natural gas to heat 12 million homes a day.²

Oil and natural gas industry employees in Colorado earn an average of \$85,134 (in direct and indirect compensation) – more than twice the state's average earnings of \$40,813.³

US Energy Extraction Industry

The four major segments of the Energy Extraction industry are:

Oil and gas exploration and production.

This US industry comprises establishments primarily engaged in (1) the exploration, development and/or the production of petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques or (2) the production of crude petroleum from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids. Establishments in this industry operate oil and gas wells on their own account or for others on a contract or fee basis. (NAICS 211111)⁴

The US oil and gas exploration and production industry includes about 7,000 companies with combined annual revenue of about \$890 billion. The industry is moderately fragmented: 10% of companies generate 60% of revenue. This industry segment does not include transmission, refining, or retailing of petroleum and natural gas products.⁵

Energy Extraction Workers

Top 5 Occupations Requiring On-the-Job Training

1. Roustabouts, oil and gas
2. Wellhead pumpers
3. Helpers, extraction workers
4. Pump operators, except wellhead pumpers
5. Derrick operators, oil and gas

Top 5 Occupations Requiring Experience or Post-Secondary Education

1. First-line supervisors/managers
2. Geological and petroleum technicians
3. Mobile heavy equipment mechanics, except engines
4. Purchasing agents, except wholesale, retail, and farm products
5. Bus and truck mechanics and diesel engine specialists

Top 5 Occupations Requiring a BA or higher

1. Geoscientists, except hydrologists and geographers
2. Petroleum engineers
3. Mining and geological engineers, including mining safety engineers
4. Environmental scientists and specialists, including health
5. Hydrologists

Demand is driven by economic activity, population growth, and energy efficiency for residential, industrial, and transportational uses of oil and gas. Profitability of individual companies is driven by the success rate of new wells drilled and the ability to increase production from existing wells. Large companies have the advantage of access to capital, including the ability to buy or merge with smaller companies. Small companies compete by focusing on, and developing expertise in, a few geographic areas. The industry is capital intensive: average annual revenue per employee is about \$5 million.⁶

Oil and gas compete with other energy sources, such as coal, nuclear power, and hydroelectric power, for industrial and home heating applications. Renewable fuels, such as ethanol and biodiesel, and hybrid-electric cars, which use stored electricity from batteries instead of or in addition to gas or diesel, are emerging alternatives for transportation applications.⁷

Production workers in oil and gas extraction require special skills and experience, resulting in average hourly wages that are about 40% higher than the national average for all industries. Most labor is in drilling, which is usually conducted 24/7, until the well is either brought into production or declared dry and capped. The industry injury and illness rate of about two per 100 employees is lower than in most manufacturing and mining industries.⁸

Oil and gas field services

This segment includes Drilling Oil and Gas Wells (213111) and Support Activities for Oil and Gas Operations (213112). The Drilling Oil and Gas Wells sub-segment is comprised of establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling. The Support Activities for Oil and Gas Operations sub-segment is comprised of establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and

Job Spotlight: Extraction Occupations

The main work of resource extraction is done by the workers who operate the equipment that builds the mine or well and that removes the resource when it is reached. Most occupations are unique to oil and gas extraction, underground mining operations, or surface mining operations.

Most oil field operations are performed by rotary drilling crews of four or five workers. *Rotary drill operators* supervise the crew and operate machinery that controls drilling speed and pressure. *Rotary-rig engine operators* are in charge of engines that provide the power for drilling and hoisting. Second in charge, *derrick operators* work on small platforms high on rigs to help run pipe in and out of well holes and operate the pumps that circulate mud through the pipe. *Rotary-driller helpers*, also known as *roughnecks*, guide the lower ends of pipe to well openings and connect pipe joints and drill bits.

Though not necessarily part of the drilling crew, *roustabouts*, or general laborers, and *helpers* do general oilfield maintenance and construction work, such as cleaning tanks and building roads, throughout the entire life cycle of the oil well. Once the well is complete and operational, *pumpers* operate and maintain the equipment that regulates the flow of oil out of the well.

Source: 2008-2009 Occupation Outlook Handbook, Bureau of Labor Statistics

cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.⁹

The US oil and gas field services and equipment industry includes 8,000 companies with combined annual revenue of \$89 billion. Large global suppliers include Halliburton, Schlumberger, and Baker Hughes. Despite recent consolidation, the industry is still fragmented and characterized by small specialty firms: over half of companies have fewer than five employees. Demand is driven by oil and gas prices. The profitability of individual companies depends on technical expertise and efficiency of operations. Large companies can offer a broad range of services. Small firms can compete effectively by specializing in a particular type of service or geographic area. The industry is relatively labor-intensive: average annual revenue per employee is about \$410,000.¹⁰

Drilling oil and gas wells requires special technical skills and experience. Workers earn wages 20% above the US average. Drilling oil and gas wells is hazardous, and safety is an ongoing concern of companies. Workers engaged in non-drilling services have an average injury rate, but the injury rate for workers involved in drilling activities, while falling in recent years, remains about 25% higher than the national average.¹¹

Natural gas production and distribution.

