Industry Guidebook: Renewable Energy



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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 Renewable Energy 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?

- Just as not all "green jobs" are radically new jobs, "green jobs" are found in a variety of sectors, not just the renewable energy sector.
- Generally, 80% of jobs created in the solar and wind sectors will be in manufacturing and 20% in construction and installation.
- Solar photovoltaic power uses more labor per installed megawatt than other renewable energy sources, so solar power produces a larger demand for a skilled workforce.
- Because the renewable energy sector is heavily dependent on manufacturing industry, the manufacturing sector's skilled labor shortage is relevant to the renewable energy sector's ability to grow.
- Large surveys by organizations such as 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.

Introduction

The term renewable energy has been used to loosely define those energy industries that do **not** rely on a finite fossil fuel energy source, such as coal, petroleum, or natural gas, and which generally emit carbon dioxide during production. The key concept in renewable energy is an overall reduction in harmful gas generation, including but not limited to CO_2, and accessing power sources that are not limited in nature. Because the term "renewable" is not defined by government policy or occupational code, variation exists among policy makers, private industry and others at to which industries exactly are renewable. This is important because job projections, investment dollars and economic impact forecasts are dependent upon which industries are counted. There is general agreement that the following sources are renewable:

- Wind
- Solar
- Geothermal
- Biomass/bio fuel

Variation exists among stakeholders and policy makers as to whether the following three should be considered to be renewable sources. (This guidebook does not consider these sources to be part of the "renewable" energy sector.)

- **Coal gasification.** Coal gasification describes the process of capturing the CO_2 that is emitted during the process of using coal to create electricity (which is the primary source of electricity in the US). The capture of CO_2 so that it does not pollute the environment is what is known as "clean coal" technology. Critics say that the CO_2 is still produced, even if it is stored, so "clean coal" is not truly renewable energy. There are also a number of safety questions about storing the CO_2. (For a more complete discussion of this energy source, please see the industry guidebook on Energy Extraction)
- **Hydro power**. While the source of electricity comes from water, a natural resource, production of electricity from water still produces CO_2. In addition, there are concerns about ecosystem disruption resulting from the diversion of water for hydro power purposes.

- **Nuclear power**. While nuclear power generation does not emit CO_2, it does produce hazardous waste. The questions related to long term storage of this waste have yet to be resolved after decades of policy debate.

As mentioned above, due to the variability in the definition of renewable industries, various agencies and industry groups posit various industry size, revenues and jobs in the renewable energy industry. A well-regarded and commonly referenced account- (by both private and public sector entities) of "green job" growth and size comes from the American Solar Energy Society in a report produced in 2008 called *Renewable Energy and Energy Efficiency: Drivers for 21st Century.* This report focused on jobs generated by renewable energy industries *and* jobs in the energy efficiency field, which is closely related. (Note, other industry groups and reports focus specifically on the renewable energy area and not energy efficiency.) The report defines the renewable energy (RE) industry as hydro, biomass, geothermal, wind, photovoltaics, and solar thermal. For example, a renewable energy job is installing solar panels on a residential building. The authors of the study state that the energy efficiency (EE) industry is harder to define because it is not an industry per se. To estimate the size of the EE industry, the authors used insulation sales, energy service company industry sales, US recycling and reuse industry sales, and then estimated portions of other industries that relate to energy efficiency, such as Energy Star appliances (but not all appliances). For example, a technician working on a heating, cooling and ventilation system would be considered a job in the energy efficiency field.

According to the *Renewable Energy and Energy Efficiency: Drivers for 21st Century* report, in 2006 the RE industry was a $39.2 billon industry, and generated 452,000 direct and indirect jobs. In 2006, the EE industry generated $932.6 billion in sales and 8,046,000 direct and indirect jobs. Combined, this represents over 8.5 million jobs generated. The combined $970 billion in revenue is larger than the $905 revenues of Exxon, Wal-Mart and GM combined in 2006.

The renewable energy industry is driven by increasing demand for power coupled with a growing recognition that US consumption of fossil fuels – petroleum and coal, primarily – will both fail to meet demand and produce one fourth of all the CO_2 emissions globally. Even absent a radical decrease in US imports of fossil fuels, exploding demand from India and China will drive up the cost of these fossil fuel based energy sources. While the Middle East has been the traditional supply source for crude oil, Russia has become the number two crude oil supplier. Notably, Russia is not a member of OPEC and therefore not subject to production quotas. Russia also holds the most natural gas reserves and is the largest natural gas producer. Over the last decade, the national discourse has linked US dependence on imported oil to national security issues.

The term "green jobs" has been used for shorthand for jobs in the renewable energy and energy efficiency sector. Like the renewable energy sector itself, there is no precise definition of "green jobs." What is clear, however, is that many of the "green jobs" in the renewable and energy efficiency sector are not radically new jobs. Many are traditional manufacturing jobs now focused on producing, for example, a generator for a wind machine, rather than a gas fueled airplane. Many jobs in biofuel draw from the biochemistry discipline to generate new plant variations to use in fuel production. Welders, pipefitters, architects, and the like are needed to build energy efficiency buildings or retrofit them. A more complete discussion of green jobs follows in the workforce section of this guidebook.

