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ENVIRONMENTAL SCAN

WIND TURBINE TECHNICIANS

in California

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CENTERS OF EXCELLENCE

Economic & Workforce Development Program

California Community Colleges

www.coeccc.net/wind

An Initiative of ECONOMIC & WORKFORCE DEVELOPMENT through the CALIFORNIA COMMUNITY COLLEGES

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Mission: The Centers of Excellence, in partnership with business and industry, deliver regional workforce resea
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Vision: We aspire to be the premier source of regional economic and workforce information and insight
community colleges.

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Contents

California wind employers will collectively need as many as 880 Wind Turbine Technicians to maintain and service both the existing and planned 13,154 wind turbines throughout the state. Community colleges should respond in a coordinated and measured manner to the industry's workforce needs.

– Centers of Excellence

Executive Summary

Wind power is attractive because it is a widely available and renewable source of energy that produces neither pollution nor climate-changing greenhouse gases. As new "smart" wind turbines are becoming more efficient in capturing the energy of the wind, turbines are becoming more complex. The rapidly increasing sophistication of these turbines coincides with a lack of industry professionals who possess the skills required to operate and maintain them. There are over 25,000 wind turbines in the United States, while there are approximately two dozen educational institutions presently training wind turbine technicians. Given the current and anticipated future growth of the wind energy industry, opportunities may exist for select colleges to develop programs to train these technicians.

The U.S. Department of Energy has set a national goal for 20% of the nation's electricity to be wind produced by 2030. Currently, the output for wind energy is 1.8% of the nation's total. So far this decade, cumulative wind power capacity has grown an average of 27% per year in the United States. In California, the gap between the energy used and what the state produces grows larger every year. However, new utility transmission lines must be installed throughout California prior to expanding wind energy sources and fully taking advantage of federal incentives.

Not all locations in California are suitable for wind power generation. There are distinct areas, such as the San Francisco Bay Area, the Central Region and Inland Empire, which provide the proper conditions for consistent and sufficiently powerful winds. Issues limiting the establishment of wind farms may include the availability of transmission lines, environmental impacts, force of winds, military airspace restrictions, public support/approval, and wind consistency.

Industry employers indicate that there is a need to train wind turbine technicians to install, inspect, troubleshoot and repair wind turbines and their internal and external components. However, not all positions within the industry are alike. Some wind turbine technicians perform basic service and maintenance for multiple farms; some remain on-site permanently at a given project; and others travel nationally for special service/repairs. Although operations and maintenance firms do account for most of the ongoing jobs in the wind energy industry, most wind farms in California outsource wind turbine technicians, to firms based outside California. Very few wind farms in California have full-time technical staff to maintain turbines.

Employers throughout California and the nation indicate that a strong training base is critical for employees in the wind energy industry, particularly for wind turbine technicians. However, **there is no nationally accepted standard for wind turbine technician training to date**. While the community college system is, in theory, capable of providing training for wind turbine technicians, not all colleges are ideally positioned to take advantage of this opportunity. Challenges to implementing programs may include proximity to sites where employment exists, access to equipment used in the industry, availability of skilled instructors and significant costs to outfit training facilities.

California's future wind industry may require anywhere between 265 – 832 technicians in total, depending upon a number of variables and the calculation method used (per megawatt or per turbine). The wind industry is very difficult to quantify regardless of the method used. There is a slow growing demand that warrants a well planned community college response even in the best case scenario. Even with a high percentage growth, the statewide need is relatively small in its absolute size and a conservative approach to curriculum development is recommended. **The key question that needs to be addressed by colleges is**

whether the number of programs established within the California Community College system should only satisfy California's workforce needs, or if the capacity to provide trained technicians should exceed statewide demand, thus providing a skilled workforce for the industry nationwide.

While an opportunity exists within defined regions of California to develop wind turbine technician programs, colleges should carefully evaluate business circumstances and trends within their local labor market area to determine the precise needs for training. The three main variables to consider in determining if a given college should respond to this opportunity are: 1) a given college's proximity to California's natural wind resources, and thus where wind farms are located, 2) colleges with existing related programs to train wind technicians, and 3) assessing the college's local need within their service area based on employer data in this report and additional outreach and information gathering from local companies. If a college does decide to offer wind technician training courses or programs, they should consider delivering the 208 hour Advanced Transportation, Technology and Energy (ATTE) curriculum in a contract education format or look for opportunities to build upon existing industrial technology programs.

Introduction

The California Community Colleges Economic and Workforce Development Program (EWD) has charged the Centers of Excellence (COE) with identifying industries and occupations that have unmet employee development needs (see Appendix A for additional information). Increasing energy and commodity costs, as well as heightened consumer demand for a more sustainable environment, have all led to a substantial push for a "green economy" and additional green training programs. Technician level training in renewable energies, such as solar and wind, are appropriate for community colleges and have recently received considerable attention. For these reasons, the Centers of Excellence decided to study the wind energy industry from a community college perspective.

Wind energy is one of the cleanest and most environmentally neutral energy sources in the world today. Wind power is attractive because it is a widely available and a renewable source of energy. Once the turbines have been installed, the only "fuel" they need is the wind. Compared to conventional fossil fuel energy sources, wind energy generation does not degrade the quality of air and water and can make important contributions to reducing climate change effects and meeting national energy security goals.[1]

The wind power industry in the U.S. has grown dramatically in recent years, and the rapid pace of development has made it difficult to keep up with trends in the marketplace. So far this decade, cumulative wind power capacity has increased an average of 27% per year, with no sign of slowing. The need for timely, objective information on the wind industry and its workforce needs have never been greater.

The intent of this report is to provide community colleges with available data and insight into the short- and long-term occupational outlook for the wind industry. In addition, the report provides recommendations for colleges interested in exploring opportunities that may exist within the local labor market to develop and implement training programs for wind turbine technicians.

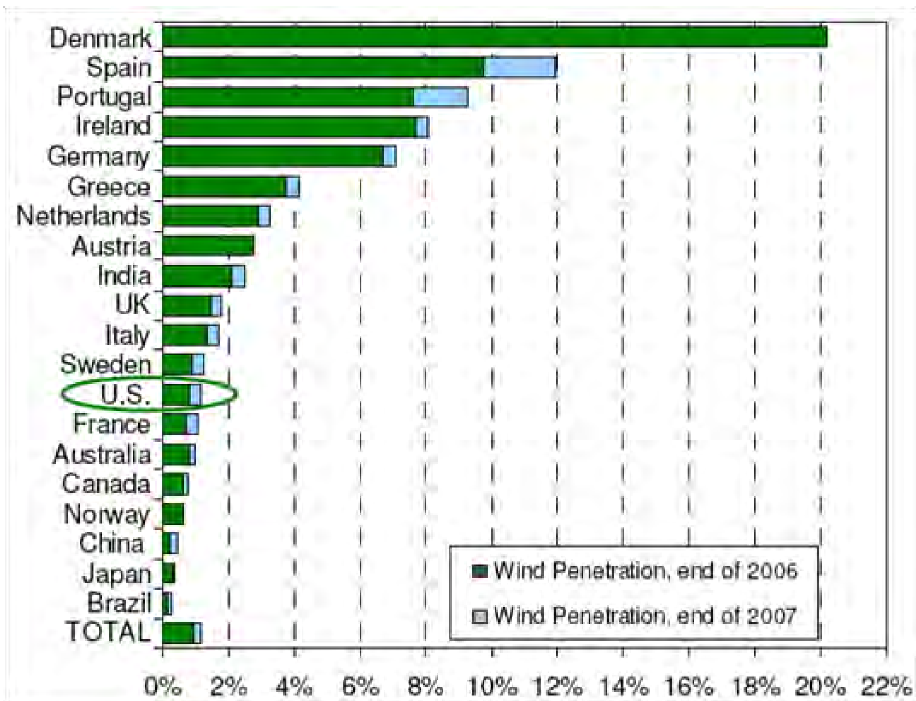
[1] "20% Wind Energy by 2030," U.S. Department of Energy

Industry Overview

National Outlook

Although wind generates only about 1% of all electricity globally, it provides a respectable portion in several European countries: 20% in Denmark, 10% in Spain and about 7% in Germany.

Figure 1: Projected Wind Generation as Percentage of Electricity Consumption
Source: Berkeley Lab estimate based on data from BTM Consult

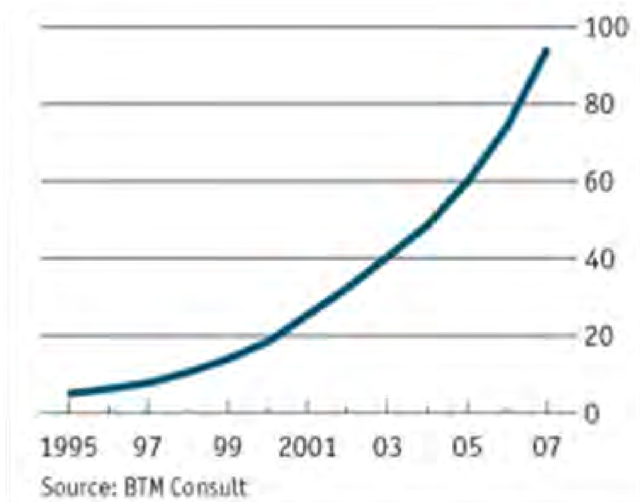


Wind power is also on the rise in the United States, where capacity jumped by 45% in 2007 to reach nearly 17 gigawatts (GW) in December 2007. This growth translates into roughly $9 billion (real 2007 dollars) invested in wind project installation in 2007. No other country, in any single year, has added the volume of wind capacity that was added to the U.S. electrical grid in 2007.[2] Furthermore, the U.S. went from 16,818 MW on December 31, 2007 to 22,613 MW of installed wind capacity on September 30, 2008. That is a national increase of 34.4% installed wind capacity in just nine months. As a result, even though the percentage is smaller, last year the U.S. surpassed Germany as the world's leading wind-powered nation with more than 25,000 megawatts in place.[3] However, some argue that Germany's 23,000 MW is far superior on both a per capita basis and per acreage.[4]

In fact, the United States has recently added more than 15,000 megawatts of wind energy for a cumulative total of 28,206 megawatts of power, nationwide.[5] For three years in a row, wind power was second to natural gas in new capacity added. The U.S. Department of Energy aims for 20% of U.S. electricity to be wind produced by 2030. Currently, the output for wind energy is 1.8% of the nation's total. As indicated in Figure 2, so far this decade, cumulative wind power capacity has grown an average of 27% per year in the United States with no sign of slowing.

[2] "20% Wind Energy by 2030," U.S. Department of Energy
[3] Dickerson, M. (March 1, 2009). "Jobs with a Rush," *Los Angeles Times*, pg. A1.
[4] Hill, Joshua (August, 2008). "U.S. Kind of a World Leader in Wind Power Generation," Cleantechnia.com.
[5] American Wind Energy Association. April 28, 2009 Press Release.

Figure 2: World wind power, MW installed, '000



Although inconsistent, wind power is rather predictable. Wind availability can now be forecast over a 24-hour period with a reasonable degree of accuracy, making it possible to schedule wind power, much like conventional power sources. But, like the sun, wind power is not always available and grid operators must ensure that reserve sources are stored and made available when the wind slows.

National Growth Potential

Wind turbines give utilities an attractive energy solution with minimal environmental impact. However, in order to achieve 20% of the nation's electricity from wind, the wind industry requires a major increase in wind power installations. In fact, the installation rate would need to be approximately 16,000 megawatts (MW) of new wind capacity each year by 2018, and continue through 2030, to reach this ambitious goal.[6] Approximately 80% of the wind capacity needed to achieve the 20% (300 GTW) scenario is already in interconnection queues nationwide, but policy enhancements and available funding are required to complete these projects.[7]

One barometer of national growth of the wind industry, albeit anecdotal, is the increased involvement in the American Wind Energy Association (AWEA). The organization has grown from having 200 business members in 2001 to 1,700 business members in 2008. At the April 2009 Wind Power conference in Chicago, AWEA had more than 800 exhibitors filling over 185,000 square feet of space.

Factors Influencing the Industry

National Legislation

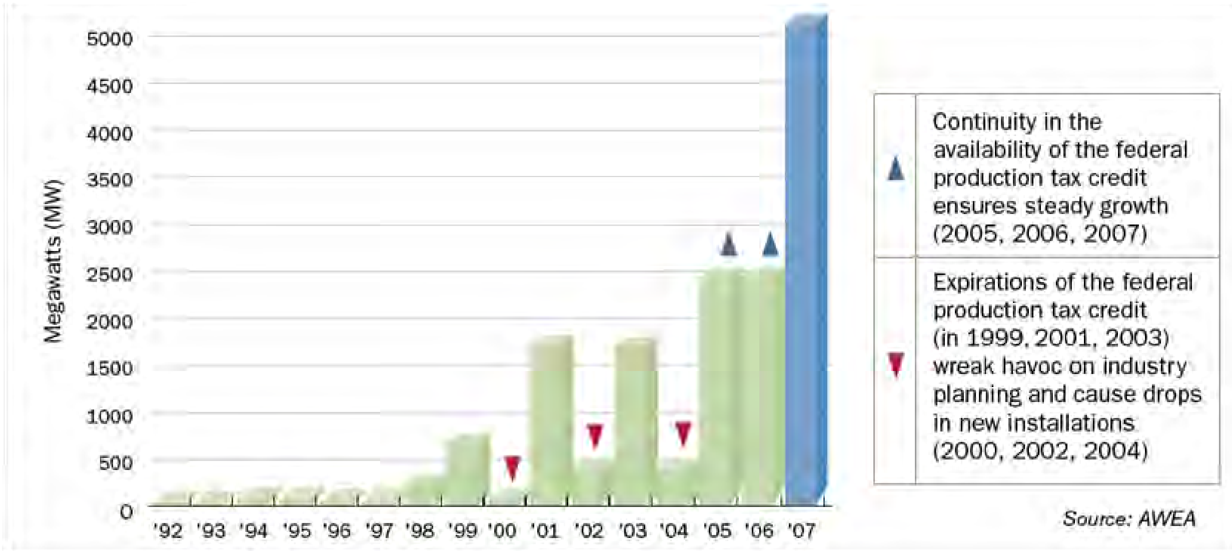
The wind production tax credit (PTC) was initially enacted to promote renewable energy development. However, this legislative incentive has not always been funded, and, when it has lapsed, the nation has seen a direct correlation in the decline of wind energy development. In 2000, 2002, and 2004 the PTC credit was not renewed and America's annual wind capacity additions dropped dramatically (by 90%, 76%, and 77% respectively).[8]

Unstable federal policy (that is, the expiration and extension cycles of the federal production tax credit, the primary incentive for wind power today) has led to costly boom and bust cycles for the industry (especially

[6] "Electrical Components for the Wind Industry," American Wind Energy Association (AWEA).
[7] Ryan Wiser, Lawrence Berkeley National Laboratory (LBNL), AWEA 2008 WindPower Conference, Houston TX.
[8] American Wind Energy Association (AWEA) and Lawrence Berkeley National Laboratory (LBNL).

between 2000-2005). Conversely, consistent availability of the PTC dramatically spurs growth (e.g. 2005 - 2007) and, along with it, thousands of new jobs and billions of dollars in new investment.