This segment includes Crude Petroleum and Natural Gas Extraction (211111) and Natural Gas Liquid Extraction (211112); as well as an overlap with Drilling Oil and Gas Wells (213111) as described in the previous section. The Crude Petroleum and Natural Gas Extraction sub-segment comprises establishments primarily engaged in (1) the exploration, development and/or the production of petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques or (2) the production of crude petroleum from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids. Establishments in this industry operate oil and gas wells on their own account or for others on a contract or fee basis. The Natural Gas Liquid Extraction sub-segment comprises establishments primarily engaged in the recovery of liquid hydrocarbons from oil and gas field gases. Establishments primarily engaged in sulfur recovery from natural gas are included in this industry.¹²

About 10,000 companies in the US explore, produce, transmit, and locally distribute natural gas, with combined annual revenue of \$100 billion. Exploration and production are conducted by large, vertically integrated petroleum companies like ConocoPhillips and Chevron, by large independents such as Anadarko and Devon Energy, and by thousands of smaller exploration companies. Transmitting gas from production to consumption areas is handled by about 1,000 pipeline operators. Local distribution is handled by thousands of utilities. Regional energy companies like KeySpan and Dominion Resources combine transmission, storage, and distribution operations. The US consumes about 20 trillion cubic feet (TCF) of natural gas annually.¹³

Demand for natural gas depends partly on the health of the US economy and partly on the price of crude oil, a competitive product. The profitability of natural gas companies depends largely on the efficiency of their operations. There are large economies of scale in the production, processing, and distribution of gas, but small companies can effectively compete with large ones in exploration, where technical ability is more important than size. Jobs in gas extraction, production, and distribution are largely technical and therefore well-paid. The steady loss of jobs in production and distribution is due largely to increased automation, which allows fewer workers to control process flows.¹⁴

Coal mining

Though coal is a nonrenewable resource, it is highly abundant in the US and China, two places where energy is in great demand. It is believed that 25% of the world's coal supply is in the US, and though coal companies are forced to refrain from most highly ecologically damaging mining practices, the product is relatively cheap and easy to extract. In the short run, this makes coal a highly effective natural resource in terms of US energy production, but in the long run, it is projected that the reserves will only last another 250 years at current consumption rates. While this may seem like a long time, one must consider how consumption is growing exponentially.¹⁵

This segment includes Coal Mining (21211) and Support Activities for Coal Mining (213113). The Coal Mining sub-segment comprises establishments primarily engaged in one or more of the following: (1) mining bituminous coal, anthracite, and lignite by underground mining, auger mining, strip mining, culm bank mining, and other surface mining; (2) developing coal mine sites; and (3) preparing coal (e.g., cleaning, washing, screening, and sizing coal). The Support Activities for Coal Mining sub-segment comprises establishments primarily engaged in providing support activities for coal mining (except site preparation and related construction activities) on a contract or fee basis. Exploration for coal is included in this industry. Exploration includes traditional prospecting methods, such as taking core samples and making geological observations at prospective sites.¹⁶

The US coal mining industry includes about 1,000 companies that operate 1,500 mines, with combined annual revenue of \$25 billion. After strong consolidation during the last decade, the 10 largest companies hold about 65% of the market. The typical company operates a single mine. The size of mines varies considerably, but a large operation produces more than 1 million tons of coal per year. Demand comes mainly from generators of electricity. Profitability depends on efficient operations, as the product is a commodity sold on the basis of price. Small companies can compete if they hold long-term contracts or if they supply local customers. Big companies have large economies of scale in production and distribution. The industry is capital-intensive and highly automated: average annual revenue per employee is almost \$300,000.¹⁷

Incentives and Policy Proposals – State and National

Colorado Policy Proposals

Colorado Oil and Gas Association (COGA) Legislative Bill Matrix for 2008

A sampling of the legislative bills detailed in the matrix includes:

- HB08-1414 (Regulate Oil & Gas Waste Disposal Pits) requires the solid and hazardous waste commission to promulgate rules for the disposal of exploration and production wastes from oil and gas operations at commercial solid waste facilities. It was signed by the Governor on 6/4/08.
- SB08-055 (Increase Air Pollutant Fees) increases fees for registration of sources of ozone-depleting compounds; emissions of regulated and hazardous air pollutants; etc. It was signed by the Governor on 5/20/08.

<http://data.memberclicks.com/site/coga/COGA%20Bill%20Matrix%202008%20Final%20Report.pdf>

Survey: Colorado loses favor with oil and gas investors

In a June 2008 article, the *Denver Business Journal* stated: “Barely six months after Colorado ranked as the No. 1 place on the planet that oil and gas companies wanted to invest money and explore for oil and natural gas, the state has fallen to No. 52 out of 81 locations, in the survey of industry executives by The Fraser Institute in Calgary, Alberta, Canada... Survey respondents were very concerned with Colorado's changes to drilling permit requirements and other more stringent regulations. The Colorado Oil and Gas Association estimates the new rules could increase drilling costs by \$60,000 to \$600,000 per well.”

<http://www.bizjournals.com/denver/stories/2008/06/23/daily40.html>

National Policy Proposals

Climate Change Concerns and Policy Proposals

Exploration and production companies are increasingly concerned about how the US government and individual states will choose to address climate change. Devon Energy says that natural gas may become the preferred fuel due to its status as the cleanest of available fossil fuels. Devon and other companies such as Murphy Oil and Chesapeake Energy are addressing climate change by producing public reports and statements about their efforts to proactively address greenhouse gas emissions.¹⁸ Additionally, with the upcoming change in the Administration in Washington, DC, there will likely be more environmental and climate change issues brought to the forefront of public policy.