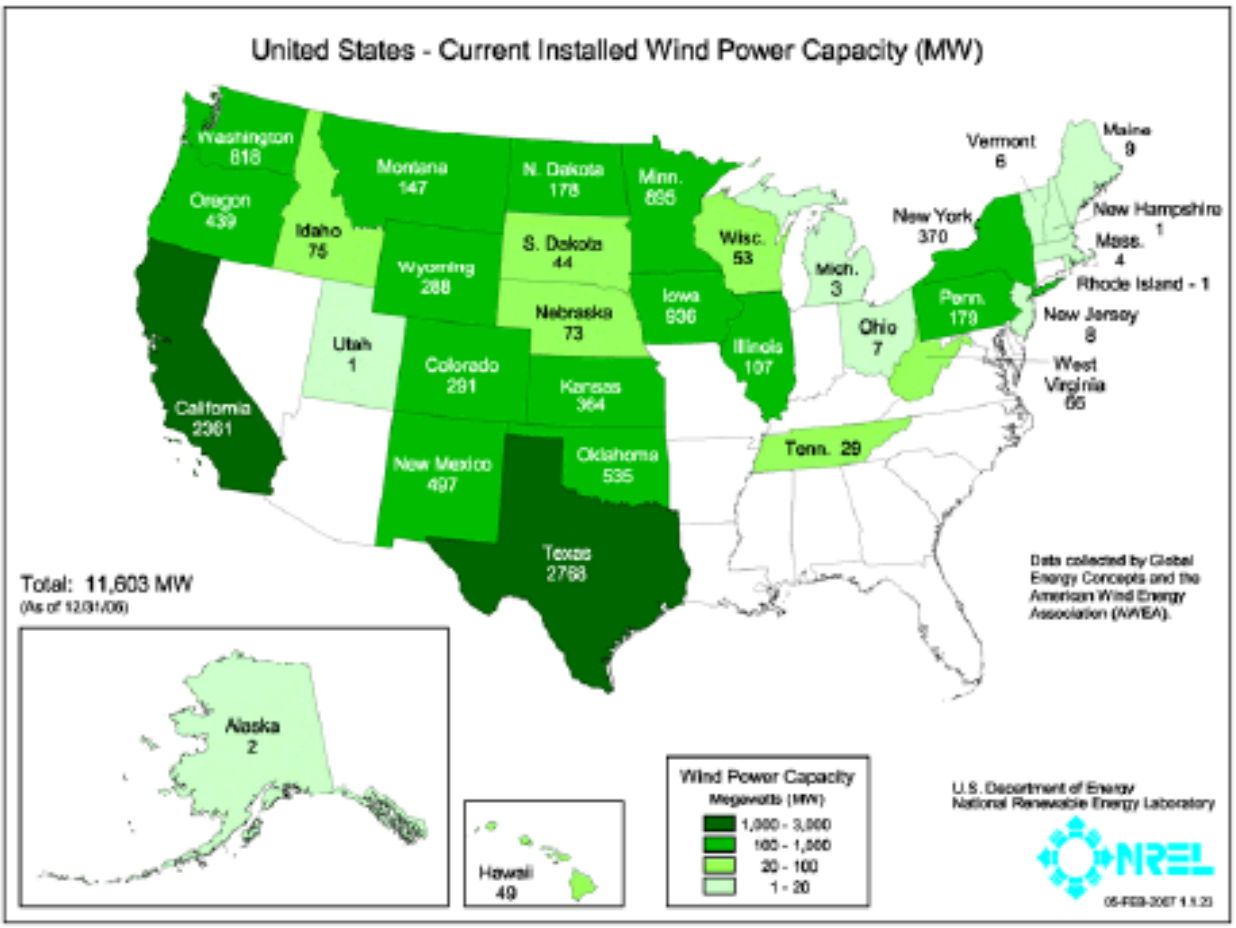
This guidebook focuses on three renewable energy sources relevant to Colorado:

- **Solar Energy**: The energy of the sun's rays that can be converted into other forms of energy, such as heat or electricity. Photovoltaic, which converts the energy into electricity, is the most common form of installed solar capacity. Low temperature solar thermal collectors are used for heating water, heating and cooling buildings, and heating swimming pools.

- **Wind Power**: The harnessing of wind by turbines that convert the energy into electricity.
- **Biomass**: Biomass includes plants grown for the production of fuel. Plants commonly grown for this purpose include corn, switchgrass, sugarcane and willow. The fuels generated include bioethanol, biodiesel, biogas, and biobutanol.

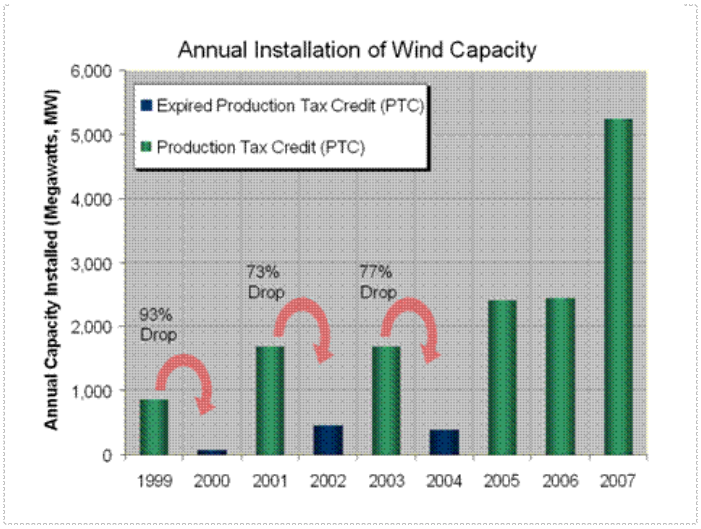
Wind

The wind sector is booming. While wind represents only 1% of the electricity generated in the US, the industry has been growing at double digit rates over the last few years. According to the American Wind Energy Association, the US wind power fleet now numbers 16,818 megawatts (MW) and spans 34 states. In contrast, in 1999, there was only 2,500 MW of installed capacity in the US American wind farms will generate an estimated 48 billion kilowatt-hours (kWh) of wind energy in 2008, just over 1% of US electricity supply, powering the equivalent of over 4.5 million homes. Installations nationwide in the last quarter of 2007 alone (2,930 MW) surpassed the amount installed in all of 2006 (2,454 MW).



Wind power has two major segments: large scale wind farms, typically linked to a utility company, and small wind, which are primarily one or two turbine installations. Large scale companies include GE Energy, Seimens and Vestas. Excl Energy, based in Colorado, has the largest capacity at 2,635 megawatts. Independent power producers (IPPs) own over 75% of the wind farms nationwide. The sector is driven by developers who buy the land on which the turbines will sit, raise capital, arrange electricity buyers, and maintain the turbines. Current estimates put the price of wind-powered electricity at $45 per megawatt hour.[1]

Public policy in the form of tax credits and the Department of Energy's (DOE) *Wind Powering America* program help to drive the industry growth. The federal government over the last decade has offered the production tax credit (PTC). This tax credit is given to power generation companies on a per kilowatt basis of renewable energy produced. Since this tax credit must be approved by legislators, it requires Congressional action. The tax credit was extended in fall 2008 through December 31, 2009. This need for Congressional action, in turn, limits investment in the sector. The importance of this tax credit and renewable portfolio standards (discussed below) to the growth of the industry cannot be overstated. The chart above shows the recent growth of wind capacity installation as it relates to availability of the tax credit.[2]



Solar

Like wind, the solar market is a tiny percentage of the overall energy generation market. However, the solar energy market is exploding. Photovoltaic – converting the sun's energy to electricity – installation is growing at double digit percentages. There is over 250 MW of installed capacity right now in the US – 26,000 sites were installed in 2007 alone. Factors driving this explosive growth are:

- A Federal tax credit that was increased in 2006 for commercial taxpayers
- A credit for residential taxpayers that took effect in 2006
- Consumer concern about rising electricity prices
- Impact of Renewable Portfolio Standards (RPS) which require increasing amounts of solar energy be used

Residential installations – averaging 4.7 kW – connected to the grid account for about 1/3 of all installations. Commercial installations – averaging 67 kW – are a solidly growing sector. McKinsey estimates that global installed capacity could rise to 20 or 40 times what it is today, reaching upwards of 200 gigawatts from 10 gigawatts today.