Figure 3: The Production Tax Credit (PTC) Creates Boom and Bust Cycles in the US Wind Industry



The recent extension of the wind production tax credit, which expires December 31, 2012, has accelerated plans for wind farm construction and small (residential) turbine sales nationwide.

According to *The Economist*, the cost of generating electricity from wind power has fallen from as much as 30 cents per kilowatt hour in the early 1980s to around ten cents in 2007.[9] Various incentives, in the form of tax credits and feed-in tariffs, mean that wind power is already cost-competitive with electricity derived from natural gas and even coal in many markets.

"20% Wind Energy by 2030" Report

In 2006, President Bush emphasized the nation's need for greater energy efficiency and a more diversified energy portfolio. This led to a collaborative effort of government and industry to explore a modeled energy scenario in which wind provides 20% of U.S. electricity by 2030. Subsequently, the U.S. Department of Energy released the "20% Wind Energy by 2030" Report in May 2008. This report provides clarity regarding how much wind power can contribute to the U.S. energy economy and the obstacles that need to be addressed. It quantifies costs and benefits associated with wind power, addresses America's manufacturing capacity and environmental impacts, and serves as a strategic plan for the renewable energy sector in America. Figure 4 illustrates the "20%" vision.

The report establishes an ambitious goal, requiring approximately 20% growth in national wind capacity year-over-year from now until 2018.[10] However, given the nation's aforementioned growth over the last few years, 20% by 2030 is obtainable. The capital investment needed to meet this goals is more than a half trillion dollars; including $60 billion in additional grid extension.

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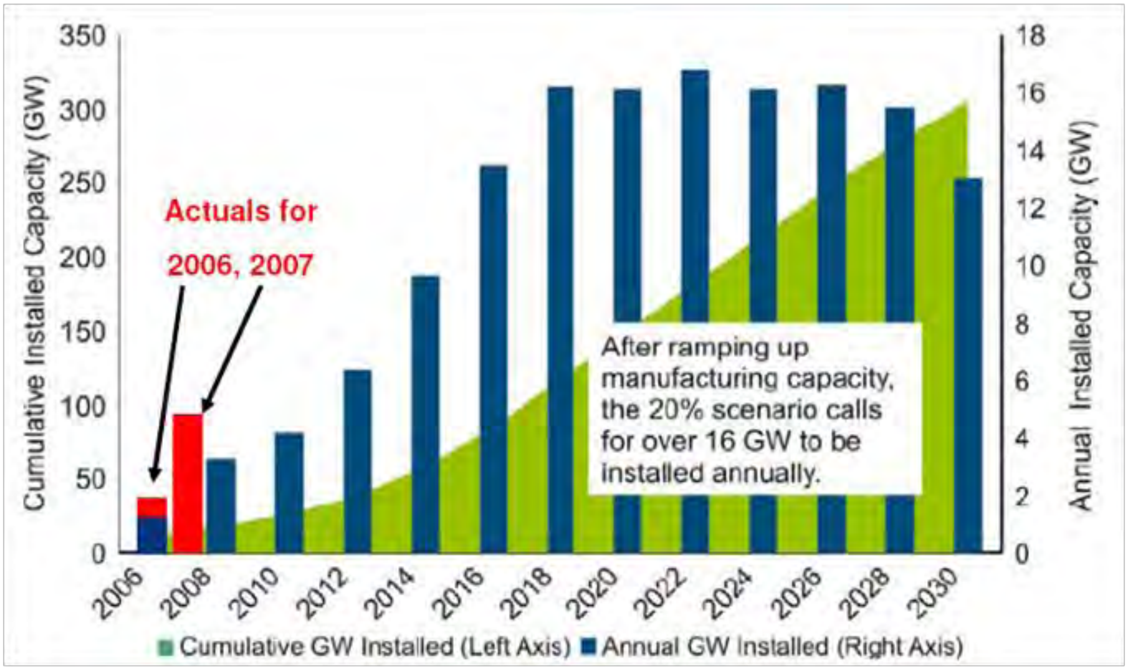
[9] "Wind of Change," *The Economist*, Case History (December 4, 2008).

[10] Paul Veers, Wind Energy Technology Department, Sandia National Laboratories, November 2008.

Figure 4: 20% Vision Growth Path for Wind



Transmission

One major challenge in developing wind farms and expanding the industry is that most people do not live where the wind blows and the wind power from these remote locations has to be delivered to urban areas. For wind to continue its remarkable expansion, the industry will need to build new transmission lines and improve the integration of wind power into the grid. Nationally, over 300,000 MW of wind energy is lined up in interconnection queues, but only 33,000 MW of transmission capacity is planned to come on line in next five years.[11] Employers cite the lack of transmission lines as the number one problem facing the industry.[12]

There are two separate and distinct power system challenges to obtaining 20% of U.S. electric energy from wind. One challenge lies in reliably balancing electrical generation and load over time with a large portion of energy coming from a variable power source such as wind, which, unlike many traditional power sources, cannot be accessed on demand or is "non-dispatchable." The other challenge is to plan, build, and pay for the new transmission facilities that will be required to access remote wind resources.[13]

Development of 293 GW of new wind capacity would require expanding the U.S. transmission grid in a manner that not only accesses the best wind resource regions of the country but also relieves current congestion on the grid including new transmission lines to deliver wind power to electricity consumers. Transmission options are based on a variety of factors. The cost of using existing transmission compared with new transmission can shift the relative amounts significantly.[14]

The press has helped to popularize the concept of a transcontinental grid, analogous to the national interstate highway system, that would supply power to the market at all times capturing wind from different locations when it blows. Given that parts of the existing infrastructure are extremely vulnerable to load variations as well, a "smart grid" is necessary that would constantly monitor its load and take particular

[11] Randy Swisher, AWEA 2008 Fall Symposium, Palm Springs CA.
[12] AWEA 2008 SondPower Conference. Wind industry survey, Houston TX.
[13] "20% Wind Energy by 2030," U.S. Department of Energy.
[14] Ibid.

consumers off-line during peaks, with their prior agreement and in exchange for a lower price.[15] A smart, transcontinental grid system would reduce spikes in demand, and allow an increased reliance on wind power without blackouts.

Policymakers are calling for the industry to look at new sources for energies and technologies. However, many of these new sources and technologies are not possible without a robust transmission grid and consistent policies for reliable tax credits/incentives.

Future Trends

A number of trends are driving growth in the wind industry. Both current and new trends will be pivotal to understanding how quickly the wind industry will grow and develop in California. See Appendix B for more information on the following future trends:

- Size of Turbines
- Smart Turbines
- New manufacturing concepts
- Residential/Small Wind
- "Wind Energizer"
- Off-Shore Wind

Most future trends are related to advances in wind turbine technology, blade design, and efficiently converting wind to energy. Appendix C provides additional information regarding wind turbine technology.

California Outlook

The first wind farms appeared in California in the early 1980s, beneficiaries of generous tax credits. In a few short years, California installed more than 1.2 GW of wind power; almost 90% of global capacity at the time.[16] However, when the tax credits expired in the 1980s, the wind industry came to a grinding halt.

The gap between the energy California uses and what it produces grows larger every year. California produces 16% of the natural gas it uses, 78% of the electricity, and 42% of the petroleum. The Bureau of Land Management is attempting to address these issues by using renewable energy sources such as wind, geothermal, solar and biomass, as well as traditional energy sources like oil and gas. As California strives to maintain a healthier environment, wind energy is once again becoming a major player in the renewable energy arena.

Wind Sources

Not all locations in California are suitable for wind power generation (see the Wind Power Map in Appendix D). There are distinct regions that provide the proper conditions for consistent and sufficiently powerful winds. Issues related to placing wind farms, or individual turbines, in regions throughout California include: transmission lines, environmental impacts, force of winds, military airspace restrictions, public support/approval, and wind consistency. Within the areas that provide suitable conditions, many wind farms are in development. According to the May 2009 California Renewable Energy Summary Statistics, 92 applications for wind turbine installations have been received, primarily located in these areas of high wind concentration, totaling 788,840 acres of land.[17]

[15] "Trade Winds," *The Economist* (June 19, 2008).
[16] "Wind of Change," *The Economist*, Case History (December 4, 2008).
[17] U.S. Bureau of Land Management, www.blm.gov

Factors Influencing the Industry

Among the 50 states, California is third in wind turbine capacity (after Texas and Iowa). There are a great number of turbines throughout the state that require maintenance, a significant number of which are many years old. Currently, California receives 2.6% of its total energy from wind. California aims to get 20 percent of its power from solar, wind and other renewable sources by 2010. The largest barrier to the wind industry's growth in California is that the transmission system is in need of an upgrade. When $1.8 billion in transmission upgrades are completed in the Tehachapi Mountains in a few years, California's wind capacity will potentially more than double. Other factors influencing the industry in California include:

- Wind resources: Wind is available in isolated areas (Tehachapi, Altamont, Palm Springs)
- Centralized development to offset fossil fuels: This requires major road developments and public land.
- Decentralized project permitting: No consistent method or standard of permitting wind projects exists; it varies from county to county. Currently, it takes an average of four years to permit a wind development project in California.
- Transmission lines: There is a significant need for more transmission lines and overall energy infrastructure (grids, energy storage).
- "Not in my backyard" attitude: Many residents and business owners do not want wind turbines or new transmission lines in close proximity to residential areas.
- Economy: Finance trends in the wind industry have significantly changed in the past 18 months. In 2007, there were 17 tax equity investors in the industry. By January 2009, there were four.

Industry Size and Economic Impact

While California is third in wind turbine capacity, many of the new Wind Turbines nationwide **will not** be located in California, according to the American Wind Energy Association.[18] This is because California is ranked 17th in the nation for its wind resources. Presently, California has 2,653 MW in developed wind capacity with an additional 1,347 MW proposed or in development.[19] Pages 12-18 provide regional industry totals for wind capacity (both existing and in development) for the Bay Area, Central Region, and Inland Empire. Pages 22-23 provide labor market projections given this capacity.

Wind energy development and operation has an economic multiplier effect consisting of new direct, indirect and induced jobs created. According to the National Renewable Energy Laboratory, a $30 million investment in a wind plant in California will yield 64 direct, indirect, and induced jobs.[20] On a national scale, every billion dollars invested in wind farms creates some 3,350 jobs — nearly four times the 870 jobs created with a similar investment in coal-fired power plants.[21]

The manufacturing of wind turbine components also carries a significant economic impact, creating direct and indirect jobs for each MW of installed capacity.[22] The Renewable Energy Policy Project (REPP) completed a thorough report in 2004 entitled "Wind Turbine Development: Location of Manufacturing Activity."[23] This report identifies twenty primary components necessary to manufacture a complete turbine as well as the location of U.S. wind manufacturing industry locations. The study found that California is ranked #1 in current wind turbine component manufacturing employing 102,255 employees. California was also ranked #1 in **job creation potential** and in **investment potential** in the REPP report.

However, at the 2008 AWEA Wind Power Conference, representatives from Suzlon Wind Energy Corporation indicated that Ohio, Michigan and Texas now outpace California as potential wind component

[18] Source: High Winds Energy Center, FPLEnergy.com
[19] AWEA U.S. Wind Energy Projects – California (as of 03/31/09) and Industrial Information Resources' Wind Map.
[20] Marguerite Kelly, National Renewable Energy Laboratory, June 2007 presentation.
[21] Data retrieved online from: www.earthpolicy.org/Updates/2008/Update80_data.htm
[22] Danish Wind Manufacturers Association, 5 jobs/MW (installation) and 17 jobs/MW (manufacturing-related).
[23] Complete report available online at: www.repp.org/articles/static/1/binaries/WindLocator.pdf

manufacturers due to wind support/policy, business climate, and manufacturing job trends. Irrespective of its ranking, California maintains a significant capacity with regard to manufacturing wind turbine equipment.

State Legislation

While some federal legislation strongly supports the development of wind energy in California, there is some concern that federal incentives and Recovery Act funds are not aligned with statewide development. Current federal funding and various incentives are available through 2013.[24] Yet in California, new utility transmission lines must be installed prior to expanding wind energy sources and fully taking advantage of federal incentives. The installation of these transmission lines will take several years and will delay any planned expansion of wind energy resources beyond 2013.

In California, several state initiatives do support the development and expansion of renewable energy or wind energy specifically. Such initiatives, legislation and goals provide incentives for both utility-scale wind and small wind. Two such influential pieces of legislation include the California Global Warming Solutions Act of 2006 and California Executive Order S-14-08.

The California Global Warming Solutions Act of 2006

Assembly Bill 32 (AB32), the California Global Warming Solutions Act of 2006, mandates that California reduce its green house emissions to 1990 levels by 2020. The bill sets a goal of approximately an 11 percent reduction from current emissions levels and nearly a 30 percent reduction from projected business-as-usual levels in 2020. Twenty-five percent (25%) of the state's greenhouse gas emissions are attributable to electricity generation while 38 percent is attributed to the transportation sector.[25]

California Executive Order S-14-08

On November 17, 2008, this order established a Renewable Portfolio Standard for California mandating that all retail sellers of electricity serve 33% of their load with renewable energy by 2020. State agencies are directed to take all appropriate actions to implement this target in all regulatory proceedings, including siting, permitting, and procurement for renewable energy power plants and transmission lines.[26] Section 16 of the order states, "In order to facilitate the timely permitting of renewable energy projects, all state regulatory agencies shall give priority to renewable energy projects as set forth in this Executive Order."

Regional Overview

This Center of Excellence statewide study encompasses California's three largest wind generation region: the San Francisco Bay Area, the Central Region and Southern California's Inland Empire. The following pages provide an overview of the wind energy industry within each region.