National Goal to Reduce Dependence on Middle East Oil

The US government has set a goal to reduce dependence on Middle East oil by 75% by 2025. Achieving this will require expanding US oil and gas production, which companies are in part addressing through the use of technology. Companies are likely to compete for the ability to extract additional oil from previously abandoned wells.¹⁹

Natural Gas Regulation

State and federal regulators control the interstate distribution and retail pricing of natural gas. In recent years, the goal of government efforts was to deregulate the industry, but deregulation difficulties in

California slowed the process. State and federal legislation could reintroduce tighter regulations. Political pressures for re-regulation increase when prices are high.²⁰

Renewable Fuels

The US and a number of state governments are passing legislation requiring the use of renewable fuels. The Energy Independence and Security Act of 2007 requires the amount of biofuel (usually ethanol) that must be mixed with gas sold in the US to increase to at least 36 billion gallons by 2020 – about 25% of the gas sold annually in the US in 2007. While this will mostly be a replacement for imported petroleum, coupled with other measures it could result in reduced overall demand for US crude oil.²¹

Coal Mining Industry Regulations

Coal mining companies face a large number of state and federal regulations, both directly through their operations and indirectly through their major customer, the electric utility industry. Regulations that effect the industry directly include permits to operate; safety of operations, under the Federal Mine Safety and Health Act; dust pollution; land reclamation after mining, under the Surface Mining Control and Reclamation Act; assurance of pension benefits for miners; and medical expenses for miners with "black lung" disease, under the Black Lung Benefits Reform Act. Major indirect regulations concern air pollution, fly ash disposal, and deregulation of the electric utility industry. The large number of regulations applicable to coal operations requires significant attention from managers.

Of greatest regulatory concern are provisions of the Clean Air Act that tighten allowable emissions of sulfur dioxide, the main cause of acid rain, from electric generation plants. Tighter restrictions are also required for emissions of nitrogen oxide, a key component of smog, and for mercury. Utilities can reduce these emissions by burning cleaner coal, investing in pollution-control devices, or burning other fuels like natural gas. Burning natural gas also eliminates the disposal problems of fly ash, which sometimes contains toxic metals. To comply with the Clean Air Act, utilities are buying more compliance coal, which emits less than 1.2 pounds of sulfur dioxide per million BTU when burned.

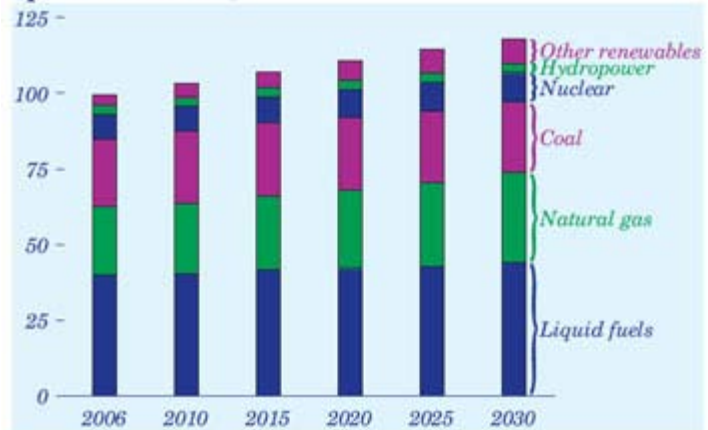
Industry Trends and Challenges

Demand for overall power will continue to grow

Even with efforts to reduce energy and improve efficiency, overall demand for power will continue to grow. The US Energy Information Administration (EIA) predicts that total primary energy consumption, including energy for electricity generation, will grow by 0.7% per year from 2006 to 2030. Fossil fuels account for 55% of the increase. Coal use will increase in the electric power sector, where electricity demand growth and current environmental policies favor coal-fired capacity additions.

According to the EIA, delivered energy use (excluding losses in electricity generation) will grow by 0.7% per year from 2006 to 2030. The growth in electricity use is driven by growing demand in the residential and commercial sectors. With the growing market penetration of electric appliances, residential electricity use will increase slightly faster than the total number of households, and commercial electricity use will outpace the growth in commercial floor space. With different assumptions about population and economic growth, average annual growth in delivered energy use from 2006 to 2030 ranges from 0.3% in the low growth case to 1.0% in the high growth case.²²

Figure 41. Primary energy use by fuel, 2006-2030 (quadrillion Btu)



Volatility and Forecasting of Oil, Gas Prices

About 35% of the world oil supply of 85 million barrels of oil per day comes from areas with political instabilities (the Persian Gulf, Venezuela, and Nigeria). Given the fragile balance of supply and demand, perceived threats to the supply can cause large price disturbances. Capital availability and investment decisions are driven by estimates of future prices and probable production levels.²³

Exploration and production investment is a long-term gamble on petroleum and natural gas prices. As prices increase, the amount of capital available for drilling increases and the size of reserves required for a well to be profitable decreases. Since a well can take two years to bring into full production and most are expected to have a productive life of 15 to 30 years, company management requires a good sense of the long-term market.²⁴