The solar sector contains a handful of various subsectors:

- The manufacturers of the silicon wafers and panels that are at the heart of collecting the sun's energy.
- The installers who put up small scale panel arrays, primarily on residences or small buildings.
- The utilities investing in enormous panel arrays.
- Start-up companies driven to produce the next innovation in solar energy capture.

The manufacturing component of the solar energy industry consists of three technologies at present:[3]

- Silicon wafer based (requiring a huge amount of the commodity silicon). This type is predominant, but somewhat costly to make and install.

- Thin film photovoltaics (generate electricity directly from light). While this type uses less silicon, it is less efficient at translating the sun's energy into electricity than silicon wafer based PV.
- Solar thermal power. Solar thermal power is the lowest cost type of PV. However, this type requires vast quantities of open space to aggregate energy absorption, which means installations are often far from end users, increasing transmission costs.

Due to materials and transmission costs, solar electricity currently costs more to the consumer than l electricity generated from traditional resources. The challenge is to bring the per kilowatt cost down to be competitive with regular electricity prices. The solar market has two dominant business models. One business model is utility driven: utilities install vast solar arrays and provide solar generated electricity to their installed customer base. The variation on this theme is connecting homeowners who have a solar array on their property to the electricity grid and providing some cost benefit for doing so. The other model avoids utilities. A company installs a solar array on a site, leading to lower electricity costs for the homeowner. The company retains ownership of the array and essentially leases it to the homeowner. In return, the homeowner dedicates a stream of payments to the solar array leasing company, generated from savings he or she received by using the solar array.

Biomass/biofuel

A young, growing industry, biomass is about a $3 billion dollar industry, with about 200 companies. Big players include traditional energy companies such as BP and Chevron, and agriculture players such as Archer Daniels Midland. Biomass is the use of natural products to produce gasoline or diesel fuel. The most common form is ethanol gas, made from corn. It is important to note that ethanol gasoline industry is heavily dominated by established players in the agribusiness and petroleum industries. While biofuels may be considered a young industry, the agribusiness and petroleum industries are mature. Government subsidies and technological breakthroughs are common, resulting in many entrants to the field. In particular, the industry is helped by tax credits put into law in the 2005 Energy Act. Accenture, the consulting firm, expects that the industry will exceed production of 120 liters of ethanol and 23 billion liters of biodiesel before 2020.

The 2005 Energy Act established minimum biofuel use and production. There are about 100 ethanol plants nationwide producing about 3.7 billion gallons of ethanol gas, with more plants under construction. E85 is car gasoline made with 85% ethanol. About 6 million cars in the US are equipped to use E85.

The industry and policy environment is shifting away from using food stock like corn to produce ethanol gas to using more environmentally friendly cellulose based items such as wood. Critics and policy makers tied the rising cost of commodity corn to ethanol production, saying that energy demands for the food stock competed with human food consumption needs. Further, critics charged that any energy savings generated by using ethanol, not petroleum, were wiped out due to the increased use of water to support the corn cultivation and the volume of energy needed to convert the corn to ethanol. Despite this, the government did not lower its biofuel production quotas outlined in the 2005 Energy Act.

Biodiesel is made from animal fats or vegetable oil. Biodiesel is mixed with regular diesel to produce B20 (20% biodiesel) or left alone as B100 (100 biodiesel). It requires no major modification of diesel engines to use it instead of regular diesel. [4]

Incentives and Policy Proposals

National Policy Trends

Demand for renewable energy sources has grown dramatically, especially over the last five years. This demand is driven by both private sector consumers and by state and local public sector actors. Because the expansion of renewable energy sources is dependent on large amounts of capital to build the harnessing machinery and distribution infrastructure, energy companies and utilities have historically made relatively little investment in this area compared to investments in oil and coal, because the demand had always been considered too little to justify the investment. The public sector has utilized legislation to create enough demand to generate investment by utilities and energy companies; the renewable portfolio standard is the most common form of this legislation.

Proliferation of Renewable Portfolio Standards (RPS)

A Renewable Portfolio Standard (RPS) articulates a percentage ratio among the variety –portfolio – of energy sources an entity uses. It is legislated by a public sector body to direct how its government operations will use energy. The public sector uses a huge amount of energy: electrical uses for lighting, heating, and cooling; transportation fuels for local bus systems and employee cars; materials usage such as paper; water usage in its buildings. It pays millions of dollars for its utility and transportation costs. An RPS essentially guarantees a certain market volume of demand to the utilities and energy companies that fall within its geographic reach, thus incentivizing private sector investment in building capacity and supply. In an RPS, a state may indicate that a certain percent of its energy must come from wind power, for example. A city may require an increasing percentage usage of solar power over a certain number of years.

Over the last several years, an increasing number of states have enacted RPSs to galvanize investment in renewable energy sources. According to the Database of State Incentives for Renewables & Efficiency, a project of the North Carolina Solar Center and the Interstate Renewable Energy Council (IREC) funded by the US Department of Energy, 42 states presently have an RPS.

Colorado's RPS for utilities is:

- 5% of its retail electricity sales 2008-2010;
- 10% of its retail electricity sales 2011-2014;
- 15% of its retail electricity sales 2015-2019; and
- 20% of its retail electricity sales 2020 and for each following year.

For investor-owned utilities, at least 4% of the standard must be generated by solar-electric technologies.

Along with state level renewable portfolio standards, there are several relevant federal government tax incentives for investment in renewable power.

Wind

The present law allows for an income tax credit of 2.1 cents/kilowatt-hour for the production of electricity from utility-scale wind turbines. The credit was extended until December 2009 as part of the Emergency Economic Stabilization Act of fall 2008. Under present law, a federal-level investment tax credit (ITC) is available to help consumers purchase small wind turbines for home, farm, or

business use. Owners of small wind systems with 100 kilowatts (kW) of capacity and less can receive a credit for 30% of the total installed cost of the system, not to exceed $4,000. For turbines used for homes, the credit is additionally limited to the lesser of $4,000 or $1,000 per kW of capacity. The ITC, written into law through the Emergency Economic Stabilization Act of 2008, is available for equipment installed from October 3, 2008 through December 31, 2016.[5]

Solar

The solar investment tax credit (ITC) provisions passed in fall 2008 extends for 8 years the 30-percent tax credit for both residential and commercial solar installations; eliminates the $2,000 monetary cap for residential solar electric installations, creating a true 30-percent tax credit (effective for property placed in service after December 31, 2008); and allows Alternative Minimum Tax (AMT) filers, both businesses and individuals, to take the credit. [6]