San Francisco Bay Area

Number of Existing Wind Farms: 28
Number of Existing Wind Turbines: 5,730[27]
Wind Capacity of Existing Wind Farms: 1,169 MW

Number of Wind Farms in Development: n/a
Wind Capacity of Wind Farms in Development: n/a

Overview

The San Francisco Bay Area has two regions where wind is plentiful and suitable for wind energy development. The first is the Altamont Pass, located east of San Francisco in Alameda County. The second is Solano County,

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[24] Source: Sageview Associates, Inc.
[25] Source: www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf
[26] Source: http://gov.ca.gov/index.php?/press-release/11073
[27] California Wind Energy Association, www.calwea.org

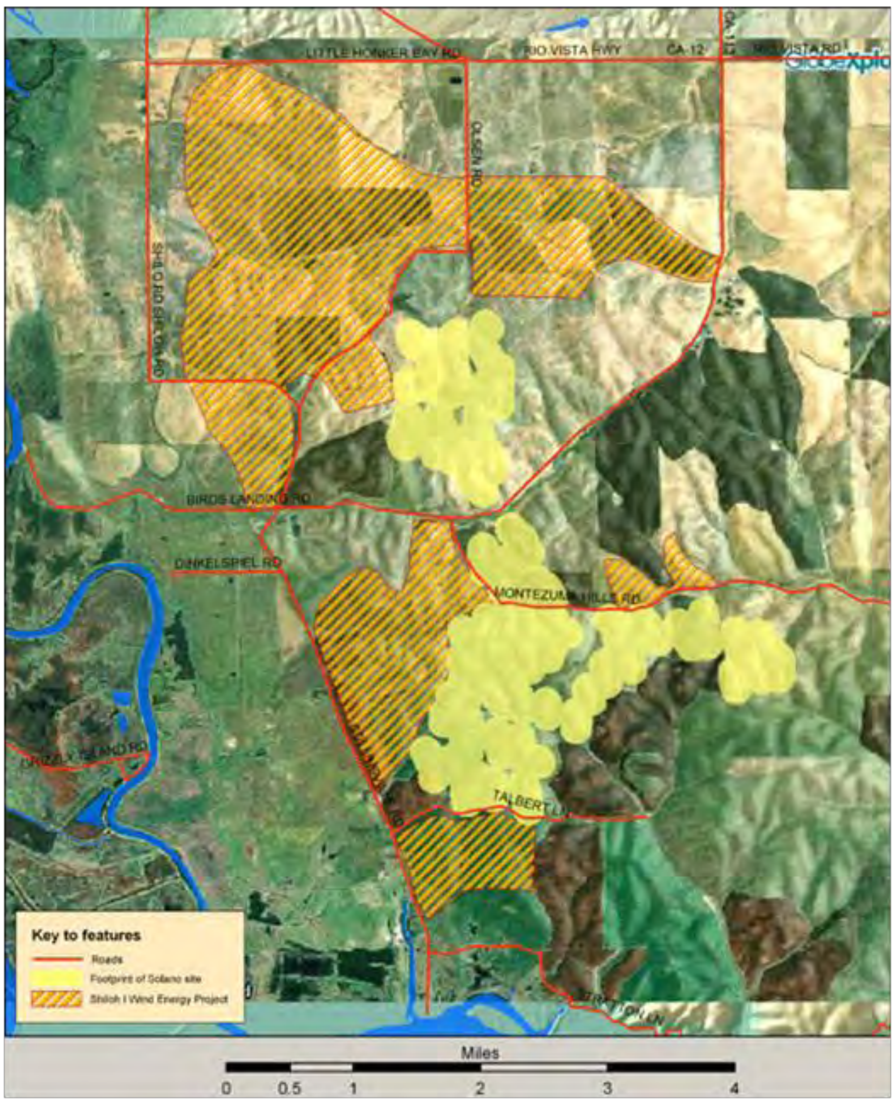
just north and east of San Francisco. Both areas are among the windiest places in Northern California and suitable for wind energy development due to steady winds.

Regional Trends/Issues

The first wind energy facility in the Altamont Pass was built in 1985. The eleven wind farms in this area produce just over 400 MW of power. Nine of the eleven wind farms in the Altamont Pass have older turbines that produce on average, 0.1 MW, yield smaller energy returns, and require additional maintenance. As individual wind turbines become obsolete and are replaced, 6 to 12 of the older turbines can be replaced by one of the new generation 1,000 kilowatt per hour turbines.

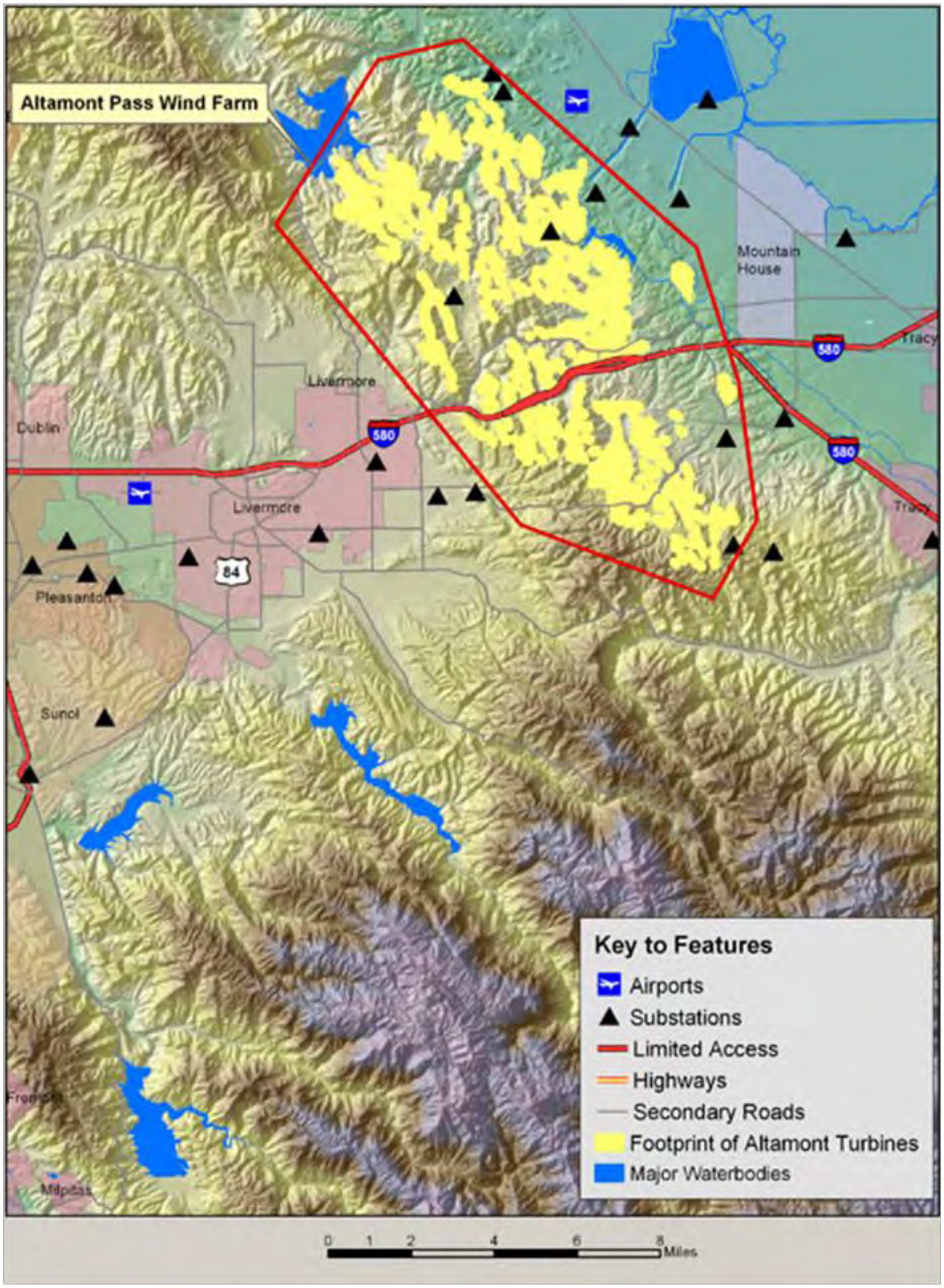
The first wind energy facility in the Solano County wind region was built in 1985. The nine wind farms in the Solano area produce 625 MW of power. Solano has experienced greater wind farm development in recent years, with 564 MW of capacity being added since 2003, which represents 90% of the area's wind generation. Eight of the nine wind farms in the Solano area have newer turbines that, on average, can produce 1.8 MW per turbine.[28]

Solano Wind Farm



[28] Maps provided by: Lawrence Livermore National Laboratory, https://eed.llnl.gov/renewable

Location of the Altamont Wind Farm



A complete list of wind energy farms in the Altamont Pass and Solano areas is provided in Appendix E.

Central Region

Number of Existing Wind Farms: 41
Number of Existing Wind Turbines: 3,431[29]
Wind Capacity of Existing Wind Farms: 742.25 MW

Number of Wind Farms in Development: 1
Wind Capacity of Wind Farms in Development: 120 MW

Overview

The Central Valley Region is home to the Tehachapi Pass, one of California's largest wind farms generating electricity. The turbines have been in place since the 1980s and have been upgraded through the years. The original wind turbines were much smaller than the much taller and larger new version turbines now sited for use. In Tehachapi, California, the wind blows more from April through October than it does in the winter.[30]

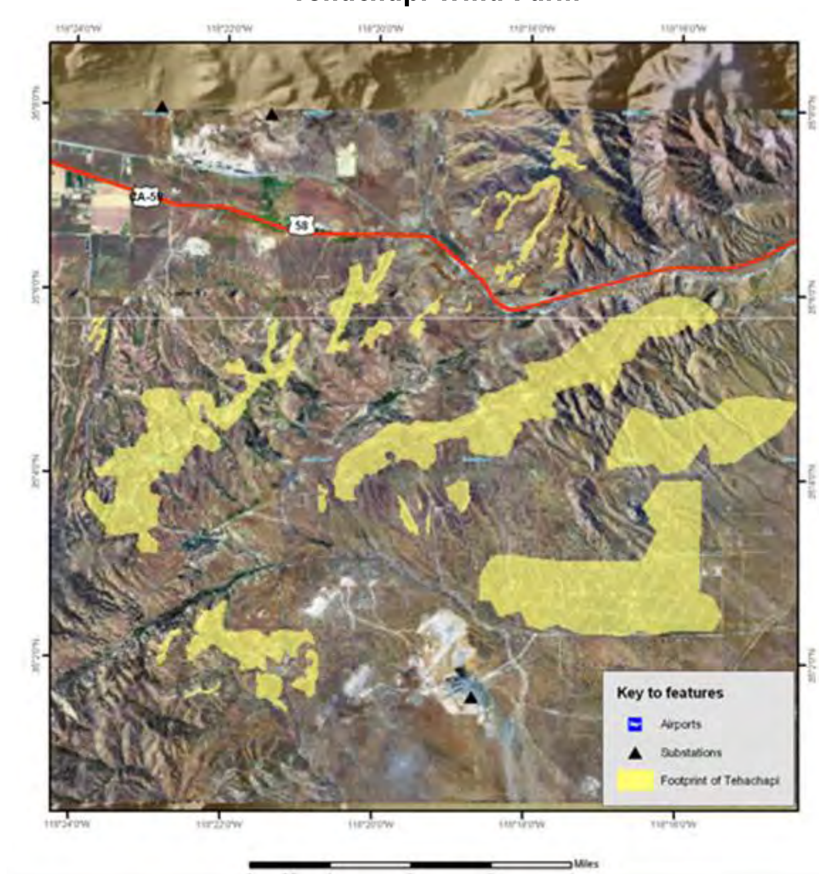
Regional Trends/Issues

Southern California Edison is working on a project that provides 1,500 megawatts (MW) or more of power generated from new projects to be built in the Tehachapi area. The 2006 contract, which more than doubles SCE's wind energy portfolio, envisions more than 50 square miles (130 km2) of wind parks in the Tehachapi region, which is triple the size of any existing U.S. wind farm.[31]

In the Central Region, much of the wind energy production is transferred to Southern California. Wind farms in the Tehachapi and Mojave areas are ready to expand, but face constrictions due to the lack of capacity in transmission lines. Once an additional transmission line is installed that will allow for the transfer of energy to Southern California, additional turbines will be added.[32]

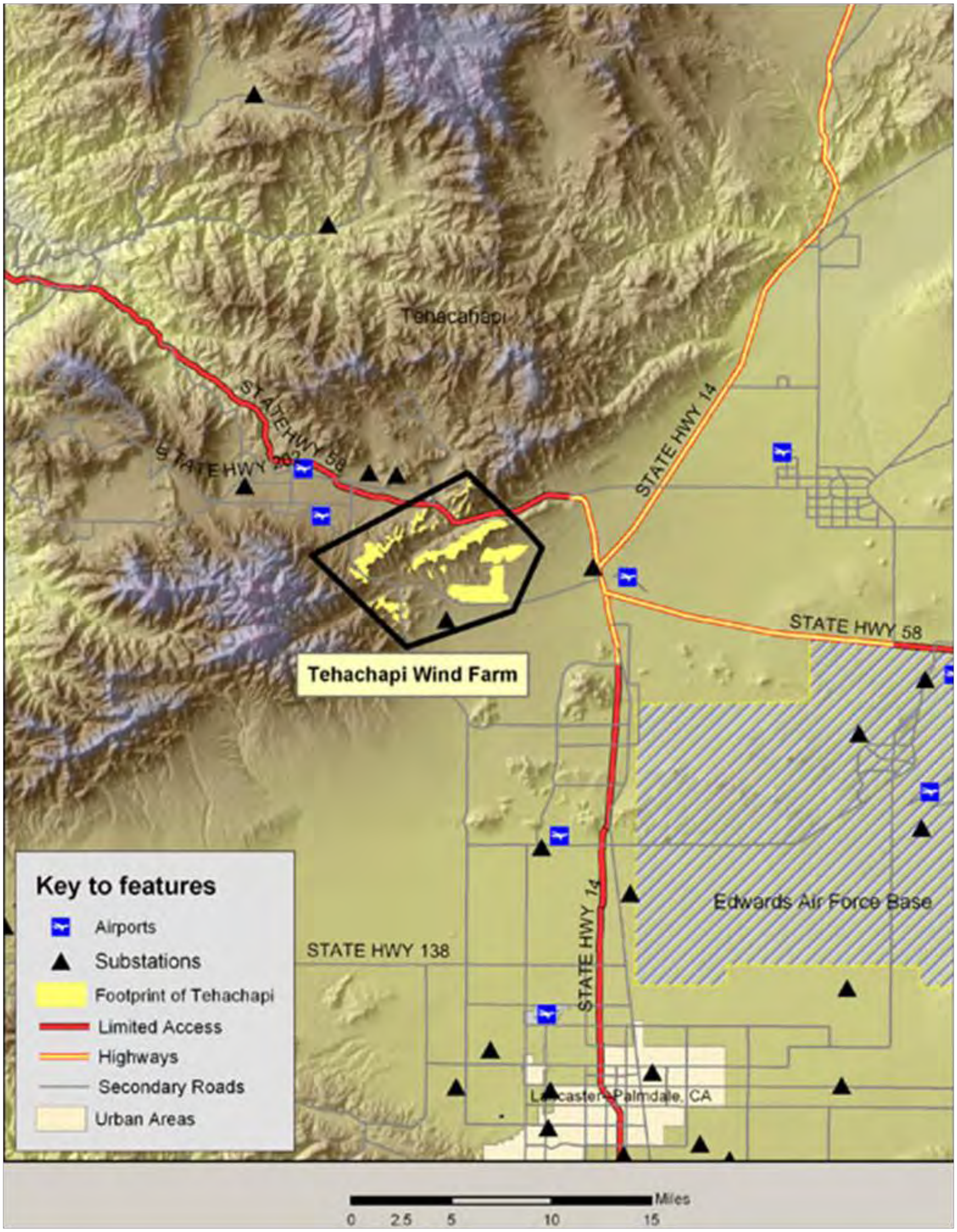
A complete list of wind energy farms in Central California is provided in Appendix E.