Environmental Compliance, Climate Change Concerns

As exploration expands in environmentally sensitive areas, the cost of compliance with environmental regulations will rise. Environmental regulations are becoming tougher across the board, according to industry experts. The industry is also concerned about the impact of climate change concerns on demand, particularly if end-users change energy use habits due to concerns about the effects of climate change. Exploration and production companies are increasingly concerned about how the US government and individual states will choose to address climate change.²⁵

Competition for Workers, Land, Equipment

High prices, and the increased drilling activity that has followed, have led to increased competition for workers, drilling land, and capital equipment. Employment in oil and gas extraction rose 20% from the end of 2006 to mid-2008, and competition for workers has led to a 26% increase in average hourly wages. Competition for drilling ships and rigs has also grown stronger, resulting in a 300% increase in drilling costs in 2008 from 2002.²⁶

New Technologies, Increasing Service Intensity

Due to higher demand and prices, the industry is increasingly focused on unconventional, or challenging, drilling environments. Developing new technologies, such as horizontal drilling, can make developing resources in challenging areas cost-effective. New technologies to enhance recovery and extend the life of existing wells are creating opportunities for an increase in what the industry calls "service intensity," which is an opportunity for additional services on a per rig basis, possibly increasing per rig revenue.²⁷

Clean Coal

Increasing consumer demand, public sentiment, and policy proposals related to carbon dioxide reduction have prompted the traditional energy companies to determine how they can lower CO₂ output from traditional coal operations.

New, coal-based technological innovations are environmentally superior and more operationally efficient than technologies in common use today. In general, they fall into the following three categories:²⁸

- **Combustion:** Combining coal with other substances in the boiler to improve efficiency and remove impurities. An example would be fluidized-bed combustion, where limestone or dolomite are added during the combustion process to mitigate SO₂ formation.
- **Post-Combustion:** Using "scrubbers" (flue gas desulphurization), chemical cleaning, or precipitators to remove large quantities of sulfur, other impurities and particulate matter (dust and ash) from emissions before they are released into the atmosphere.
- **Conversion:** Using heat and pressure to convert coal into a gas or liquid that can be further refined and used cleanly. An example would be Integrated Gasification Combined Cycle, and other gasification and liquefaction technologies. Duke Energy is one of the first utilities to begin experimenting with this technology. With the help of \$134 million in tax incentives from the Department of Energy, and an additional \$75 million in state incentives, Duke is planning on building a 600 megawatt integrated gasification combined cycle (IGCC) plant in Indiana. Other companies experimenting with IGCC technology include ConocoPhillips, Royal Dutch Shell, Siemens, and Mitsubishi.²⁹

Major Technological Benefits Of Clean Coal Technology Program

Technology	Impact
Low Nitrogen Oxide (NOx) Burners	<ul style="list-style-type: none"> ➤ Now on 75% of US coal-based power plants. ➤ 1/2-to-1/10th the cost of older systems. ➤ Helped utilities comply with more stringent January 2000 Clean Air Act NOx emission requirements. ➤ Between 1980-2000, NOx emissions from coal power plants declined 56%, measured by pounds of emissions per kilowatt hour — low NOx burners have played an increasing role in this success story.
Selective Catalytic Reduction (SCR)	<ul style="list-style-type: none"> ➤ Achieves NOx reductions of 80-to-90% or more. ➤ Technology today costs half what it did in the 1980s. ➤ Systems are on order or under construction on 30% of the existing US coal-fired generating capacity.
Flue Gas Desulfurization (FGD)	<ul style="list-style-type: none"> ➤ FGD systems now cost one-third what they did in the 1970s. More than 400 commercial units have been deployed. ➤ SO2 emissions from coal-based power plants declined 61% between 1980-2000 (based on lbs. of emissions per kWh) — while coal use by utilities rose 74% over the same period. FGD systems have played an important role.
Fluidized Bed Combustion (FBC)	<ul style="list-style-type: none"> ➤ Now over 170 operating FBC units in the US and 400 worldwide. ➤ Commercialized — more than \$6 billion in domestic sales and nearly \$3 billion in overseas sales have resulted from US public and private investment in FBC technology research, development and demonstration. ➤ Removes SO2, NOx inside the boiler — no additional controls necessary.
Integrated Gasification Combined Cycle (IGCC)	<ul style="list-style-type: none"> ➤ Over 1,500 megawatts of coal-based generation operating today; another 1,900 megawatts are gasifying refinery wastes; another 2,200 megawatts are in design. ➤ 16,500 MWw (megawatt equivalent) of IGCC is expected to be operating in the United States by 2020.

Source: US Department of Energy, Office of Fossil Energy, via http://www.nma.org/pdf/clean_coal_a.pdf

Workforce Issues

Colorado Workforce Issues

Education and Training

With the rapid changes in technology and mining and drilling methods, the energy extraction industry, now more than ever, needs a variety of workers with special technical skills and experience. In particular, the oil and gas industry needs entry-level and experienced workers such as welders, pipe-fitters, instrumentation technicians, engineers, and electricians.³⁰ There are various educational programs in Colorado and out-of-state that prepare workers for careers in energy. Some of the key programs include:³¹

Center for Advanced Engineering and Technology Education – University of Colorado at Boulder
<http://caete.colorado.edu/>