Biofuels

There are several tax incentives related to biodiesel. The biodiesel fuel credit, which is more germane for traditional end-users because it does not require the end-user to register, is claimed as a general business credit when an end-user purchases and uses biodiesel directly from a biodiesel producer (i.e., the credit may not be claimed if the biodiesel was purchased from a retail sale).[7] The small agri-biodiesel producer tax credit program is a volumetric based income tax credit for the production of agri-biodiesel (biodiesel made from first-use vegetable oils and first-use animal fats). The credit is 10 cents per gallon, up to 15 million gallons per year.[8] The blenders excise tax credit is one penny per percent of biodiesel in a fuel blend. It is taken at the blender level, generally petroleum distributers.[9]

The Emergency Economic Stabilization Act of fall 2008 included four provisions relating to biodiesel. Income tax credits, the blenders excise tax credit, and the small producer tax credit all were extended for one year and will now expire Dec. 31, 2009. A provision allowing all biodiesel to be eligible for the $1 per gallon tax incentive was added, effective Jan. 1, 2009. The $1 renewable diesel tax credit was modified, and disallowed renewable diesel produced with petroleum products from benefiting.[10]

The Energy Act of 2005 mandates 36 billion gallons of renewable fuel be added to the national fuel supply each year beginning 2022. Currently, this requirement is met mostly through E-85 gasoline, which contains 10% ethanol.

Biomass

The Emergency Economic Stabilization Act of fall 2008 extends the tax credits for closed-loop and open-loop biomass facilities until Dec. 31, 2010. In addition, new biomass power generation units placed in service to connect existing qualified open-loop biomass and closed-loop biomass facilities are treated as qualified facilities, to the extent of the increased amount of electricity produced by the new units. This provision is effective for property placed in service after Oct. 3, 2008. The act also extends the 50 percent bonus depreciation to property used to produce cellulosic biofuels, rather than just cellulosic ethanol. The provision is effective for property placed in service after Oct. 3 2008.[11]

State Policy & Incentives

The Governor's Energy Office (GEO) expanded its **Solar Rebate Program**, which promotes solar energy installations and the solar industry in Colorado. The Solar Rebate Program was created with the goal of extending rebates on residential solar technologies to Colorado residents state-wide. Funding for this program was effectively doubled by partnering with cities, utilities, and non-profit organizations through a matching grant program. These matching grant funds are provided to selected program partners to assist them with setting up their own local solar rebate programs. For more information, visit http://www.coseia.org/newsite/index.php?id=96

The Governor's Energy Office also offers a rebate program for the wind industry by partnering with four utility companies to offer a **rebate for Small Wind Turbine installations**. Homeowners and businesses who are customers of one of these four utilities and are interested in installing a small wind turbine can contact their utility for specific program details.
http://www.colorado.gov/energy/renewables/small-wind-incentive.asp.

To support the biofuel industry and increase adoption of biofuels by consumers, the Governor's office runs a **Biofuels Coalition** (GBC) which represents Colorado organizations, businesses, government agencies, environmental groups, and others that are involved in the production, distribution, promotion, and usage of biodiesel and ethanol. The GBC aims to educate Colorado's almost 300,000 vehicle owners to the benefits and availability of E-85 and biodiesel. Additionally, the GBC wants to maximize the number of installations of E85 and biodiesel pumping facilities within Colorado by furnishing funds that will go directly for equipment. The CBC makes grants available to fueling stations.
http://www.colorado.gov/energy/renewables/governors-biofuels-coalition.asp

Colorado New Energy Communities program is a funding strategy to bring $10 million in state matching funds to support renewable –energy and energy-efficiency projects in local communities. Energy Impact Assistance funds are available – up to a maximum of $2 million per project.
http://www.dola.colorado.gov/NewEnergyCommunities/#overview.

Business and tax incentives are being used to grow the clean energy sector in northern Colorado. Ft. Collins is leading an effort to become a zero energy district, known as **FortZED**. In early 2008, the US Department of Energy (DOE) announced that the City of Fort Collins and its partners will receive $6.3 million in federal grant money, pending appropriation from Congress, to research, develop, and demonstrate new electric grid technologies. The project will result in a 20 - 30 percent peak electric load reduction. Fort Collins project was one of only nine demonstration projects to be selected by the DOE. The effort is a cooperative project between the City of Fort Collins, Larimer County, Colorado State University, InteGrid Lab, Community Foundation of Northern Colorado, Advanced Energy, Woodward, Spirae, Eaton, the Brendle Group, and New Belgium Brewing Company. These community partners, along with the Governor's Energy Office, the Fort Collins Downtown Development Authority and other local contributors, have committed $4.9 million in matching funds, including cash and in-kind services, to make the DOE grant a reality. http://www.nccleanenergy.com/initiatives.html

Industry Trends and Challenges

National Trends

Aside from the public sector use of regulations and legislation to drive market growth, a number of other trends are driving growth in the renewable energy sector.

Increasing cost of oil

Since Hurricane Katrina in 2005, oil and gas prices have been steadily rising, topping $100 a barrel in summer 2008. Since oil is used in virtually every manufacturing process and is a primary cost driver in transportation, the private sector has experienced a major increase in its cost basis, irrespective of industry sector. Private sector companies have begun to generate increased demand for renewable energy, in conjunction with their move to improved energy efficiency. Although prices have dropped dramatically over the latter part of 2008, the long term trend of increasing oil costs holds.

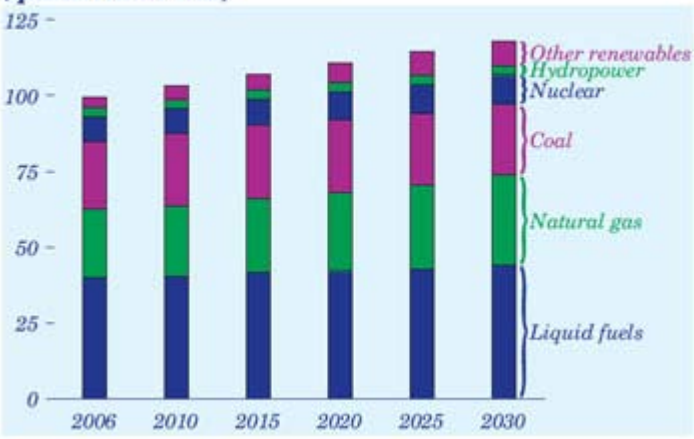
Increased consumer awareness of and demand for sustainably produced products

Consumers are increasingly interested in purchasing products which have been made sustainably or are sustainable – with less harm to the environment than traditional products. Furniture is an example- the wood used is from a forest which is managed for long term growth, the fabric is made from organically grown cotton, and the item is shipped in materials that can be recycled. Similarly, consumers are considering how their power is generated. When offered the opportunity, they wish to purchase "green" energy through their utility, or buy ethanol gasoline.