Tehachapi Wind Farm



[29] California Wind Energy Association, www.calwea.org
[30] Source: Department of Energy, www.eia.doe.gov/kids/energyfacts/sources/renewable/wind.html
[31] Southern California Edison, www.edison.com/pressroom/pr.asp?id=6487
[32] Source of Maps: Lawrence Livermore National Laboratory, https://eed.llnl.gov/renewable/

Location of the Tehachapi Wind Farm



Inland Empire

Number of Existing Wind Farms: 43
Number of Existing Wind Turbines: 3,210[33]
Wind Capacity of Existing Wind Farms: 670 MW

Number of Wind Farms in Development: 2
Wind Capacity of Wind Farms in Development: 45 MW

Overview

The San Gorgonio Pass, located just east of White Water in Riverside County, is one of the windiest places in Southern California. This area is very suitable for wind energy development due to steady westerly winds that are funneled between the San Jacinto and San Bernardino Mountain Ranges. The best season for these winds is from the middle of April through the end of October.

According to the U.S. Bureau of Land Management, 5,487 acres of land in this area are determined to be suitable for wind energy development. Of these lands, 2,300 acres of private and 3,187 acres of BLM administered public lands are presently developed for wind energy production.

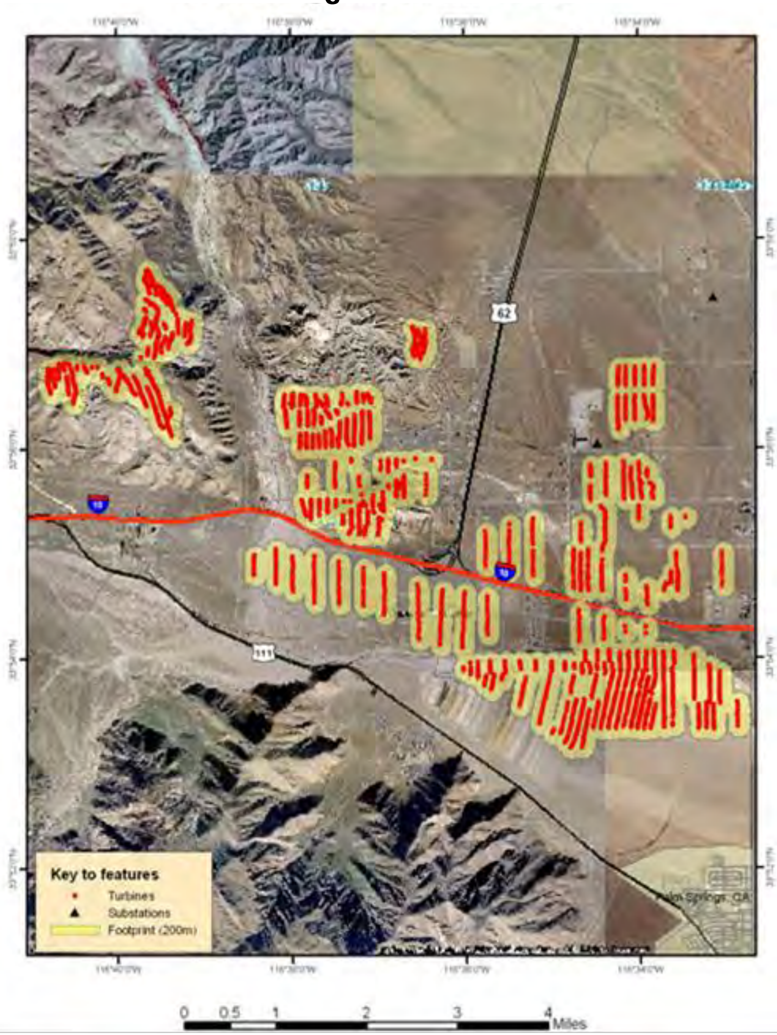
Regional Trends/Issues

The first wind energy facility in the area was built in Palm Springs in 1981. Many of the turbines presently in use are more than 20 years old, yield smaller energy returns, and require additional maintenance.

As individual wind turbines become obsolete and are replaced, as many as a dozen of the older turbines can be replaced by one of the new generation 1,000 kilowatt per hour turbines. Over time, the 2,675 wind turbines presently on these public lands are expected to substantially decrease in number as they are replaced by a smaller number of larger machines.[34]

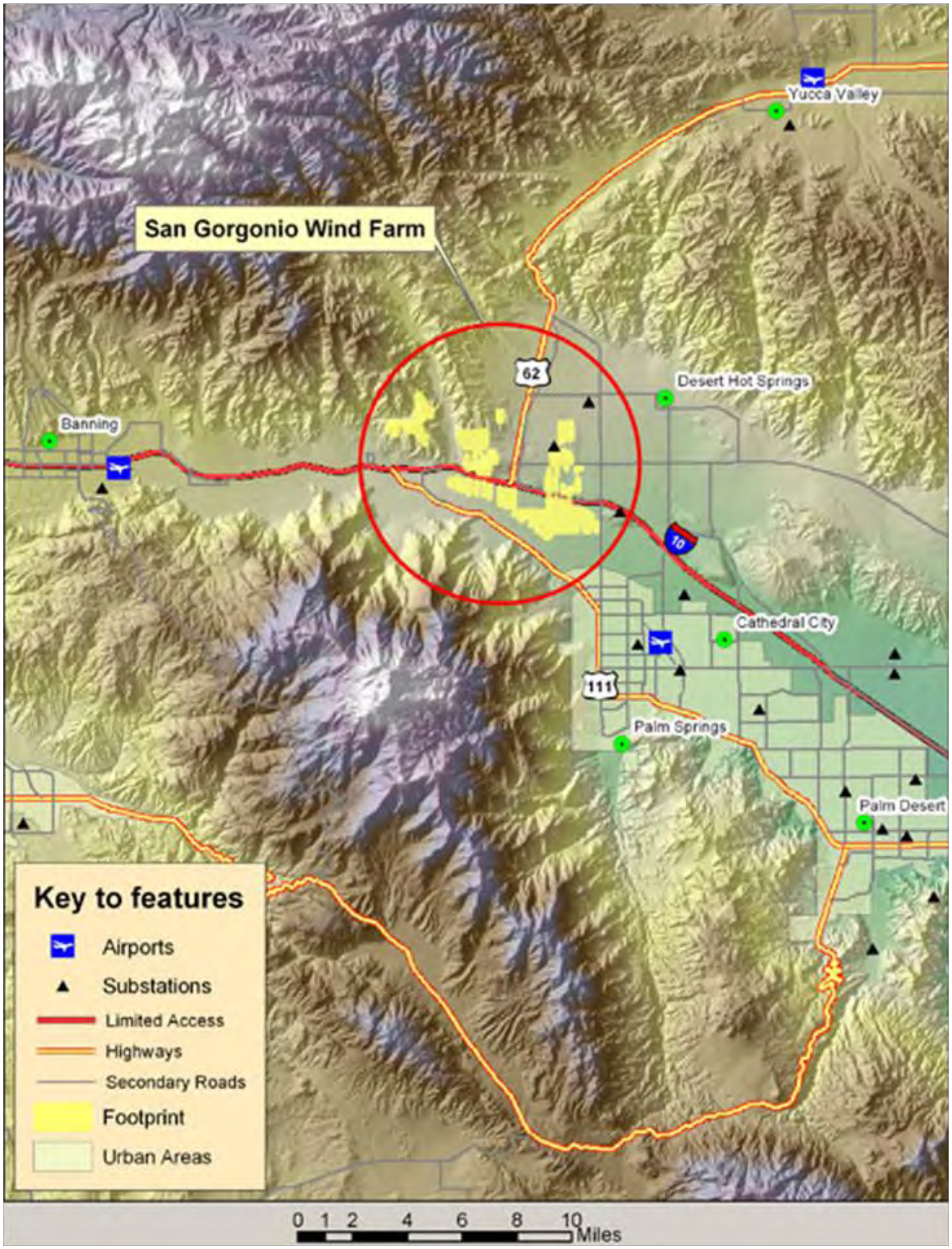
A complete list of wind energy farms in the San Gorgonio Pass is provided in Appendix E.

San Gorgonio Wind Farm



[33] American Wind Energy Association, U.S. Wind Energy Projects (as of 03/31/09).
[34] Source of Maps: Lawrence Livermore National Laboratory, https://eed.llnl.gov/renewable/

Location of the San Gorgonio Wind Farm



Occupational Overview

Overview of Wind Energy Related Occupations

The wind energy industry is comprised of several occupations that can be categorized into five occupation sectors: Manufacturing, construction, operations and maintenance, utilities, and finance/development. Table 1 provides examples of common wind industry job titles for each sector. In California, there are 52 existing wind farms (see Appendix E for a complete list wind farm projects), with more under development; each of which will require a skilled workforce.

Table 1: Wind Industry Sectors and Job Titles[35]

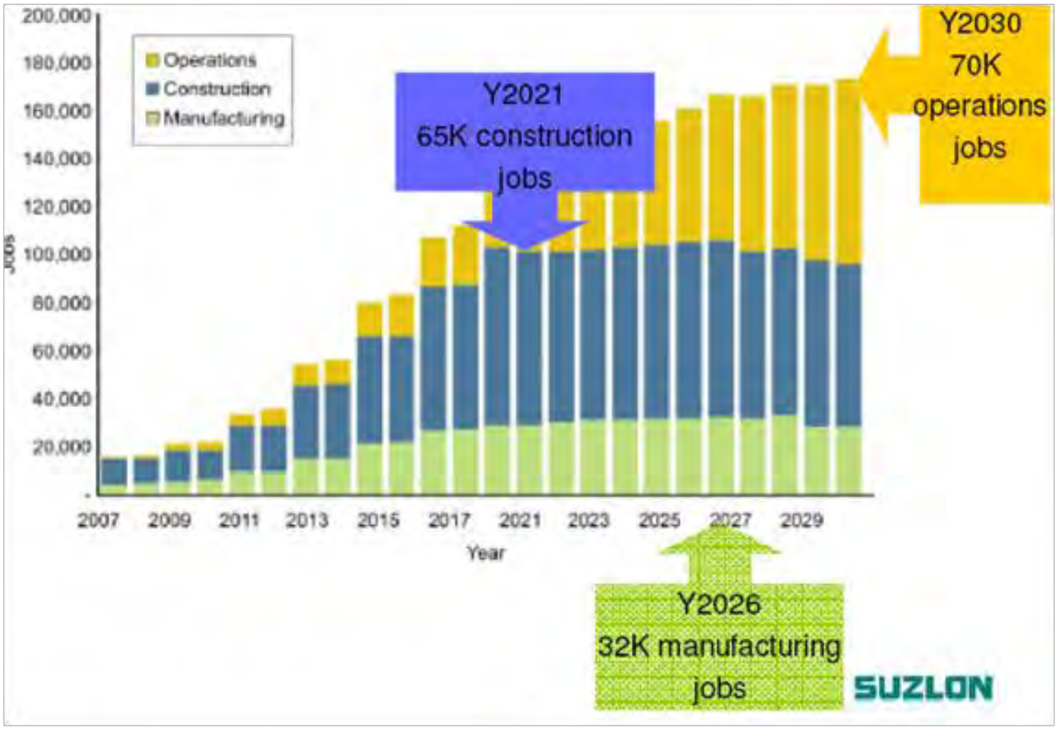
Sector	Sample Job Titles
Manufacturing	Turbine production assemblers Tower production assemblers Gearbox and component parts assemblers
Construction	Site prospecters Construction laborers Construction supervisors
Operations and Maintenance	Wind turbine technicians Wind turbine engineering technicians Wind farm operations manager
Utilities	Electricians
Finance/Development	Wind farm developers Project managers Financers/Accountants

The construction sector of the wind energy industry is the second largest employment base within the industry cluster nationwide. The actual number of employees needed fluctuates with current wind farm development. Initially, a wind farm is constructed with assistance from: Civil engineers (road improvements and turbine access roads), structural engineers (turbine foundations), electrical engineers (medium voltage collection from the turbines, step-up transformation, and high voltage transmission to the grid), and wind turbine generators (installation, erection, and maintenance). Together, these occupational sectors comprise the value chain of the wind energy industry. There are 40-140 combined jobs needed during wind farm construction per 100 MW.[36] California currently has 1,347 MW in various stages of wind farm development. Thus, during development and construction, 520 to 1,820 jobs will be temporarily added within these sectors.

A projective analysis conducted by Suzlon Wind Energy Corporation for the U.S. identified that the peak of construction jobs (65,000) will occur in 2021with operation jobs picking up steadily beginning in 2012 resulting in 70,000 ongoing jobs in 2029.[37] Figure 5 on the next page indicates nationwide job projections based on Suzlon's research.

[35] Information for this table compiled from Centers of Excellence research and Windustry website: www.windustry.org
[36] Marguerite Kelly, National Renewable Energy Laboratory, June 2007 presentation.
[37] Suzlon Wind Energy Corporation, AWEA 2008 Fall Symposium presentation, Palm Springs CA.