Colorado Northwestern Community College

- Process Technology http://www.cnc.edu/programs/process_technology/default.html
- Power Plant Technology
http://www.cnc.edu/programs/power_plant_technology/default.html
- Energy and Facilities Management Technology
http://www.cnc.edu/programs/energy_mgmt_technology/default.html

Colorado School of Mines

- Special Programs and Continuing Education http://www.mines.edu/outreach/cont_ed/
- Department of Geology and Geological Engineering <http://www.mines.edu/Academic/geology/>

Rockies Alliance for Process Technology - Red Rock Community College, Arvada, CO – a regional, multi-state alliance of community colleges and industry partners that includes BP America, EnCana Oil and Gas (USA) Inc., Shell Exploration and Production, Suncor Energy USA, Williams Exploration and Production, and Xcel Energy. <http://www.rccc.edu/isod/rapt.html>

Additional educational opportunities can be found at Rockies Energy Workforce:
http://www.rockiesenergyworkforce.org/education/quick_links.html

National Workforce Issues

Increasing interest in corporate social responsibility and sustainability by incoming workers

Linked to the increasing focus on generating energy from “greener” sources is a broader interest by citizens and new workforce entrants in sustainability and “green” strategies. Companies in all sectors are aligning their corporate responsibility efforts to becoming more sustainable and “green.” The future workforce is a big driver in this critical change. Large surveys by organizations such as the Society for Human Resource Management and American Management Association show that many employees desire more explicit action by their employers on issues of sustainability, and, crucially, they want to be involved in those actions. Younger employees – the future workforce needed to replace retiring baby

boomers – are especially interested in a company’s sustainability vision, goals and efforts. Younger potential employees tend to search out the company’s corporate social responsibility publications/practices as part of their decision making process in job searches, and they are actively willing to participate in corporate social responsibility activities within the company.³²

Traditional energy companies are quickly deepening their investment in renewable energy sources and environmental responsibility. Depending on the perceived authenticity of their efforts by sustainability focused workers, these companies could compete very effectively for the same engineering and technical talent renewable energy companies are targeting. As mentioned previously, Devon and other companies such as Murphy Oil and Chesapeake Energy are addressing climate change by producing public reports and statements about their efforts to proactively address greenhouse gas emissions.³³

Devon Energy’s Corporate Responsibility Report

http://www.devonenergy.com/CorpResp/Documents/07_DVN_CSR_report.pdf

Murphy Oil’s Environmental Commitment

<http://www.murphyoilcorp.com/responsibility/environment/default.aspx>

Mining Engineer Shortage

Experts estimate the US must triple the number of mining engineering graduates over the next decade just to replace retirees, a calculation that does not account for industry growth. Despite the critical need, the supply of educational institutions has shrunk: in the past 20 years, 10 universities dropped mining engineering programs and the remaining 15 programs are struggling. In 1980, about 700 mining engineers graduated in the US; in 2005, roughly 100.³⁴ Colorado is fortunate to have The Colorado School of Mines, a nationally renowned public research university devoted to engineering and applied science; and one of a very few institutions in the world having broad expertise in resource exploration, extraction, production and utilization. See Colorado Resources section for additional details.

Job Spotlight: Mining and geological engineers

Mining and geological engineers find, extract, and prepare coal, metals, and minerals for use by manufacturing industries and utilities. They design open-pit and underground mines, supervise the construction of mine shafts and tunnels in underground operations, and devise methods for transporting minerals to processing plants. Mining engineers are responsible for the safe, economical, and environmentally sound operation of mines. Some mining engineers work with geologists and metallurgical engineers to locate and appraise new ore deposits. Others develop new mining equipment or direct mineral-processing operations that separate minerals from the dirt, rock, and other materials with which they are mixed. With increased emphasis on protecting the environment, many mining engineers work to solve problems related to land reclamation and water and air pollution. Mining safety engineers use their knowledge of mine design and practices to ensure the safety of workers and to comply with State and Federal safety regulations. They inspect walls and roof surfaces, monitor air quality, and examine mining equipment for compliance with safety practices.

Source: 2008-2009 Occupation Outlook Handbook, Bureau of Labor Statistics

Oil and Gas Sub-Sector

Workforce Overview

Oil and gas companies today are operating in an extremely dynamic business environment - some would argue an unprecedented one. The industry's key business challenges, such as the increasing global demand for energy, the development of unconventional oil and gas reserves, or the need for continuous innovation, cannot be resolved without a robust global talent supply. This phenomenon, combined with changing workforce demographics, is moving talent up the CEO's strategic agenda as an increasingly critical business issue. CEOs are looking to their HR executives to drive the strategic path forward for people issues. Unfortunately, HR executives have been weighed down by compliance and HR operations, leaving them unable to perform a more strategic role.³⁵

Winning the Talent Management Battle — The Oil and Gas Industry's Business Challenge

The talent crisis is particularly important among oil and gas companies, which are expected to face the greatest level of talent depletion. How should the energy industry respond to the depleting talent pool? How can business leaders and HR leaders alike create a talent road map that ensures their organization's survival in the competitive environment?

A talent whitepaper, "*Reap what you sow: Cultivating progress by getting to the root of the talent management challenge*," details steps that can be taken to help companies address the talent crisis and transform their human resources leaders from "stewards" to "strategists."³⁶

This whitepaper recommends three strategies for HR leaders as they move from "stewards" to "strategists".