Demand for overall power is growing

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 percent per year from 2006 to 2030. Fossil fuels account for 55 percent of the increase. Coal use will increases in the electric power sector, where electricity demand growth and current environmental policies favor coal-fired capacity additions.[12]

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



According to the EIA, delivered energy use (excluding losses in electricity generation) will grows by 0.7 percent 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 floorspace. With different assumptions about population and economic growth, average annual growth in delivered energy use from 2006 to 2030

ranges from 0.3 percent in the low growth case to 1.0 percent in the high growth case.

Thus renewable energy sources are being tapped to replace fossil fuel based sources, and to meet increasing demand.

Linking renewable energy to energy efficiency

Often, an increase in energy efficiency precipitates converting to renewable energy. This linkage is part of the reason why the some industry analysts combine renewable energy and energy efficiency into one mega industry grouping. For example, some retailers are lowering their electricity costs and reducing wasted cooling efforts by planting "green roofs." Green roofs, which contain living material on the roof, lower cooling costs by reducing the temperature of the building through absorption of solar heat, which reduces need for air conditioning. Green roofs also produce oxygen to combat CO_2 emissions, serve as gathering space for wildlife, and capture water for various uses. Homeowners' efforts to reduce energy wastage include replacing old windows and heating systems, and taking the opportunity to switch to solar powered heating.

Backlog of demand for manufactured components

Because the installed base of machines to produce renewable energy is still so small, the manufacturing demand for component parts is considerable. According to AWEA, the wind industry is facing a two year backlog of orders for turbines, which are the key driver in wind generators. Half of all wind components are imported. Similarly, while the technology for solar power keeps improving, demand for panels outstrips manufacturing capacity.

Colorado Trends

Wind Trends

Like the national market, the wind market in Colorado is exploding with growth. Nationally, Colorado ranks sixth in terms of installed wind power capacity, behind Texas, California, Minnesota, Iowa and Washington. The additional installation of 776 MW of installed capacity in 2007 brought Colorado up to 1,067 MW of installed capacity at the start of 2008.[13]

Due to the state's RPS, which is driving investment by Colorado utilities in renewable power, Colorado has attracted a huge amount of wind manufacturing investment from international companies. Vestas, a Danish company, has invested millions with Xcel, the state's largest utility, to increase wind farm capacity in Colorado. According to coverage in the Rocky Mountain News, since its announcement in early 2007 to build a plant in Windsor, Vestas has:[14]

- Opened the first U.S. wind-blade manufacturing facility in Windsor in March, employing 650.
- In August announced it will spend $290 million to build two more plants in Brighton that will make blades and turbine units.
- Later in August chose Pueblo as the site of a factory to build the towers that support its wind turbines, the biggest in the world.

In fact, by 2010, Vestas plan to spend $680 million at its Colorado plants and employ 2,450 people. Even with the economic downturn in late 2008, Xcel continues to plan for expansion in 2009. A bid for work for 150 new megawatts generated proposals far in excess of the 150 needed.

In a cluster effect, Vestas has pulled wind-power companies to Colorado. In June, Siemens Energy, an arm of the giant German multinational, said it will establish its U.S. wind turbine research center in

Boulder. Soon after, Connecticut-based Hexcel, a producer of carbon fiber and advanced materials that supplies parts to Vestas, said it will build a plant in Windsor next year.

In addition, Xcel and TriState Generation, another Colorado utility, signed an agreement in late 2008 to develop additional transmission lines in Colorado. Under the agreement, Xcel and Tri-State will consider three projects building lines from the San Luis Valley to farmland near Lamar to the Front Range. Those lines could support future solar plants in the San Luis Valley, or wind farms near Lamar, or even Xcel's coal-fired power plant near Pueblo scheduled to come online in late 2009 or early 2010.[15] Lack of transmission capacity is a major wind power challenge, as the further power travels along a transmission line, the more of its energy it loses. Northeast Colorado is the windiest portion of the state, but quite removed from population centers. Lawmakers in 2006 passed a bill to help alleviate the problem by offering incentives for the construction of transmission lines.

Solar Trends

Photovoltaic solar installation in Colorado more than doubled from 2006 to 2007. Since Xcel Energy is the largest utility in the state, its actions relative to renewable energy have a significant impact on the state's overall solar activity. In 2007, one of the largest solar installations in the nation occurred: an 8 MW solar installation in Alamosa for Xcel Energy. To encourage more residential customers to use solar, Xcel launched a program two years ago that offered customers a $2.50-per-watt renewable energy credit and a $2.00-per-watt rebate for residential solar systems. The credit comes from Xcel's operating costs, while the rebate is funded by a surcharge that Xcel collects from all customers. According to the company, the intention was to help cover half the cost of solar installations for customers. In October 2008, Xcel cut its renewable energy credit from $2.50 per watt to $1.50 per watt, citing the enactment of a federal 30% residential solar investment tax credit that month. The Governor pushed back on Xcel, noting that the federal credit is not available until 2010, but Xcel kept its policy unchanged.[16]

While the utilities dominate large scale investment, the solar market in Colorado is crowded with start-ups – over 100 companies operate in the Front Range. Counties in Colorado have also used fiscal policy – tax incentives – to encourage consumer uptake of solar power. Boulder county voters in November passed a ballot measure allowing the county to offer loans to homeowners who want to install solar panels. The loan could be repaid with property taxes over time.[17] However, the economic downturn of late 2008 may force companies to consolidate or go out of business.

Biofuel Trends

Use of biofuels continues to grow in Colorado. Colorado has five ethanol plants in Yuma, Windsor and Sterling. Nearly 100 stations are currently open and selling E85 and/or biodiesel, 75% of which received support from the Governor's Biofuels Coalition. In 2007, the stations reporting to the Governor's Biofuels Coalition sold 2.614 million gallons of biofuels. From January 1st - June 30th, 2008, 3.74 million sold gallons have been reported.