Figure 5: Projections for Direct Manufacturing, Construction, and Operations jobs as supported by the National 20% Wind Scenario



Collectively, these occupations will provide thousands of additional jobs nationwide. Given current nationwide economic situations, it is unclear how job projections are effected based on the introduction of the American Revenue and Recovery Act of 2009 (ARRA). The Act may have influenced employers to be more liberal or conservative on their projections of employee growth based on their personal views of the federal stimulus legislation. Each of the identified occupations in the wind energy industry requires some level of training. In terms of greatest training need and best fit for California Community Colleges, wind turbine technicians emerge as the most significant opportunity. Data collected for this report indicates the need for a few additional wind turbine technician training programs through California Community Colleges. While the community college system is positioned to provide much needed training for wind turbine technicians, the traditional delivery method may need to be revised.

Although operations and maintenance account for most of the jobs in the wind energy industry, research conducted for this report revealed that most wind farms in California outsource the hiring of these positions, particularly wind turbine technicians. These positions are typically outsourced because it is difficult to find a local pool of trained applicants. Many employers indicated that if there were a trained local workforce, the industry would most likely hire directly rather than outsource. Many wind industry employers hire technicians with no formal training (37%). Nationwide, the trend is to train new technicians on the job. It is more difficult to find technicians with formal training and experience. Figure 8 below indicates the level of experience and education of new technician hires nationally.

In terms of greatest training need and best fit for California Community Colleges, wind turbine technicians emerge as the most significant opportunity. Data collected for this report indicates the need for a few additional wind turbine technician training programs through California Community Colleges. While the community college system is positioned to provide much needed training for wind turbine technicians, the traditional delivery method may need to be revised.

Wind Turbine Technicians[38]

Just as a car requires periodic tune-ups, so do wind turbines. Oil and filter changes are stipulated by the turbine manufacturer in order to meet warranty requirements (most commonly once per month). This scheduled and predictable maintenance becomes the primary role of the wind energy technician. Given this monthly scheduled maintenance, approximately one wind turbine technician is needed per 20 turbines. However, this varies depending on the age and model of the turbine.

Wind turbine technicians install, inspect, troubleshoot and repair wind turbines and their internal and external components such as programmable controllers, gear boxes, drive components, and electrical equipment. They review related manuals, blueprints, schematics and diagrams to determine the tasks, tools, equipment, and parts necessary to maintain a highly automated system.[39] There are three main service provider options for wind turbine technicians.

Original Equipment Manufacturer

Wind turbine manufacturers provide basic service and maintenance for multiple farms for a given duration. Technicians can travel (inter)nationally.

- Pros: Familiarity with equipment, meets specifications, is experienced, and has parts.
- Cons: Often the most expensive

Independent Providers

Operation and Maintenance firms provide basic service and maintenance for multiple farms, often traveling nationally, occasionally remaining on-site permanently at a given project.

- Pros: Reduced cost and no internal training/oversight is required
- Cons: Involves procurement process and contract set-up. May supply parts.

Internalized Employees

Employed permanently on-site at a given wind farm to perform basic service and maintenance

- Pros: This is the least costly option.
- Con: Need to develop competence (training, SOPs, management), and supply parts.

Many California employers end up using original equipment manufacturers and independent providers. Very few wind farms in California have full-time technical staff to maintain turbines. A majority of employers interviewed outsource this function, often to firms based outside California.

"The U.S. wind industry is clamoring for skilled technicians to maintain the 30,000 wind turbines already in the ground. The best workers combine the knowledge of a top flight mechanic with the endurance of an alpine mountaineer."

– M. Dickerson, LA Times

[38] May also be referred to as Wind Energy Technicians.
[39] "Wind Energy Technician," *Techniques*, p. 52 (April, 2008), www.acteonline.org

Entry level wind energy technicians earn wages from $15 to $25 per hour.[40,41] Some California businesses indicate that they are advancing workers quickly into supervisory and team leader positions paying more than $60,000 per year for workers with only 3 years experience. Top technicians, who are willing to travel, can earn up to $120,000 annually. Experienced technicians, those traveling with overtime, and most supervisors can earn over $120,000. Additional information on the occupation is provided in Appendix F.

Calculating Wind Turbine Technician Projections

For many occupations, we can look to state and national labor market figures to identify the current employment size and projected demand. These figures are typically calculated for each Standard Occupational Code (SOC). However, there is not a specified SOC for wind turbine technicians.[42] Rather the occupation is currently included in the larger SOC of industrial machinery mechanics (SOC 49-9041.00). Simply using calculations for this SOC to identify the need for wind turbine technicians would be misleading and exaggerated. Thus, alternate methods for calculating the projected employment are needed. Two different calculations are used within the industry, and both are presented below to establish a range of projected need within California.

Projections per Megawatt

The number of estimated jobs required per Megawatt (MW) of wind energy varies depending on which report you read. At the 2008 national AWEA conference, however, multiple speakers and industry representatives cited a range of 10-20 Wind Technicians needed per 100 Megawatts (MW) of wind energy in operation. Since wind turbines in California come in various sizes with capacities ranging from 40 kilowatts to 3 MW, a range is a better predictor than a specific number or average.[43] Additionally, it is important to remain mindful that not all Technicians will come from the local workforce, many are servicing turbines still under warranty from out-of-state manufacturers or are under contract with operation and maintenance companies located outside of California. Thus, without surveying 100% of all wind farms in the state, a calculated range is best.

According to the March 2009 AWEA U.S. Wind Energy Project listing, California currently has 2,653 MW of installed wind generation capacity. There is an additional 1,347 MW in development totaling 4,000 MW of current and in-development capacity.[44] Thus, the estimated range of technicians needed to maintain and service California's turbines could range from 265 to 531 at any given time. After the Tehachapi transmission upgrades are complete, the total demand could grow to as many as 400 to 800 technicians. In addition, according to interviews with industry experts, the average turnover rate for technicians is about three years, creating a significant need for replacement workers. [45]

Projections per Turbine

Another approach to calculating the projected number of technicians is per wind turbine. Just as a car requires maintenance on a fairly regular schedule, so does each turbine. In an issue of Community College Week (July 14, 2008, p.12) Christine Real de Azua, a spokesperson for AWEA, is quoted as saying, "a general rule of thumb is that a two-person operation and maintenance team is needed for every 10 turbines." A second popular calculation use by industry is that 1 technician is needed per 20 turbines, especially for the newer models and farms in development which will require less regular maintenance. If we average the two ratios and calculate for 1 technician per 15 turbines, California would need a total of 832

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[40] "Jobs with a Rush," Dickerson, M., *Los Angeles Times*, pg A1.
[41] "Wind Energy Technician," *Techniques*, p. 52 (April, 2008), www.acteonline.org
[42] In the green technology field, two emerging occupations will be assigned an SOC code in the Bureau of Labor Statistics' 2010 SOC Manual. Wind Turbine Service Technicians will be assigned SOC 49-9081. (Solar Photovoltaic Installers is the second new green SOC.)
[43] 1,000 watts = 1 kilowatt. 1, 000 kilowatts = 1 megawatt.
[44] Source: Industrial Information Resources' Wind Map
[45] After the $1.8 billion in transmission upgrades are completed in the Tehachapi Mountains, California's wind capacity should increase, but an exact MW figure is currently unknown.

technicians to service the 12,486 turbines presently in operation.[46] With 668 turbines proposed or in development, California would need an additional 45 technicians to maintain the 13,154 projected total number of turbines in the future.

Calculation Summary

Using these two calculation methods, California's wind industry requires between 265 to 832 technicians in total (range of estimate: 10 technicians per MW to 15 turbines per technician), depending upon a number of variables including: the age of the turbines, manufacturer specifications for maintenance, and the percentage under warranty at a given time serviced by out-of-state firms. Additional considerations in using these calculations in developing programs include the average turnover of wind turbine technicians (presently three years), as well as the number of wind farms that contract with out-of-state firms for their operations and maintenance.

Employment Estimates for Wind Turbine Technicians in California				
Megawatt (MW)	*Currently installed*		*In development*	
10 to 20 technicians per 100 MW	2,653 MW	**265-531 technicians**	1,347 MW	**135-269 technicians**
Turbine	*Currently installed*		*In development*	
15 turbines per technician	12,486 turbines	**832 technicians**	668 turbines	**45 technicians**

While the wind industry is very difficult to quantify, regardless of the method used, there is a slow growing demand that warrants a well planned community college response even in the best case scenario. Even with a high percentage growth, the statewide need is relatively small in its absolute size and a conservative approach to curriculum development is recommended.

Employer Needs and Challenges

California's wind energy employers face a number of challenges and barriers, which may vary depending on the geographic location of the wind farm within the State. For example, several employers in the northern portion of the state indicated that the main challenges are the negative perceptions and environmental concerns about wind turbines. Those in Northern California communities expressing concerns have cited problems regarding turbines which include being 1) not visually attractive, 2) too noisy, 3) bothersome to local farmers, and 4) threatening to the avian population.

In the southern portion of the state, the challenges and barriers for wind energy employers are somewhat different. The most significant challenge for these employers is the utility transmission line. At present, the wind farms in the Southern California area cannot increase megawatt production until a new transmission line is installed. Once this occurs, wind farms in the region will be able to significantly increase MW production, thereby increasing employment opportunities.

The various logistical challenges facing employers have created a significant barrier to wind energy development in California. Some companies have gotten around this challenge by simply purchasing wind energy from other states, such as Oregon or Washington. For example, Modesto Irrigation District recently purchased the wind energy outputs from a 50-megawatt wind system in Oregon at the Columbia River

[46] U.S. Wind Energy Projects – California, AWEA (as of 03/31/09)

Gorge wind farm. Turlock Irrigation District also purchased a 136 megawatt wind farm in Washington.[47] In both instances, the companies are working towards meeting the state's 2020 deadline for 33% renewable energy sources and decided not to wait for new wind farms to be developed in California.

Throughout this report's data collection and industry validation process, wind industry employers expressed interest in California Community Colleges providing training in the wind energy industry. Employers offered many suggestions on how community colleges can assist in providing a skilled workforce for the wind industry.

- Work with high schools to develop curriculum that teaches conservation and renewable energy in order to create the value base for working in the renewable energy sector.
- Train more engineers and engineering technicians. There are not enough professionals in these fields to meet current demand.
- Offer job readiness and work maturity skill training to workers. Make this subject a standard course in existing degree/certificate programs.

College Response and Programs

With thousands of wind turbine generators constructed nationwide in recent years (and thousands more being planned), having sufficient numbers of qualified workers to operate and maintain them is not only an existing reality, but also a growing challenge. Throughout the United States, technical education for renewable energy workers is scarce even though many programs are currently in development. According to Michael Schmidt, the creator and instructor of Wind Energy Technician programs at both Iowa Lakes and Laramie County Community Colleges, there were only twelve functioning Wind Turbine Technician training programs in the nation in 2008. The projected number of programs is expected to double in 2009 to twenty-four.[48]

Factors influencing the surge of technicians needed include the rapid growth of the industry in the last five years and the significant advancements in turbine designs requiring highly skilled technicians. As stated, industry growth and the need for new workers is driving the expansion of training programs at community colleges across the country.

Wind Turbine Technician Training Programs

2004: 1 program nationally (Iowa Lakes Community College (ILCC))

2005: 2 programs nationally (ILCC & Minnesota West CC)

2006: 4 programs nationally

2007: 7 programs nationally

2008: 12 programs nationally (only 10 with enrolled students)

2009: 24+ programs nationally

As the wind turbine industry continues to expand exponentially, the need for certified wind turbine technician training programs will grow as well. **To date, there is no nationally accepted standard for wind turbine technician training.** However, there are basic curriculum elements that are widely agreed upon, such as safety, climb assists, electrical, electronics, hydraulics, and mechanical systems. The AWEA Education Working Group is currently working on developing three curriculum standards for the industry: 1) curriculum for one- to two-week modules, 2) curriculum for one-year programs, and 3) curriculum for two-year programs.

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[47] "TID approves $450 million in bonds for wind energy," *The Modesto Bee* (June 10, 2009)

[48] Wind Industry Webinar (March, 2009). Some existing programs include: Iowa Lakes CC, Lakeshore Technical College, Cloud County Cc, Minnesota West Community and Technical College, Texas State Technical College, Mesalands CC, Cerro Coso CC, Columbia Gorge CC, Fond du Lac CC, and Shasta CC. A sampling of university programs include: California State University, Chico (CSUC), University of Massachusetts, University of Texas at Austin Law School (Wind Law), Texas Tech University, Appalachian State University, and Illinois State University.

In general, successful college start-up programs in wind energy will be facilitated by the infrastructure in both curriculum and technology to reduce start-up expenses and the time to delivery. Colleges that already have electronics, electricity, hydraulics, and/or mechanical programs in place are prime candidates to expand offerings to include a wind energy program.[49] Appendix G provides a description of model programs that have been implemented by a number of community colleges across the nation.

There are a number of existing programs and courses within the California Community College system that could serve as the foundation, or core courses, to train wind turbine technicians. Leveraging these existing programs, instead of building a program from scratch, could save colleges money and expedite the development timeline to begin training students for this profession. To identify colleges within California who offer certificate or degree programs that could potentially train a wind turbine technician, a review of the California Community College's Taxonomy of Programs (TOPs) was conducted. Based on research conducted for this report, the following table indicates programs that could successfully serve as foundational courses within a wind technician training program. A complete listing of programs statewide, including the colleges who offer them, is located in Appendix H.

Table 2: Potential Wind Turbine Technician Programs

TOP Code[50]	Program Name	Program Description
0934.20	Industrial Electronics	Assembly, installation, operation, maintenance, and repair of electronic equipment used in industry and manufacturing. Includes fabrication and assembly of electronic and related components.
0934.40	Electrical Systems & Power Transmission	Installation, operation, maintenance, and repair of electrical systems and the power lines that transmit electricity. Includes assembly, installation, maintenance and repair of motors, generators, transformers, and related equipment.
0945.00	Industrial Systems Technology & Maintenance	Design, construction, maintenance, and operation of mechanical, hydraulic, pneumatic, and electrical equipment and related systems, such as production machinery. Includes building and plant maintenance.
0952.20	Electrical	Installation, operation, maintenance and repair of electrical systems in buildings, including residential, commercial, and industrial electric power wiring and motors, controls, and electrical-distribution panels.
0956.00	Manufacturing & Industrial Technology	Engineering principles and technical skills for the manufacture of products and related industrial processes. Includes shaping and forming operations, materials handling, instrumentation and controls, and quality control. Includes Computer Aided Manufacturing and Robotics. Also includes optimization theory, industrial and manufacturing planning, and related management skills.
0956.30	Machining & Machine Tools	Fabrication, assembly, and repair of parts and components or systems on machines, such as lathes, grinders, drill presses, milling machines, and shaping machines. Includes Computer Numerical Control and tool design.
0934.00	Electronics and Electric Technology	Theory and application of electric and electronic systems and components, including circuits, electro-magnetic fields, energy sources, communication devices, radio and television circuits, computers, and other electric and electronic devices.
0999.00	Other Engineering & Related Industrial Technologies	Includes emerging occupations.