- **Align** – Create a clear line of sight between your business and your HR organization. Clearly identify which resource skills are needed to support the business strategies.
- **Analyze and prioritize** – Get a fact-based understanding of your organization's capabilities to deliver the identified HR strategies.
- **Differentiate and organize** – Assess options and develop a roadmap that will deliver the mix of talent and work solutions that will drive competitive advantage.³⁷
http://www.deloitte.com/dtt/cda/doc/content/us_er_talentmanagement%20POV_Reap%20what%20you%20sow%281%29.pdf

The Corporation for a Skilled Workforce has begun significant work in this area of HR strategy, specifically related to using business networks to recruit talent. In a project report supported by the Mott Foundation titled *Networking For Talent*, CSW concludes that "the concepts of talent management, networking and corporate citizenship are clearly inter-connected. Specifically, effective talent management assures the recruitment and retention of competent workers while networking uses those workers to interchange skills, methodologies and technologies within and between companies. The umbrella of corporate citizenship aspires to improve the social and environmental conditions within a region so there are positive effects that derive from the company's products or services. In a broad sense, these three concepts acknowledge the vital importance of people, their skills, individual and company inter-relatedness and their socio/economic/environmental context."³⁸
<http://www.skilledwork.org/pdfs/Networking%20for%20Talent%20report.pdf>

Hiring and Retaining Highly Skilled Employees

Expansion in exploration and processing, coupled with a large number of retiring workers, has led to a shortage of skilled labor in the oil and natural gas industry. Jobs in gas extraction, production, and distribution are largely technical and therefore well-paid. There is a specific challenge in recruiting and housing drilling rig staff who often live onsite and work 8- or 12-hour shifts until the well is completed. This land-based rig staff includes laborers, roustabouts, roughnecks, drill operators, and geologists. While the pay is above average, turnover is high at the lower positions due to hard physical labor and long shifts. To accommodate the turnover, entry-level laborers can progress through higher paid positions to drill operator and tool pusher. In boom times, personnel are in chronically short supply. To meet demand for skilled workers, like engineers and geologists, companies are recruiting from colleges and universities and looking overseas for workers.³⁹

Improving Worker Safety

Workers who drill oil and gas wells have injury rates 25% higher than the average for all US workers. The risk for injuries rises as companies rapidly increase their number of employees to meet world demand for oil and gas.

Companies are investing in worker training and implementing safety procedures to reduce injuries. High injury rates increase disability insurance costs and contribute to shortages of skilled workers.⁴⁰

Replacing Low-Skilled Workers with Automation

An overall loss of jobs in the natural gas industry over the past 15 years is due largely to increased automation, which requires fewer workers to control extraction, processing, and distribution. Automation requires specialized training on the part of employees and allows workers to control equipment from air conditioned compartments with easy to use joysticks and computer controls. Automation also provides a higher level of safety, reducing manual handling of pipes on platforms where falls and contact with heavy machinery can result in injuries. Drilling companies began to increase hiring in 2004 to keep pace with rising production.⁴¹

Coal Mining Sub-Sector

Workforce Overview

Jobs in traditional underground coal mines require special skills to operate complex mining and extraction machinery. Jobs in surface mines involve operating large pieces of earthmoving equipment. Due to the specialized nature of both types of work, employees are well-paid. The average wage is 40% higher than the national average. Many miners, both underground and surface, are members of the

Job Spotlight: Geological and Petroleum Technicians

Geological and petroleum technicians measure and record physical and geologic conditions in oil or gas wells, using advanced instruments lowered into the wells or analyzing the mud from the wells. In oil and gas exploration, technicians collect and examine geological data or test geological samples to determine their petroleum content and their mineral and element composition. Some petroleum technicians, called scouts, collect information about oil well and gas well drilling operations, geological and geophysical prospecting, and land or lease contracts.

Source: 2008-2009 Occupation Outlook Handbook, Bureau of Labor Statistics

United Mine Workers of America (UMWA) union. Mines with nonunion workers generally pay the same hourly wages as union mines. The cost of fringe benefits differs for underground and surface workers: underground mines pay an extra 40% of payroll for fringe benefits; surface mines pay 30%. The number of miners has been steadily decreasing for several decades because of more efficient machinery and because a greater proportion of coal is produced from surface mines, which are less labor-intensive. As more coal mining has moved above ground, the rate of accidents has declined, but safety is still a major issue. The industry injury rate is still almost three times as high as the national average. More than half of accidents are serious, resulting in more than 30 days away from work.⁴²

Improving Safety

Despite an average injury rate comparable to the national norm, mining accidents receive high media visibility, usually include fatalities, and are a public relations nightmare. While mining states update their regulations periodically, usually after disasters, federal mining safety regulations have not been updated since 1977. Companies train miners in safety and modern rescue technology. Canadian mines provide safe rooms with stored oxygen and food where miners retreat during explosions; safe rooms are not required in the US, but West Virginia passed a law in 2006 that requires mines to store more oxygen underground and equip miners with tracking and communication devices.⁴³

Creating Community Environment

New miners and mining engineers are in short supply, as demand for coal rises and many coal miners reach retirement. To reduce migration of potential workers from mining localities, companies help their communities build better environments by constructing community centers and hospitals, and sponsoring athletic teams and events.⁴⁴