As in the rest of the nation, Colorado investor interest and public fascination with ethanol fuel has cooled considerably over the last two to three years with increased disinterest in using corn-based ethanol. Also, the positive effect of high gasoline prices making renewable energy attractive disappeared with the dramatic decrease in gasoline prices in late 2008. In 2007, Panda Ethanol announced it would build a plant in Yuma, but it has yet to close on financing. Other plants in Colorado are holding their own, however. Yuma Ethanol, for example, has contracted with agri-giant Archer Daniels Midland to market 50 million gallons per year of its product. It has arrangements with local farmers to buy corn and with feedlots to sell distillers grain (an animal feed), shielding the plant from some of the economic fluctuations experienced elsewhere.[18]

Next generation ethanol – think cellulosic ethanol – is still primarily at the research and demonstration stage. In August, 2008, Vancouver, British Columbia- based Lignol Energy Corp. announced it will locate its cellulosic ethanol demonstration plant in Grand Junction. The $88 million plant, which received a $30 million dollar grant from the DOE, will convert beetle-kill and other wood residues into motor fuel. It will be operated by Suncor Energy (USA) Inc.[19] The Colorado Agricultural Value Added Development Board of the Colorado Department of Agriculture has awarded $150,000 in Advancing Colorado's Renewable Energy (ACRE) grants to organizations for biodiesel-related projects. In partnership with Colorado State University in Fort Collins, Colo., the International Center for Appropriate and Sustainable Technology (iCast) in Lakewood, Colo., was awarded $100,000 to assist with the implementation of two farm-scale oilseed crushing and biodiesel production facilities. During the past two years, iCast has been using a mobile biodiesel demonstration unit, dubbed Seeds Into Diesel (SID), to educate farmers and ranchers in Colorado and Wyoming about how to make biodiesel on the farm.[20]

After three years in the waste vegetable oil recycling business, Rocky Mountain Sustainable Enterprises LLC is in the final planning stages to build a 4.5 million gallon/year biodiesel plant in Morgan County, Colorado. In late October 2008, the company received word its application for a $500,000 grant from the USDA Renewable Energy and Energy Efficiency Program had been approved.

Industry Subsector Challenges

Wind Challenges

- **Questionable energy storage capacity**. Wind power turbine installations have met with criticism that they cannot act as a means to serve as a large-scale energy resource due to unreliability of wind patterns and the technological difficulties associated with storing energy created in non-peak usage periods.
- **Vulnerability to tax policy**. Government subsidies and the increasing use of RPSs have driven growth in the industry. Historically, the possibility of discontinuation of government tax breaks has reduced investment in the industry.

Solar Challenges

- **Cost.** Solar power still has a cost barrier to cross. Its generation costs are higher than conventional electricity. In addition, installation of a residential system is costly upfront with a long payback time.
- **Vulnerability to sourcing instability**. Solar power also suffers from dependence on the commodity market for silicon, which is also used by the semiconductor industry.

Biofuel Challenges

- **Cost effectiveness questionable**. Because biofuel gets about 30% less gas mileage than regular gasoline, and is costly to produce, it is only economically viable when gas is over $3.00 per gallon. In general, ethanol production is energy intensive, countering any energy savings created by using food stock rather than fossil fuels. Biofuel relies on the cultivation of massive amounts of land, which raises questions about sustainable water use and soil use. Biofuels must move to sources that are not food stocks in order to have adequate supply. Given government mandates on biofuel production and use, this issue is critical.
- **Vulnerability to tax policy.** The industry is dependent on government investment and tax incentives. If those are removed, the industry's growth will contract.

- **Poor distribution model to get to market.** Distribution of biofuel – both ethanol and biodiesel – is low due to lack of infrastructure. Both kinds of biofuel require separate transportation and storage facilities than gasoline and diesel , meaning tanks and pipeline used for gas cannot be used for ethanol gas. However, because large petroleum companies are the primary distributors of ethanol gasoline, increased distribution of these gas alternatives is heavily linked to this industry's investment. E85 is available at less than 1% of gas stations nationally.

Workforce Issues

National Workforce Issues

"Green Jobs"

The term "green jobs" has been used as shorthand for jobs in the renewable energy and energy efficiency sector. Like the renewable energy sector itself, there is no precise definition of "green jobs." Many consider all jobs in the renewable energy sector to be "green jobs" because the sector itself is environmentally friendly. What is clear, however, is that many of the "green jobs" in the renewable and energy efficiency sector are not radically new jobs. Many are traditional manufacturing jobs now focused on producing, for example, a generator for a wind machine, rather than a gas fueled airplane. Many jobs in biofuel draw from the biochemistry discipline to generate new plant variations to use in fuel production. Welders, pipefitters, architects, and the like are needed to build energy efficiency buildings or retrofit them. Further, most companies, no matter their core product, have traditional functions such as accounting, HR, and purchasing. This variation is a large part of the reason that there are so many estimates of job growth related to the renewable sector.

Just as not all "green jobs" are radically new jobs, "green jobs" are found in a variety of sectors, not just the renewable energy sector. Market brand managers in consumer packaged good industry must understand not only the core principles of marketing but also the environmental impact of the packaging they choose to use for their products. Office housekeeping/cleaning companies may adopt environmentally friendly products and market themselves as a "green" company. Landscape architects who point clients to native vegetation, reducing water usage, and wild-life friendly planting

Job Spotlight: Mechanical Engineering Technicians

Engineering technicians use the principles and theories of science, engineering, and mathematics to solve technical problems in research and development, manufacturing, sales, construction, inspection, and maintenance. Their work is more narrowly focused and application-oriented than that of scientists and engineers. Many engineering technicians assist engineers and scientists, especially in research and development. Others work in quality control, inspecting products and processes, conducting tests, or collecting data. In manufacturing, they may assist in product design, development, or production.

Mechanical engineering technicians help engineers design, develop, test, and manufacture industrial machinery, consumer products, and other equipment. They may make sketches and rough layouts, record and analyze data, make calculations and estimates, and report on their findings. When planning production, mechanical engineering technicians prepare layouts and drawings of the assembly process and of parts to be manufactured. They estimate labor costs, equipment life, and plant space. Some test and inspect machines and equipment or work with engineers to eliminate production problems.

About 35 percent of all engineering technicians worked in manufacturing, mainly in the computer and electronic equipment, transportation equipment, and machinery manufacturing industries. Another 25 percent worked in professional, scientific, and technical service industries, mostly in engineering or business services companies that do engineering work on contract for government, manufacturing firms, or other organizations.

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

schemes are promoting an environmentally sustainable way of landscape upkeep. Most large companies now have a chief sustainability officer whose job it is to understand the company's carbon footprint and environmental stewardship activities.

As mentioned earlier in the report, according to the *Renewable Energy and Energy Efficiency: Drivers for 21st Century* report, in 2006 the RE industry was a $39.2 billon industry, and generated 452,000 direct and indirect jobs. In 2006, the EE industry generated $932.6 billion in sales and 8,046,000 direct and indirect jobs.

Projecting Workforce Demand

One common method of trying to predict workforce demand in the various renewable energy sectors is to start with estimating needed capacity installation of a renewable energy source such as wind turbines or solar arrays. Energy efficiency goals are often used as a starting point for figuring out that targeted capacity need. Since much of the cost of renewable energy comes from the manufacturing infrastructure and parts, not the cost of the energy itself, analysts can then estimate the dollar investment needed to reach that capacity goal. Using models which predict how many jobs are generated from a certain dollar investment, a workforce projection can be articulated.