[49] There are, however, examples of successful start-ups from scratch. Iowa Lakes CC did not have any existing technical programs to support a wind program. All the curriculum and lab stations were created specifically for the wind program. Such an endeavor requires strong college, faculty, and administrative support as well as financial resources.
[50] California Community Colleges Taxonomy of Programs, http://misweb.cccco.edu/webproginv/prod/invmenu.htm

Determining California's Role

With more than 25,000 turbines generating energy in the USA and only approximately 24 programs educating technicians nationally, there has been a shortage of wind energy technicians to service them for some time. Companies at a recent AWEA symposium spoke of international firms that have been hired and flown staff to the U.S. to perform the operations and maintenance work. However, most of this work, and the projected industry growth, will not be in California. For the California community colleges, this occupation presents both a challenge and an opportunity.

The opportunity lies in the fact that there is an unquestionable industry need. Many programs report students being hired before completing a 2-year wind program and colleges cannot count on retention.[51] Local operation and maintenance firms are clamoring for quick, short-term training solutions and are sending workers across the nation. However, a key challenge is determining the right number of programs to offer in California so the Community College system does not over saturate the local labor force. Given the distribution of turbines nationally, many students trained to be wind turbine technicians in California will undoubtedly be recruited by an out-of-state firm and leave California for work within the industry.

Nevertheless, it is appropriate to consider an alternate view regarding the role of California Community Colleges in responding to the workforce needs of the wind industry. The key question that needs to be addressed by colleges is whether the number of programs established within the California Community College system should only satisfy California's workforce needs, or if the capacity to provide trained technicians should exceed statewide demand, thus providing a skilled workforce for the industry nationwide. For example, there is only one Wind Technician program in the Pacific Northwest, at Columbia Gorge Community College in northern Oregon. This program produces 34-72 student graduates per year. While a successful program, this does not satisfy the industry needs according to a study entitled "An Analysis of Clean Energy Workforce Needs and Programs in Oregon," completed in spring 2008. The report projects that Oregon companies will need 600 wind turbine technicians during the next three years and will have to import them from other states.[52]

It is also important to understand the nature of the industry and that, as mentioned, many of the students trained in California may not work exclusively in the state, if at all. Many of the maintenance companies for wind turbine technicians operate nationwide and their employees are expected to work throughout the country. For colleges considering building wind energy programs they must strike a balance in the decision-making process between providing the opportunity for skill training and ensuring local jobs are available. See Appendix I for information regarding wind turbine training programs currently offered or in development through California Community Colleges.

[51] Sources: 1) "The Wind Technician Boom is Here," Hill, Joshua, CleanTechnia.com (July 31, 2008); 2) "Community Colleges Tap into Wind Energy Boom," MSNBC (July 31, 2008). www.msnbc.msn.com/id/25886533
[52] "Looking for Renewable Energy Workers," *Community College Times* (April 25, 2008), p. 5

Advanced Transportation Technology and Energy (ATTE) Initiative Model

The ATTE, an initiative of the California Community College Economic & Workforce Development program, created a 208-hour training curriculum in partnership with industry to increase the pipeline of Wind Technicians. Taking a lead nationally, in cooperation with AIRSTREAMS LLC, the Cypress College ATTE Center has assisted in the development of 13 wind turbine technician training courses. The accelerated not-for-credit training program is 26 days long and is for entry-level technicians seeking a career in the wind turbine industry (see curriculum outline and the Master Tooling and Material List in Appendices J and K).

Twenty-seven faculty have been trained throughout the state to teach the curriculum. Cerro Coso Community College currently offers an Energy Technology Certificate with an emphasis in Wind, and an Industrial Technology AS degree, with an emphasis in wind, based upon this curriculum. A number of community colleges in the state currently offer the 208-hour curriculum through contract education units. While some are still under development, a few colleges have found success in offering the program in a modular format that could also be offered to companies through contract education.

Small Wind Curriculum

Some colleges have expressed interest in offering programs specifically for small or residential wind technologies. Although consumer demand is not yet large enough to warrant many new programs in this area, some curriculum has already been developed as a model for colleges who wish to add small wind courses.[53]

The North American Board of Certified Energy Practitioners (NABCEP) creates quality certification programs utilizing industry accepted standards for accreditation bodies. The Board is known for its Solar PV Installer Certification and Solar Thermal Installer certification programs. In October 2008, the NABCEP Board of Directors finalized and approved an “Objectives and Task Analysis” for a Professional Small Wind Energy System Installer. This industry-validated analysis, focused upon systems under 100 kW in size, defines a general set of knowledge, skills and abilities typically required of small wind practitioners who install, maintain and troubleshoot small wind systems. As the cost of residential turbines decrease, this technology will increase in popularity and may be preferable to include as a course in wind turbine technician programs.[54]

Barriers to Program Development

As a result of the recent popularity of “green” instructional programs, and, in part, due to the success of the existing wind turbine technician programs nationally, many colleges are interested in establishing wind energy programs, but have not properly assessed if the institution is in a good position to do so. Community colleges can face many challenges in establishing new programs in wind energy.

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[53] Demand for small wind systems is slowly increasing due to new legislation. In October 2008, Congress passed the Emergency Economic Stabilization Act of 2008, H.R. 1424, which included a new federal-level investment tax credit to help consumers purchase small wind turbines for home, farm, or business use. Owners of small wind systems with 100 kilowatts (kW) of capacity or less can receive a credit for 30% of the total installed cost of the system, not to exceed $4,000. The credit will be available for equipment installed through December 31, 2016. For turbines used for homes, the credit is limited to the lesser of 44,000 or $1,000 per kW of capacity. Source: AWEA.

[54] A second source is the Interstate Renewable Energy Council (IREC). IREC organizes an annual Small Wind State Stakeholder Meeting and provides news, resources, links, and a quarterly newsletter about wind turbines rated 100kW or less. www.irecusa.org

Access to Working Turbines

Given the strenuous work requirements for wind turbine technicians, access to the towers and nacelle control systems is critical to students' experiencing actual work requirements. It is considered a best practice among existing programs to coordinate a tower climb for students early in their training process so that may develop realistic expectations for work-related climbing requirements. For all but very few colleges, the ability to simulate this experience would be cost prohibitive. Therefore, training programs must gain access to real wind turbines. This requires that programs be located within reasonable proximity to wind farms. In addition, arrangements must be made with businesses to provide students access to equipment, which is often difficult to negotiate, as businesses are disinclined to interrupt operations and allow non-employees to participate in work scenarios for which there is a risk of injury.

Securing Support from Industry Partners

For the reasons described above and to determine training requirements within a labor market area, it is essential that colleges build a team of wind energy industry partners to assist in developing course content and to ensure that programs keep pace with the implementation of evolving technologies and business needs. A team of partners may include local businesses, capital investments groups, energy companies, public utilities, turbine manufacturers, project development companies, operations and maintenance companies, site managers, lead technicians, existing technicians, educators, and other subject matter experts.

Quality Instructors

Given that fact that the industry is fairly new and, until very recently, relatively small, there are likely to be few individuals who both possess requisite industry experience and are interested in teaching, which may pay significantly less than they are accustomed to.

Financial Requirements

The cost necessary to implement a program can be staggering. Among the nation's premier models, the Wind Energy Technician program at Laramie County Community College boasts a state-of-the-art Integrated Systems Training Center, which came with a $1.2 million price tag. Their Wind Energy Technical Lab included a donated nacelle but still cost over $145,000 thus far and is still in development. Other model programs also indicate that equipment and facilities costs can run into the range of several hundred thousand dollars (or higher). Some existing programs have received substantial support through specialized grant programs, while others have relied extensively on industry donations. Given the current economy, funding from these sources may be more difficult to access than they have been in recent years. Appendix L provides a list of suggested facilities, hardware and materials for wind energy training programs.

Partnership Success Story

Some companies, such as Knight & Carver, LLC in National City, are true examples of retooling existing processes to serve this growing industry. Knight & Carver has been fabricating and repairing yachts for over 35 years and adapted their composite manufacturing process in 1997 to make wind turbine blades. The company is now internationally recognized as a wind blade fabricator and service produce for utility-scale wind plants. Their manufacturing process can produce multiple 9mm blades in just 11 hours. Knight & Carver plans to donate a blade to Cerro Coso Community College's Industrial Technology program so students can learn from its bolt pattern and design. In addition, the company is interested in working with community colleges and hiring program completers from plastics/composites manufacturing technology programs, such as the one at Cerritos College.

Conclusion and Recommendations

Criteria for Program Development

What colleges in the California community college system should offer wind courses or programs? Three main criteria to consider in answering this question are 1) is the college close to where wind farms, are located, 2) is their labor market demand for wind technicians within their service area, and 3) does a given college have related programs to build upon for training wind technicians?

1. **Proximity to Wind Farms**

   Wind farms in California are located primarily in five distinct regions. It seems logical for colleges closest to existing farms to develop programs, due to their access to industry partnerships, potential local employment, site visits and turbine assents, regional labor market demand, and access to adjunct faculty working within the industry. The COE mapped proximity of community colleges to existing wind farms throughout the state. Appendix M provides GIS maps identifying colleges within a 20, 30, and 40 mile radius from wind farms within California. If a college has a satellite campus within 20 miles of a wind farm, they may also be a prime candidate to implement a wind turbine technician training program.

Figure 15: California Wind Generation Regions

2. **Need in College's Service Area**

   Colleges should assess the need for workers in their region based on employer data in this report and additional outreach and information gathering from local companies. Colleges should consider:

   - How many jobs are there for wind technicians in the region both now and in the future (given best and worst case scenarios)?
   - How many wind technicians are community colleges supplying to the labor market? (See Appendix I for information on planned community college wind programs and enrollments in 2009-2010.)
   - What financial resources are needed to create a wind technician training program?
   - Can qualified instructors be found to teach these classes?

3. **Existing Related Programs**

   Colleges should assess if they have any existing programs that can be leveraged in establishing a wind technician training program. By tapping existing industrial technology infrastructure, in both curriculum and technology, colleges can to reduce start-up expenses and the time to delivery.

Recommendations

California's future wind industry may require anywhere between 265 to 832 technicians in total, depending upon a number of variables and the calculation method used (per turbine or per MW). While the wind industry is very difficult to quantify, regardless of the method used, there is a slow growing demand that warrants a well planned community college response even in the best case scenario. Even with a high percentage growth, the statewide need is relatively small in its absolute size. Therefore, not every college in a region that has wind farms will need to develop a wind technician program.

In response to the commonly asked question "How many wind programs are needed in California?" colleges should make available only as many as are required to meet the employer demand for wind technicians. The three criteria established in the previous section are recommended for determining if a college should proceed with the development of a wind technician training program.

Those colleges located closest to wind resources (within 20 miles) that should consider responding to this workforce need include:

- College of the Desert
- Diablo Valley College
- Gavilan College
- Las Positas College
- Los Medanos College
- Mt. San Jacinto College
- Ohlone College
- Solano Community College

If a college determines that a wind technician program is warranted, then the following two options for responding to the wind industry's need for trained technicians should be considered:

1. **Deliver the 208 hour Advanced Transportation Technology and Energy (ATTE) wind technician curriculum in a Contract Education format.**

   The ATTE, in partnership with Airstream, LLC, created a 208 hour training curriculum to increase the pipeline of Wind Technicians. Twenty-seven community college faculty in California have been trained as of June 2009, to teach the curriculum. A few community colleges currently offer the 208 hour curriculum through contract education units. They have found success in offering students the program in both an intensive "boot camp" format and a modular format. The curriculum can also be offered to wind firms with incumbent workers through contract education.

2. **Build wind programs leveraged off of an Industrial Technology Program.**

   Colleges that already have in place courses and/or programs in industrial technology, such as mechatronics, mechanical engineering, hydraulics, electronics, electricity, automotive, and aviation are prime candidates to expand offerings to include a wind energy program. One example is Cerro Coso Community College, which has developed an Industrial Technology program to allow students the opportunity to enter the industrial setting in the areas of renewable energy (wind/solar), engineering technology, or electronics. Students exiting the program will complete 19 units of core skill sets and choose an emphasis in energy (wind tech/solar tech) technology, engineering technology, or electronics technology. Completers can expect to gain employment in the renewable energy, aerospace, mining, or manufacturing industries.

Solano Community College has taken a similar approach to Cerro Coso. Solano has developed a mechatronics program, which will serve as the core program that students will need to complete, prior to selecting a specialized track in one of the following areas: wind technician, advanced manufacturing, systems controls, or buildings infrastructure/maintenance. Students who complete the wind technician track, based on the ATTE wind curriculum, will be able to seek employment in the wind industry in the local area. Once they gain enough experience and if they are inclined to travel, they can seek employment in the wind industry in one of the many regions in the U.S. (Texas, Iowa, North Dakota) or overseas (Spain, Germany, Japan) where wind technicians are in great demand and wages may be higher. Finally, these students, with their mechatronics training, could choose to leave the wind industry and return to the college to pursue training in one of the other three program areas related to mechatronics.

Appendix H lists all the California Community Colleges that have existing programs which can be leveraged to offer training for wind turbine technicians. Among those that are located within 20 miles of existing wind farms, Diablo Valley College, Las Positas College, and Los Medanos College each have approved programs that can be leveraged to establish a wind technician program potentially more easily then starting from scratch.

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Appendices

Appendix A: How to Utilize this Report

This report is designed to provide current industry data to:

Define potential strategic opportunities relative to an industry's emerging trends and workforce needs;

Influence and inform local college program planning and resource development;

Promote a future-oriented and market responsive way of thinking among stakeholders; and,

Assist faculty, Economic Development and CTE administrators, and Community and Contract Education programs in connecting with industry partners.

The information in this report has been validated by employers and also includes a listing of what programs are already being offered by colleges to address those workforce needs. In some instances, the labor market information and industry validation will suggest that colleges might not want to begin or add programs, thereby avoiding needless replication and low enrollments.

About the Centers of Excellence

The Centers of Excellence (COE), in partnership with business and industry, deliver regional workforce research customized for community college decision making and resource development. This information has proven valuable to colleges in beginning, revising, or updating economic development and Career Technical Education (CTE) programs, strengthening grant applications, assisting in the accreditation process, and in supporting strategic planning efforts.

The Centers of Excellence Initiative is funded in part by the Chancellor's Office, California Community Colleges, Economic and Workforce Development Program. The total grant amount (grant numbers 08-305-013, 08-305-018, and 08-305-021 for $205,000 each) represents funding for multiple projects and written reports through the Center of Excellence. The Centers aspire to be the premier source of regional economic and workforce information and insight for California's community colleges.