Providing Support during Mining Accidents

When mining accidents occur, they garner substantial media attention and scrutiny for the mining operation and community. Serious injuries and fatalities are likely, and if the situation isn't managed well, it can be a public relations disaster. Companies provide family support during disasters and ensure that benefits are paid promptly.⁴⁵

Resources

Colorado Resources

Rockies Energy Workforce - This excellent website is a cooperative effort started by employers, educators and state and local workforce boards in Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming. Links on this website provide industry profiles by state, as well as career and educational opportunities information. The website indicates that the industry needs entry-level and experienced workers such as welders, pipe-fitters, instrumentation technicians, engineers, electricians, and many more. <http://www.rockiesenergyworkforce.org/index.html>

The **Colorado Oil and Gas Conservation Commission (COGCC)** promotes the responsible development of Colorado's oil and gas natural resources. It manages the **Colorado Oil and Gas Information System (COGIS)** which can be queried by facilities, production, etc. and the **GIS online oil and gas mapping system**. <http://cogcc.state.co.us/>

GIS online <http://cogcc.state.co.us/infosys/Maps/gismain.cfm>

Colorado School of Mines is a public research university devoted to engineering and applied science. Mines has distinguished itself by developing a curriculum and research program geared towards responsible stewardship of the earth and its resources. In addition to strong education and research programs in traditional fields of science and engineering, Mines is one of a very few institutions in the world having broad expertise in resource exploration, extraction, production and utilization. As such, Mines occupies a unique position among the world's institutions of higher education. A Colorado energy producer recently gave the Colorado School of Mines \$300,000 to establish the Center for Reservoir Studies. The Center will fund unique educational programs dedicated to developing new technologies that can further protect the environment. ⁴⁶ <http://www.mines.edu/>

The **Colorado Energy Research Institute (CERI)**, located at the Colorado School of Mines, was established by the Colorado Legislature to develop energy-related research and educational programs involving government, industry, universities, and the public. Since July 1, 2004, CERI has worked to identify new energy R&D opportunities by increasing cooperation and communication among these stakeholders. The web site is rich with economic impact studies, publications, and presentations about the energy industry. <http://www.ceri-mines.org/home.htm>

The **Rocky Mountain Coal Mining Institute (RMCMI)** is a nonprofit corporation in Littleton, CO, dedicated to the promotion of western coal through education. Member states are Arizona, Colorado, Montana, New Mexico, North Dakota, Texas, Utah and Wyoming. Membership is diverse and includes individuals from both surface and underground mines, equipment manufacturers, service/supply firms, utilities, coal transporters, law firms, government, universities and colleges, financial institutions, and others interested in supporting the industry. The two major goals of RMCMI are:

1. To sponsor educational programs pertaining to coal mining technologies and production techniques, mining management and safety, federal, state and local laws, rules and regulations pertaining to coal mining and other energy related issues.
2. To disseminate to the public and to educational and scientific institutions knowledge and the results of study and research into recent developments in coal mining technologies and

production techniques, mining management and safety, federal, state and local laws and regulations pertaining to coal mining and other energy related issues.

<http://www.rmcmi.org/index.cfm/ID/2/About-RMCM/>

In December 2007, **Rocky Mountain News** examined whether Colorado is ready to deal with the greatest natural resource boom in its history, with more than 33,000 oil and gas wells pumping and tens of thousands more on the drawing board. In four days of special reports, Beyond the Boom, Rocky Mountain News examined the multi-billion dollar energy bonanza and the enormous potential social and environmental consequences for the state. <http://www.rockymountainnews.com/special-reports/colorado-oil-gas/beyond-the-boom/>

Associations, Publications and Association Related Web Resources

The **Colorado Oil and Gas Association's (COGA)** purpose is to “foster and promote the beneficial, efficient, responsible and environmentally sound development, production and use of Colorado oil and natural gas.” <http://www.coga.org/mc/page.do>

COGA Industry Studies

<http://www.coga.org/mc/page.do?sitePagelId=60091&orgId=coga>

The **Colorado Petroleum Association (CPA)** is a non-profit trade organization deeply rooted in the professional representation of the oil and gas industry before state, regional and federal governmental entities. Since 1951 large and small companies have banded their voices together through the association to advance ideas and plans which have helped shape a strong and thriving energy industry. Through public and professional education, lobbying, regulatory activities and media relations, CPA has long been recognized as the primary spokesperson for the industry in Colorado and the Rocky Mountain Region. <http://www.coloradopetroleumassociation.org/facts.htm>

An excellent presentation of maps and graphs that details the Colorado Oil and Gas Industry http://www.coloradopetroleumassociation.org/whitepapers/001_COGUpdate.pdf

The **Colorado Mining Association (CMA)**, established in 1876 and incorporated in 1897, is a trade association with membership numbering 140 companies and 800 individuals. It is composed of both small and large enterprises engaged in exploration, production, and refining of metals, coal, oil shale, and industrial minerals; firms that manufacture and distribute mining and mineral processing equipment and supplies; and other institutions providing services and supplies to the mineral industry. The CMA website is an excellent resource for mining related policy, legislation, industry facts and resources. <http://www.coloradomining.org/>

CMA Mining Facts and Resources http://www.coloradomining.org/mc_miningfacts.php

NMA Mining in Colorado Fact Sheet <http://www.nma.org/pdf/states/co2003.pdf>

Mining Industry Today – Colorado Mining News is an on-line news monitoring service (by subscription) for the mining industry <http://mining.einnews.com/colorado/>