Wind

According to the National Renewable Energy Laboratory, a goal to get to 20% of all electricity nationwide being powered by wind over the next 20 years – known in the industry as "20% by 2030" – requires an installed wind capacity base of 300-350 GW.

The Renewable Energy Policy Project uses the following assumptions for the future wind workforce:[21]

- Every 1000MW of installed capacity requires a $1 billion dollar investment in rotors, towers, generators and other related investments.
- Every 1000MW created of installed capacity could lead to 3,000 manufacturing jobs, 700 jobs in installation, and 600 in operations and maintenance.

Solar

In the early 2000s, the Renewable Energy Policy Project outlined a growth trajectory of the solar industry for the nation in a report called *Solar PV Report: Location of Economic Activity*.[22] Since solar photovoltaic power uses more labor per installed megawatt than other renewable energy sources, solar power produces a larger demand for a skilled workforce. Because PV technology is primarily distributed in nature, construction and installation of a facility generally provides direct employment benefit to that locale. The industry projects direct employment of 260,000 people nationally to meet a goal of 200 GW of installed capacity. The logic flow is outlined here:

Assume growth from 340 MW in 2005 to 9,600MW of installed capacity by 2015.

- This capacity will use a $34 billion dollar investment.
- Jobs will grow from 20,000 in 2005 to 62,000 in 2015.
- Generally, 80% of jobs created will be in manufacturing and 20% in construction and installation.

- This report also suggests, as of 2005, that Colorado would receive an investment of $572 million dollars and the creation of 708 jobs. Due to the explosive growth in the sector just over the last three years, this figure is probably overly conservative.

Biofuel

A large majority of biofuel production and distribution to the marketplace is done by traditional energy companies. They face a continued need to hire additional workers as baby boomers retire, but detailed modeling has not been conducted for this subsector.

Overall Shortage of Workers

Because the renewable energy sector is heavily dependent on manufacturing industry, the manufacturing sector's skilled labor shortage is relevant to the renewable energy sector's ability to grow. The following table outlines some occupations distributed across the traditional and renewable energy sectors.

Overall Industry Demand	Traditional Industry Demand	Renewable Industry Demand
Electrical Power-Line Installers and Repairers	Control and valve installers	Aeronautical engineers
Mechanics, installers, and repairers	Supervisors/ Managers of construction trades and extraction workers	Architects
First and second line supervisors	Supervisors/ Managers of mechanics, installers, repairers	Materials science specialists
Plant maintenance staff	General & operations managers	Physicists
Skilled laborers	Extraction workers	Chemists and biochemists
Electrical, mechanical, and civil engineers	Maintenance and repair workers	Agricultural specialists
Construction workers and skill laborers	Meter readers, utilities	Hydrologists and hydraulic engineers
Customer service representatives	Power plant operators	HVAC contractors
Operating engineers and construction equipment operators	Roustabouts, Oil and Gas	Biologists and ecologists
	Service Operators, Oil, Gas, & Mining	Geologists, geochemists, and geophysicists
	Heavy and Tractor-Trailer Truck Drivers	Sales and marketing
		Business support services

In the renewable energy sectors specifically, here is a breakdown:

Wind Power	Solar Power	Biofuel
Meteorologists	Electrical engineers	Chemists, microbiologists, biochemists
Engineers	Material science engineers	Engineers and construction
Construction workers	Sales (retail and wholesale)	

Mechanical and electrical technicians Scientists	Electrical technicians Architects	workers Equipment operators and engineering technicians

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 (SHRM) and the American Management Association (AMA) 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 process, and they are actively willing to participate in corporate social responsibility activities within the company.[23]

This emphasis on sustainability presents an opportunity to the renewable energy sector because its core products clearly communicate value to employees seeking work related to sustainability. Renewable energy companies can leverage this desire on the part of the incoming working generation to secure top talent. Likewise, traditional energy companies are quickly deepening their investment in renewable energy sources. 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.

Job Spotlight: Materials Scientists

Chemists and materials scientists search for and use new knowledge about chemicals. Such research has led to the development of thousands of products, such as synthetic fibers, paints, adhesives, and electronic components. Chemists and materials scientists also develop processes such as improved oil refining and petrochemical processing that save energy and reduce pollution. Applications of materials science include studies of graphite materials, superconducting materials, integrated-circuit chips, and fuel cells. Research on the chemistry of living things spurs advances in medicine, agriculture, and food processing.

Materials scientists apply physics as well as chemistry to study all aspects of materials. Chemistry, however, plays an increasingly dominant role in materials science because it provides information about the structure and composition of materials.

Materials scientists study the structures and chemical properties of various materials to develop new products or enhance existing ones. They also determine ways to strengthen or combine materials or develop new materials for use in a variety of products. Materials science encompasses the natural and synthetic materials used in a wide range of products and structures, from airplanes, cars, and bridges to clothing and household goods.

A bachelor's degree in chemistry or a related discipline is the minimum educational requirement; however, research jobs require a master's degree or Ph.D. Materials scientists are increasingly expected to work on interdisciplinary teams, so some understanding of other disciplines, including business and marketing or economics, is desirable.

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

Colorado Workforce Issues

Increased collaboration among educational institutions to train future workforce

Several regions in the state have developed collaborative initiatives to train workers, drive business investment, and grow local companies. Most have secured significant private sector funding.

The Northern Colorado Economic Development Corporation, for example, formed the **Northern Colorado Workforce Initiative** that connects education and training, employers, and workers who can be transitioned into new jobs. This initiative is specifically focused on helping to grow the renewable energy sector in northern Colorado. According to the NCEDC, their region has:

- 40 clean energy businesses (29.0% increase, 2001-2006)
- Roughly 1,300 clean energy workers (in 2006)
- The 4th highest clean energy employment concentration in nation

In a further effort to support this sector, in September 2008, Colorado State University, Front Range Community College in Fort Collins, and the University of Northern Colorado and Aims Community College in Greeley created a formal, regional collaboration that reaches across counties to help train future workers. The combination of research and teaching institutions is a powerful draw for local employers, according to local press. For more information see http://www.ncedc.com/industry_workforce_initiative.html

In Denver, the University of Colorado at Boulder (CU), Colorado State University (CSU), the Colorado School of Mines (CSM) and the US Department of Energy's National Renewable Energy Laboratory (NREL) formed the **Collaboratory** in February 2007. The purpose of the collaboration is to perform research in the development of new energy technologies and to transfer these discoveries as rapidly as possible to the marketplace. The schools' ability to teach and train the needed workforce is an important component as well. The Collaboratory has formed two research centers, each with a number of private sector partners. The first center is the Colorado Center for Biorefining and Biofuels, known as C2B2. The center will develop new biofuels and biorefining technologies and transfer these advances as rapidly as possible to the private sector. The second center, known as the Center for Revolutionary Solar Photoconversion, or CRSP opened in 2008. The ultimate goal of the center is to find ways to directly convert the sun's energy to low-cost electricity and fuels through new science and technologies. More information can be found on the Colorado State University's website at http://www.newsinfo.colostate.edu/index.asp?url=news_item_display&news_item_id=567489638.