More information about the Centers of Excellence is available at **www.coeccc.net**.

Important Disclaimer

All representations included in this report have been produced from primary research and/or secondary review of publicly and/or privately available data and/or research reports. Efforts have been made to qualify and validate the accuracy of the data and the reported findings; however, neither the Centers of Excellence, COE host District, nor California Community Colleges Chancellor's Office are responsible for applications or decisions made by recipient community colleges or their representatives based upon components or recommendations contained in this study.

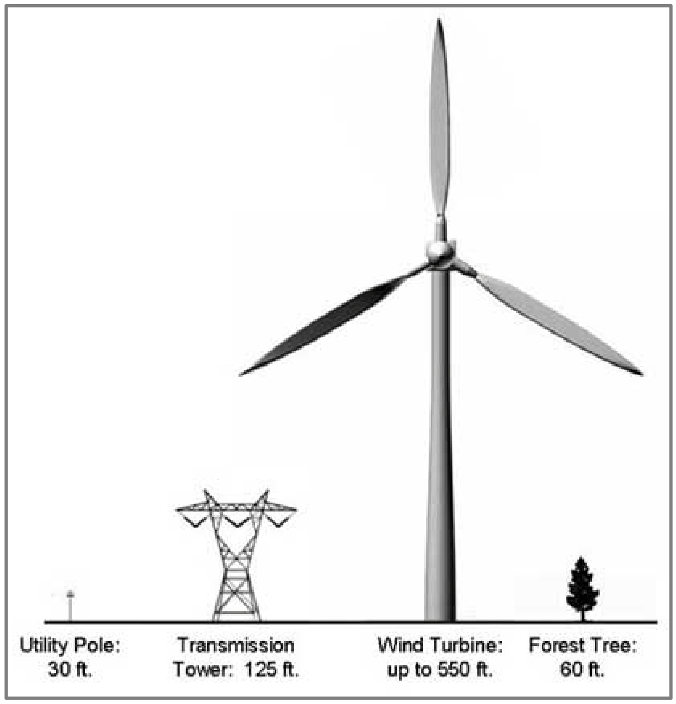
Appendix B: Future Trends in Turbine Technology

The power companies that buy the turbines are getting smarter. They employ teams of meteorologists to scour the world for the best places to put turbines. It is not just a question of when the wind blows, but also of how powerfully. A difference of as little as one or two kilometers (one mile) an hour in average wind speed can have a significant effect on electrical output.[55]

Size of Turbines

Turbines are getting larger in size as technology advances to best capitalize on available wind resources. A typical 1.5-megawatt GE unit costs $2.5 million installed. It sits about 30 stories above the ground at the hub, where its three 100-foot-long blades connect to the tower.

Turbines can range from 1kw to 3 MW in capacity, which is relative to its size. New turbines typically have a capacity of 1.5-2.5 megawatts (MW), or 30 to 50 times that of the early Palm Springs and Altamont Pass turbines. Rotor diameters are increasing to as great as 100 meters, so that their blades sweep an area about the size of a football field. Today's machines extract around 50% of the kinetic energy in the wind—close to the theoretical limit of 59%. However, the scaling up of machines and their components has also caused problems, in particular with gearboxes that are exposed to vibrations and movements inside the turbines.



On average the turbine sizes will continue to grow, but much slower than before. Earlier we had an exponential growth curve for turbine size, with a doubling time of four years. In the future we will see much slower growth, maybe reaching 10 MW for offshore applications in 2030. The bulk volume onshore is likely to remain in the 2-3 MW range.

Smart Turbines

New, innovative "smart" wind turbines are being designed to increase the efficiency in capturing the wind and creating energy. Wind farms generate massive amounts of data through automated sensors and routine monitoring.[56] Newer turbines adjust their positioning and speed of rotation based upon atmospheric conditions, shear over the rotor plane, and wind direction.

New Manufacturing Concepts

New manufacturing and transportation concepts anticipated include:

- Lighter turbines - due to less material and/or advanced materials
- More automation in manufacturing processes
- Design for manufacturability (i.e. turbine designs that will allow for manufacturing of wind turbines to become more efficient, and cost-effective)

[55] "Trade Winds," *The Economist* (June 19, 2008)
[56] Truewind 2008, AWS

Residential/Small Wind

The U.S. leads the world in the production of small wind turbines for homes and small businesses. Small turbines range from 20 W to 100 kW. The North American Board of Certified Energy Practitioners (NABCEP) creates quality certification programs utilizing industry accepted standards for accreditation bodies. In October 2008, the NABCEP Board of Directors finalized and approved an "Objectives and Task Analysis" for a Professional Small Wind Energy System Installer. This industry validated analysis, focused upon systems under 100 kW in size, defines a general set of knowledge, skills and abilities typically required of small wind practitioners who install, maintain and troubleshoot small wind systems. As the cost of residential turbines decrease, this technology will increase in popularity and might be preferable to include as a course in wind turbine technician programs.

"Wind Energizer"

The passive structure design of the "Wind Energizer" created by Leviathan Energy reportedly increases wind turbine efficiency by 30% in field tests. By placing passive objects around a wind farm it will change the circulation around a large wind turbine, thereby "funneling" wind to the turbine and turning the blades faster.

Off-Shore Wind

Off-shore wind is an excellent potential energy source for coastal California. It has the advantage of generating significantly larger MW's of power than land based wind turbines and is closer to the cities where energy is in greatest demand, thus making transmission easier. Nearly 80% of the country's population lives in coastal states. And when turbines are placed 5-15 miles off the coast, then they don't ruin anyone's view. The costs of building foundations and installing turbines that can be anywhere from 20 to 60 meters below the surface, are significantly higher than installing turbines on land. There will also be some significant turbine design challenges to overcome before wind farms can move into deeper waters.

Appendix C: Wind Turbine Technology

Technology

Current wind turbines are very complex compared to older models, and they incorporate many components, including gear box, electronic controllers of various natures, brake, anemometer, wind vane, low speed shaft, high speed shaft, yaw drive, yaw motor, and other electrical devices that comprise the wind turbine.

Turbines can range from 1kw to 3 MW in capacity, which is relative to its size. New turbines typically have a capacity of 1.5-2.5 megawatts (MW), or 30 to 50 times that of the early Palm Springs and Altamont Pass turbines, with rotor diameters as great as 100 meters, so that their blades sweep an area about the size of a football field. Today's machines extract around 50% of the kinetic energy in the wind—close to the theoretical limit of 59%. However, the scaling up of machines and their components has also caused problems, in particular with gearboxes, which are exposed to vibrations and movements inside the turbines.[57]

Turbines are getting larger in size as technology advances to best capitalize on available wind resources. A typical 1.5-megawatt GE unit costs $2.5 million installed. It sits about 30 stories above the ground at the hub, where its three 100-foot-long blades connect to the tower.

Turbines are reactive machines transforming variable kinetic energy from the wind. Engineers are borrowing from aircraft design, using sophisticated composite materials and equally sophisticated variable-geometry blades to make those blades as long as possible (bigger is better with turbine technology) and as smart as possible (a blade that can flex when the wind blows too strongly, and thus "spill" part of that wind, is able to turn when other, lesser turbines would have to be shut down for their own safety). The theoretical maximum efficiency of a turbine, worked out in the early 20th century by Albert Betz, is 59.3%. Modern turbines get surprisingly close to that, being about 50% efficient.[58] Large turbine nacelles weigh 100 tons.

Operations and Maintenance

Turbine suppliers used to provide five years of operation and maintenance services for a fixed fee. However, the term for many has been reduced to two years and many do not cover operations (e.g. GE).[59] This further drives the need for additional operation and maintenance technicians within the industry.

Turbine operation and maintenance costs are site specific and model specific. There are three types of operations and maintenance: 24/7 remote monitoring, schedule maintenance, and on-site services/repairs. Operations and maintenance is the most expensive cost for owner/operators after the warranty service expires. According to Ortech Power, the service, maintenance and repairs reserve costs equate to 59% of total operating costs; that's more than the land, insurance, taxes and administration combined.[60]

Frontier Pro Services conducted an informal survey of approximately 75 wind farm operators in the United States during the first 6 months of 2008. They found that regular, scheduled preventative-maintenance, like oil changes and gearbox lubrication (services that are often still under warranty), are falling behind as manufacturers as well as operation and maintenance companies are resource constrained.[61] Their survey found that, in general, gearbox failures account for the largest amount of downtime, maintenance, and lose of power production. "These costly failures can total 15-20% of the price of the turbine itself, making wind turbine and gearbox maintenance a high priority." Clearly, the wind operations and maintenance business is significant and will only get larger.

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[57] "Wind of Change," Case History, *The Economist* (December 4, 2008)
[58] "Trade Winds," *The Economist* (June 19, 2008)
[59] Andrew Fowler, Renewable Energy Systems America, AWEA WindPower Conference 2008, Houston, TX.
[60] Uwe Roeper, President, ORTECH Power, AWEA WindPower Conference 2008, Houston, TX.
[61] "Survey Says 60% of US Wind Turbines May Be Behind in Maintenance," RenewableEnergyWorld.com (September 5, 2008)

There are three main service provider options for wind turbine operations and maintenance.

Original Equipment Manufacturer

Pros: Familiarity with equipment, meets specifications, is experienced, and has parts.

Cons: Often the most expensive

Independent Providers

Pros: Reduced cost and no internal training/oversight is required

Cons: Involves procurement process and contract set-up. May supply parts.

Internalized Employees

Pros: This is the least costly option.

Con: Need to develop competence (training, SOPs, management), and supply parts.

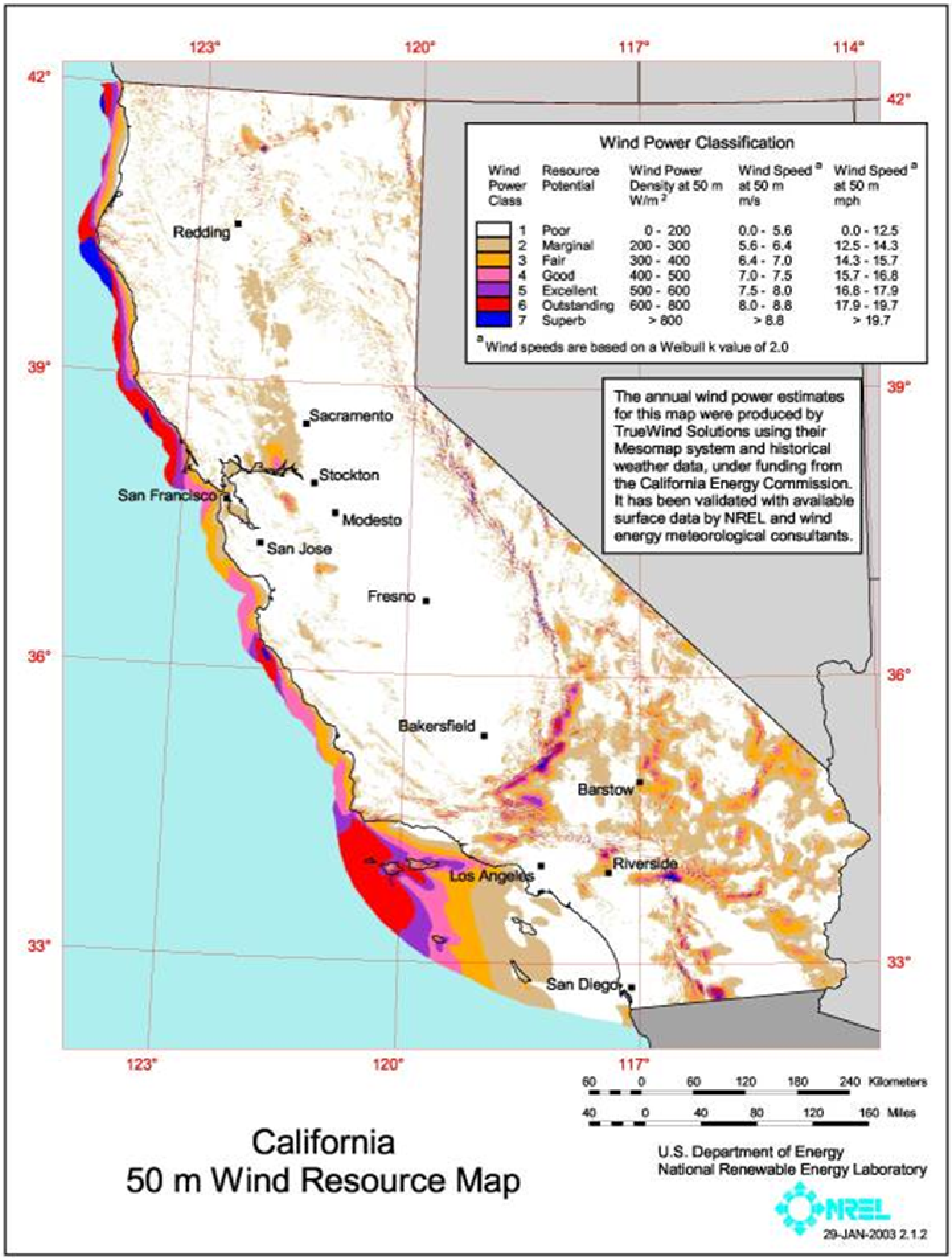
Many CA employers end up using original equipment manufacturers and independent providers. Very few wind farms in California have full-time technical staff to maintain turbines. A majority of employers interviewed outsource this function, often to firms based outside California.