Colorado Energy News is an excellent on-line newsletter about the business, technology and politics of Colorado's energy industry, including industry trends and career information. <http://coloradoenergynews.com/>

National Resources

Associations, Publications and Association Related Web Resources

American Petroleum Institute (API) is the primary trade association of the oil and natural gas industry, and represents more than 400 members involved in all aspects of petroleum. Conducts industry research; and presents policy issues, educational material, statistics, conferences, and sub-sector information. <http://api-ec.api.org/>

Society of Petroleum Engineers (SPE) is a professional association whose 79,000-plus members worldwide are engaged in energy resources development and production. SPE is a key resource for technical information related to oil and gas exploration and production and provides services online and through its publications, meetings, and other programs. <http://www.spe.org/>

American Gas Association (AGA) is the trade association of the natural gas industry. Website provides research/statistics, publications, best practices, and various other industry issues. <http://www.aga.org>

Oil and Gas Journal provides current news, conference and market data on the oil and gas industry, including a resource center of statistics and special reports. <http://www.ogj.com/index.cfm>

Natural Gas Supply Association (NGSA), established in 1965, encourages the use of natural gas within a balanced national energy policy, and promotes the benefits of competitive markets to ensure reliable and efficient transportation and delivery of natural gas and to increase the supply of natural gas to US customers. NGSA's members produce approximately one-third of the US natural gas supply. The website provides news, statistics, energy white papers, and other industry background information. <http://www.ngsa.org>

NaturalGas.org is an educational website developed and maintained by NGSA that covers a variety of topics related to the natural gas industry. The purpose of this website is to provide visitors with a comprehensive information source for topics related to natural gas, and present an unbiased learning tool for students, teachers, industry, media, and government. <http://www.naturalgas.org>

National Mining Association is the "official voice" of the American mining industry in Washington, DC, representing the interests of mining before Congress, the Administration, federal agencies, the judiciary and the media. Their website provides news, policy issues and papers, statistics and other related industry information. <http://www.nma.org/>

Clean coal resources from the NMA:

National Mining Association's (NMA) Clean Coal web page
http://www.nma.org/modern/clean_coal.asp

An excellent **whitepaper on clean coal** by the National Mining Association – *Clean Coal: Current Progress, Future Promise* http://www.nma.org/pdf/clean_coal_a.pdf

Office of Fossil Energy (OFE, USDOE) - This US Department of energy site is an excellent source of industry information, with a link to clean coal technology descriptions and initiatives. <http://www.fe.doe.gov/>

The World Coal Institute (WCI) is a non-profit, non-governmental organization of coal enterprises and associations - the only international body working on a worldwide basis on behalf of the coal industry.

Their website provides a good discussion of industry issues, clean coal technology, and mining basics. <http://www.wci-coal.com>

The **American Coal Council (ACC)** is dedicated to advancing the development and utilization of American coal as an economic, abundant and environmentally sound energy fuel source. The ACC provides educational programs, advocacy support, peer-to-peer networking forums and market intelligence. <http://www.clean-coal.info/drupal/index.php>

The **Institute for Energy Research (IER)** is a not-for-profit organization that conducts intensive research and analysis on the functions, operations, and government regulation of global energy markets. IER maintains that freely-functioning energy markets provide the most efficient and effective solutions to today's global energy and environmental challenges and, as such, are critical to the well-being of individuals and society. <http://www.instituteforenergyresearch.org/>

The **National Energy Foundation** is a nonprofit educational organization and a national leader in teacher training, student programs, instructional materials, development and distribution. <http://www.nef1.org/>

The **Society for Mining, Metallurgy, and Exploration (SME)** is an international society of professionals in the minerals industry. The SME membership is more than 11,500 strong, with members in nearly 100 countries. SME is organized into seven distinct divisions, including coal & energy and mining & exploration. <http://www.smenet.org/about/>

MiningJobs.org – Affiliated with SME, MiningJobs.org connects uniquely skilled mining and mineral industry professionals with companies and staffing firms that have hard to fill or specialized industry positions. <http://www.miningjobs.org/>

Data and Research Resources

Deloitte's web resources for the Oil and Gas Industry include reports, conference proceedings, research, web casts, etc. http://www.deloitte.com/dtt/section_node/0,1042,sid%253D2307,00.html

US Energy Information Administration's Annual Energy Review (AER) is the Energy Information Administration's primary report of historical annual energy statistics. For many series, data begin with the year 1949. Included are data on total energy production, consumption, and trade; overviews of petroleum, natural gas, coal, electricity, nuclear energy, renewable energy, international energy, as well as financial and environmental indicators; and data unit conversion tables. <http://www.eia.doe.gov/emeu/aer/contents.html>

The **Annual Energy Outlook 2008 (AEO2008)** presents projections and analysis of US energy supply, demand, and prices through 2030. The projections are based on results from the Energy Information Administration's National Energy Modeling System. The *AEO2008* includes the reference case, additional cases examining energy markets, and complete documentation. <http://www.eia.doe.gov/oiaf/aeo/index.html>

Statistical Review of World Energy 2008 from BP Global includes current and historical statistics on coal, natural gas and oil, as well as videos and sustainability reports. <http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622>

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