Driven by the changing policy landscape, consumer marketplace, and business trends, educational institutions traditionally focused on traditional energy sources are also implementing research centers and innovation labs related to renewable energy sources. The Colorado School of Mines has long trained future workforce for jobs in the traditional energy field. The Colorado School of Mines opened the Colorado Energy Research Institute in 2004 to focus on the issue of renewable energy. CERI conducts research and supports public/private partnerships. For more information, visit www.ceri-mines.org.

Resources

National Associations

American Solar Energy Society. Established in 1954, the Colorado-based American Solar Energy Society (ASES) is the nonprofit organization dedicated to increasing the use of solar energy, energy efficiency, and other sustainable technologies in the U.S. ASES leads national efforts to promote solar energy education, public outreach, and advocacy. ASES publishes the award-winning SOLAR TODAY magazine, organizes and presents the ASES National Solar Conference, and leads the ASES National Solar Tour – the largest solar energy event in the world. http://www.ases.org/

American Wind Energy Association. AWEA is a national trade association representing wind power project developers, equipment suppliers, services providers, parts manufacturers, utilities, researchers, and others involved in the wind industry. http://www.awea.org/

> Page on website lists all wind projects in Colorado
> http://www.awea.org/projects/Projects.aspx?s=Colorado

Clean Heat and Power Association. USCHPA brings together diverse market interests to promote the growth of clean, efficient energy in the United States. It is a private, non-profit association, formed in 1999 to promote the merits of CHP and distributed generation and achieve public policy support. http://www.uschpa.org/i4a/pages/index.cfm?pageid=1

National Biodiesel Board. The NBB is the national trade association representing the biodiesel industry as the coordinating body for research and development in the US. Founded in 1992, the NBB has developed into a comprehensive industry association, which coordinates and interacts with a broad range of cooperators including industry, government, and academia. NBB's membership is comprised of state, national, and international feedstock and feedstock processor organizations, biodiesel suppliers, fuel marketers and distributors, and technology providers. www.biodiesel.org/

Solar Energies Industry Association. The Solar Energy Industries Association (SEIA) is the leading national trade association for the solar energy industry. It works to expand markets, strengthen research and development, remove market barriers, and improve education and outreach for solar energy professionals. SEIA was founded in 1974. http://www.seia.org./

Colorado Associations

Alliance for a Sustainable Colorado. The mission of Alliance for Sustainable Colorado is to catalyze the shift to a truly sustainable world by fostering collaboration among nonprofits, businesses, governments, and academia. Alliance for Sustainable Colorado pursues sustainability through major program areas that value education, coalition building, and the promotion of sustainable policies and practices. http://www.sustainablecolorado.org/

Colorado Independent Energy Association. CIEA's members are independent power producers (IPPs) who have been an integral part of Colorado's energy industry for more than fifteen years. There are more than fifty independent power projects in Colorado that supply electricity for consumers throughout the region. http://www.ciea-colorado.org/

Colorado Solar Energy Industries Association. The Colorado Solar Energy Industries Association represents the solar industry in Colorado. Membership is comprised primarily of active, passive, and photovoltaic companies that provide both residential and commercial system products and services to consumers and businesses. CoSEIA is the Colorado state chapter of the national Solar Energy Industries Association (SEIA) , and was organized in 1989. http://www.coseia.org/newsite/index.php?id=49

Colorado Renewable Energy Society. The Colorado Renewable Energy Society (CRES) is a nonprofit membership organization that works for the sensible adoption of cost-effective energy efficiency and renewable energy technologies by Colorado businesses and consumers. It is the local chapter of the American Solar Energy Society. www.cres-energy.org

Interwest Energy Alliance. Based in Colorado, the Interwest Energy Alliance is a trade association that brings the nation's renewable energy industry together with the West's advocacy community. It has used a consensus-based, collaborative approach to market development since its inception in 2002. Together, its members support state-level public policies that harness the West's abundant –and inexhaustible– renewable energy and energy efficiency resources. Currently, the primary states of focus are Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming. http://www.interwest.org/

Centers

Colorado Energy Research Institute. The Colorado Energy Research Institute, located at the Colorado School of Mines, leverages Colorado's long tradition of energy leadership by bringing industry, government, and academic interests together to tackle challenging energy issues. Established in 2004 by state legislature. www.ceri-mines.org.

Colorado State University's Clean Energy SuperCluster. The mission of the CSU Clean Energy Supercluster is to promote an institution-wide effort to develop and disseminate market-driven clean energy solutions – on a sufficient scale to significantly reduce the accumulation of greenhouse gases that are forcing global climate change. http://www.energy.colostate.edu/

National Renewable Energy Laboratory. The National Renewable Energy Laboratory (NREL) is the nation's primary laboratory for renewable energy and energy efficiency research and development (R&D). NREL's mission and strategy are focused on advancing the US Department of Energy's and our nation's energy goals. http://www.nrel.gov/

Northern Colorado Clean Energy Cluster. The Northern Colorado Clean Energy Cluster is a business-led, project-oriented group of regional partners seeking to have a global impact. Through mass collaboration, the Cluster intends to position Northern Colorado as the "Go To" region for smart grid technologies, renewable energy and energy efficiency, and cleaner and more efficient engines. http://www.nccleanenergy.com/

Northern Colorado Economic Development Corporation. Has an extensive workforce initiative focused on renewable energy sector. http://www.ncedc.com/industry_workforce_initiative.html

US Department of Energy Efficiency and Renewable Energy, Tribal Energy Program. Information rich website with reports. http://apps1.eere.energy.gov/tribalenergy/wind.cfm

Rocky Mountain Institute. Rocky Mountain Institute® (RMI) is an independent, entrepreneurial, nonprofit organization. It fosters the efficient and restorative use of resources to make the world secure, just, prosperous, and life-sustaining. www.rmi.org

Newsletters

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Biomass Magazine. http://www.biomassmagazine.com/

Colorado Energy News. www.coloradoenergynews.com

SolarBuzz. http://www.solarbuzz.com/StatsCosts.htm

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