Logistics

The cost of turbine logistics equals about 10-15% of the total turbine cost. This averages to approximately $225k per turbine (or $140k per MW). In 2008, $1.1 billion was spent in the U.S. wind transportation market (of which 85% was by truck).[62]

[62] PLG Group presentation, AWEA Fall Symposium 2008, Palm Springs, CA

Appendix D: Wind Power Map of California



Appendix E: Wind Farm Projects in California

Source: U.S. Wind Energy Projects - California (As of 06/27/2009)
(www.awea.org/projects/Projects.aspx?s=California)

San Francisco Bay Area Wind Farms							
Name	**Location**	**Power Capacity (MW)**	**# of Units**	**Developer**	**Owner**	**Power Purchaser**	**Year Online**
Buena Vista	Altamont Pass	38	38	Babcock & Brown	Babcock & Brown	PG&E	2006
Tres Vaqueros	Altamont Pass	0.75	1	International Wind Co	-	PG&E	-
Diablo Winds	Altamont Pass	20.46	31	FPL Energy	FPL Energy	PG&E	2004
Tres Vaqueros I	Altamont Pass	28.05	85	International Wind Co	-	PG&E	-
Green Ridge Power	Altamont Pass	12.3	41	Kenetech	FPL Energy	PG&E	-
Buena Vista	Altamont Pass	36.92	211	-	International Wind Co	PG&E	-
Wind Power Partners	Altamont Pass	96.7	967	Kenetech	FPL Energy	PG&E	-
Green Ridge Power	Altamont Pass	147.6	1,476	Kenetech	FPL Energy	PG&E	-
Venture Wind I	Altamont Pass	1.2	12	SeaWest	SeaWest	PG&E	-
Zond Windsystem Partners	Altamont Pass	18	200	Zond Systems	-	PG&E	1985
Patterson Pass	Altamont Pass	21.84	336	International Wind Co	International Wind Co	PG&E	-
SeaWest Energy Group	Altamont Pass	1.04	16	SeaWest	SeaWest	PG&E	-
SeaWest Wind Farms	Altamont Pass	11.57	178	SeaWest	SeaWest	PG&E	-
Venture Wind II	Altamont Pass	1.69	26	SeaWest	SeaWest	PG&E	-
Viking Energy	Altamont Pass	1.69	26	SeaWest	SeaWest	PG&E	-
CWES I	Altamont Pass	1.08	18	SeaWest	SeaWest	PG&E	-
Altech Energy, Ltd	Altamont Pass	5.76	144	SeaWest	SeaWest	PG&E	-
CWES II	Altamont Pass	0.24	5	SeaWest	SeaWest	PG&E	-
-	Altamont Pass	97.58	1,000	-	-	-	-
Solano IIA	Solano County	24	8	SMUD	SMUD	SMUD	2006
Shiloh Wind Power Project	Solano County	150	100	PPM Energy	PPM Energy	PG&E/Modesto Irrigation District/ City of Palo Alto	2006
Solano Wind Project	Solano County	4.62	7	FPL Energy	SMUD	SMUD	2004
Solano Wind Project	Solano County	10.56	16	SMUD	SMUD	SMUD	2003
SMUD	Solano County	0.66	1	SMUD	SMUD	SMUD	1999
Solano County	Solano County	60	600	Kenetech Windpower	-	PG&E	1985
Solano Wind Project	Solano County	63	21	SMUD	SMUD	SMUD	2007
High Winds	Solano County	162	90	FPL Energy	FPL Energy	PPM Energy	2003

Central Region Wind Farms							
Name	**Location**	**Power Capacity (MW)**	**# of Units**	**Developer**	**Owner**	**Power Purchaser**	**Year Online**
Coram Energy (Aeroman repower)	Tehachapi	10.5	7	Coram Energy	Coram Energy	SCE	2005
Coram Energy (Aeroman repower)	Tehachapi	4.5	3	Coram Energy	Coram Energy	SCE	2004
Aeroman Repower	Tehachapi	3	2	Coram Energy	Coram Energy	SCE	2003
Oak Creek Energy Systems	Tehachapi	1.35	1	Oak Creek Energy Systems	Oak Creek Energy Systems	SCE	2002
Oasis Power Partners	Tehachapi	60	60	enXco	enXco	SDG&E	2004
Oak Creek Energy Systems	Tehachapi	0.8	1	Oak Creek Energy Systems	Oak Creek Energy Systems	SCE	2002
Oak Creek – Phase 2 A	Tehachapi	1.6	2	M & N Wind Power / OCES	Oak Creek Energy Systems	SCE	1999
Victory Garden	Tehachapi	6	8	Caithness	Caithness	SCE	2005
Oak Creek Wind Power Phase II	Tehachapi	23.1	33	M & N Wind Power / OCES	Caithness	SCE	1999
Cameron Ridge	Tehachapi	56	80	FPL Energy/M & N Wind Power/RES America	Caithness	SCE	1999
Victory Garden	Tehachapi	0.66	1	Caithness	Caithness	SCE	2005
CalWind II CEC	Tehachapi	8.58	13	Calwind Resources	-	SCE	2003
Pacific Crest	Tehachapi	46.86	71	FPL Energy	Caithness	SCE	1999
Victory Gardens Phase IV	Tehachapi	1.32	20	Zond Systems	FPL Energy	SCE	1990
Mojave/Morowind	Tehachapi	35.4	59	Tomen	Tomen	SCE	2002
Oak Creek Phase I	Tehachapi	4.2	7	M & N Wind Power / OCES	Nichimen America / OCES	SCE	1997
Mojave 16, 17, 18	Tehachapi	18	30	SeaWest	FPL Energy / Tomen	SCE	1989
Ridgetop Energy	Tehachapi	14	28	-	Caithness	SCE	1985
Mogul Energy	Tehachapi	4	8	Mogul Energy	-	SCE	-
Victory Gardens I & IV	Tehachapi	1	2	Zond Systems	-	SCE	-
Cannon II	Tehachapi	12.6	28	-	-	SCE	-
Mojave 3 & 5	Tehachapi	46	184	SeaWest	FPL Energy / Tomen	SCE	1990
Mojave 4	Tehachapi	29	116	SeaWest	-	SCE	1990
Mojave 16, 17, 18	Tehachapi	66.75	267	SeaWest	FPL Energy / Tomen	SCE	1989
Ridgetop Energy	Tehachapi	0.25	1	-	Caithness	SCE	1985
Sky River	Tehachapi	76.95	342	Zond Systems	FPL Energy	SCE	1993
Victory Gardens, Phase IV	Tehachapi	21.15	94	Zond Systems	FPL Energy	SCE	1990
AB Tehachapi	Tehachapi	6.97	31	AB Energy	Coram Energy	SCE	-
-	Tehachapi	0.2	1	Zond Systems	Enron Wind Corp	SCE	1986
Windland	Tehachapi	14.3	111	Windland, Inc	Windland, Inc	SCE	-
Ridgetop Energy	Tehachapi	1.3	12	-	Caithness	SCE	1985
Cannon	Tehachapi	4.54	42	-	-	SCE	-
Cannon I	Tehachapi	0.86	8	-	-	SCE	-
-	Tehachapi	63.99	711	Zond Systems	-	SCE	-
CalWind Resources	Tehachapi	14.11	217	CalWind Resources	-	SCE	-
Windridge	Tehachapi	2.34	36	Windridge	-	SCE	-
-	Tehachapi	23.98	369	Zond Systems	-	SCE	-
Ridgetop Energy	Tehachapi	12.76	232	-	Caithness	SCE	1985

Central Region Wind Farms							
Name	**Location**	**Power Capacity (MW)**	**# of Units**	**Developer**	**Owner**	**Power Purchaser**	**Year Online**
Alite Wind Farms	-	24	8	Allco/OCES	-	CA-Portland Cement	2008
Oak Creek Energy Systems		3.46	36	Oak Creek Energy Systems	Oak Creek Energy Systens	SCE	-
International Turbine Research	Pacheco Pass	15.87	167	International Turbine Research	-	PG &E	-

Inland Empire Wind Farms							
Name	**Location**	**Power Capacity (MW)**	**# of Units**	**Developer**	**Owner**	**Power Purchaser**	**Year Online**
Karen Avenue II	San Gorgonio	4.5	3	San Gorgonio Farms	San Gorgonio Farms	SCE	2003
Whitewater Hill	San Gorgonio	4.5	3	Cannon Power Corp	Cannon Power Corp	-	2003
Whitewater Hill	San Gorgonio	61.5	41	Cannon Power Corp	-	LA Dept. of Water Resources	2002
Energy Unlimited	San Gorgonio	10	10	Energy Unlimited	Energy Unlimited	SCE	1999
Cabazon	San Gorgonio	39.75	53	Enron Wind Corp	FPL Energy	SCE	1999
Green Power	San Gorgonio	16.5	22	Enron Wind Corp	FPL Energy	SCE	1999
Westwind – Pacificorp	San Gorgonio	1.5	2	SeaWest	PacifiCorp	SCE/ PacifiCorp	1999
Pacific West I	San Gorgonio	2.1	3	SeaWest	PacifiCorp	SCE/ PacifiCorp	1999
West Winds	San Gorgonio	43.4	62	SeaWest	Caithness	SCE/ PacifiCorp	1999
Mountain View Power Partners III	San Gorgonio	22.44	34	PPM Energy	PPM Energy	SDG&E	2003
Cabazon	San Gorgonio	40.92	62	Cannon Power Corp	-	LA Dept. of Water Resources	2002
Mountain View Power Partners II	San Gorgonio	22.2	37	SeaWest	MDU Resources	LA Dept. of Water Resources	2001
Mountain View Power Partners I	San Gorgonio	44.4	74	SeaWest	MDU Resources	LA Dept. of Water Resources	2001
East Winds	San Gorgonio	4.2	7	SeaWest	Nichimen America	SCE	1997
Karen Avenue (San Gorgonio Farms)	San Gorgonio	3	6	San Gorgonio Farms	San Gorgonio Farms	SCE	1995
Dutch Pacific	San Gorgonio	10	20	Dutch Pacific, LLC	Dutch Pacific, LLC	SCE	1994
San Gorgonio Farms	San Gorgonio	2	4	-	-	SCE	-
Kenetech	San Gorgonio	30.3	101	Kenetech	-	SCE	-
Alta Mesa II	San Gorgonio	9.45	42	SeaWest	SeaWest	SCE	-
Alta Mesa I	San Gorgonio	18.72	117	SeaWest	SeaWest	SCE	-

Inland Empire Wind Farms

Name	Location	Power Capacity (MW)	# of Units	Developer	Owner	Power Purchaser	Year Online
Meridian Trust	San Gorgonio	0.15	1	Kenetech Windpower	FPL Energy	SCE	-
San Gorgonio Farms	San Gorgonio	26	222	-	-	SCE	-
Altech 3 (b)	San Gorgonio	21.71	201	SeaWest	SeaWest	SCE	-
Difwind Ltd I	San Gorgonio	12.72	115	-	enXco	SCE	-
Difwind V	San Gorgonio	7.88	73	SeaWest	enXco	SCE	-
Meridian Trust	San Gorgonio	7.4	74	Kenetech Windpower	FPL Energy	SCE	-
San Jacinto	San Gorgonio	5	50	SeaWest	SeaWest	SCE	-
Energy Unlimited	San Gorgonio	14.5	148	Energy Unlimited	-	SCE	-
So Cal Sunbelt	San Gorgonio	4.94	52	-	-	SCE	-
Westwind Trust	San Gorgonio	15.7	167	-	-	SCE	-
Section 28 Trust	San Gorgonio	26.2	287	-	-	SCE	-
Painted Hills B & C	San Gorgonio	15.3	170	Zond Systems	-	SCE	-
Difwind Ltd II	San Gorgonio	2.54	39	-	enXco	SCE	-
San Gorgonio Farms	San Gorgonio	3.19	49	-	-	SCE	-
So Cal Sunbelt	San Gorgonio	5.53	85	-	-	SCE	-
Zond-PanAero Windsystems	San Gorgonio	29.9	460	Zond Systems	-	SCE	-
Painted Hills B & C	San Gorgonio	3.96	61	Zond Systems	-	SCE	-
Altech 3 (a)	San Gorgonio	3.31	51	SeaWest	SeaWest	SCE	-
Kenetech/Wintech	San Gorgonio	7.08	147	-	-	SCE	-
Lake Palmdale	Palmdale	0.95	1	Palmdale Water Dist.	Palmdale Water Dist.	Palmdale Water District	2004
Edom Hills Repower		20	8	BP Alt. Energy	BP Alt. Energy	SCE	2008
Dillon		45	45	Iberdrola Renewables	Iberdrola Renewables	SCE	2008
Victorville Wind Project	Victorville	0.75	1	NORESCO	NORESCO	Victorville Prison	2005

Other California Wind Farms

Name	Location	Power Capacity (MW)	# of Units	Developer	Owner	Power Purchaser	Year Online
Kumeyaay Wind Power Project	East of San Diego	50	25	Superior Renewable Energy	Babcock & Brown	SDG&E	2005
Wind Turbine Co. test	Los Angeles County	0.5	1	Wind Turbine Co.	Cannon Power Corp	SCE	2001
San Clemente Island	San Clemente Island	0.68	3	Pacific Industrial Electric	U.S. Navy	U.S. Navy	1998
Various		21.5	86				

Appendix F: Wind Turbine Technicians – Employment Requirements

Frontier Pro Services released the results of an informal survey of approximately 75 wind farm operators in the U.S. Designed to assess the specific operation and maintenance service needs of wind energy operators, the survey reveals what could be serious threats to wind farms largely because of the industry-wide shortage of qualified turbine technicians.[63]

According to the findings, many wind farm operations and maintenance teams are so resource constrained that they are barely able to keep up with the unscheduled maintenance repairs their wind turbines require to continue generating electricity. Even regular, scheduled preventative-maintenance like oil changes and gearbox lubrication (services that are often still under warranty) are falling behind as manufacturers face similar resource struggles related to the shortage of qualified technicians.

In a 2008 survey conducted by the American Wind Energy Association, 91% of companies anticipate growth over 25% in the next 2 years (24% anticipate growth over 50%).[64]

Interviews with regional employers indicate that the average turnover for a Wind Technician is 3 years. Often, they either get promoted or experience burnout. The work requires smarts and stamina, good knees, and no fear of heights (since many turbines are 300 feet in the air). Reaching the gearbox to perform diagnostics and repairs means climbing rung by rung on a narrow steel ladder attached to the inside of the tower. An agile worker can climb a 30 story tower in less than 10 minutes; several times a day.

The industry has been searching for additional human resources and, for several years, has been forced to compete over a small pool of experienced and qualified candidates. Some employers have contracted with firms oversees simply due to the lack of domestic applicants. Interviews with California-based businesses has confirmed that technicians are quickly promoted into lead workers, site supervisors, and safety officer positions providing them with a career ladder and accelerated earning potential.

Key Functions

Wind Energy Technicians install, inspect, troubleshoot and repair wind turbines and turbine's internal and external components such as programmable controllers, gear boxes, drive components, and electrical equipment. They review related manuals, blueprints and schematics, diagrams to determine the tasks, tools, equipment, and parts necessary to maintain a highly automated system.[65] There are three basic types of wind turbine techs: some technicians do basic service and maintenance for multiple farms; others remain on-site permanently at a given project; and others travel nationally for special service/repairs.

According to the findings, many wind farm operations and maintenance teams are so resource constrained that they are barely able to keep up with the unscheduled maintenance repairs their wind turbines require to continue generating electricity. Even regular, scheduled preventative-maintenance like oil changes and gearbox lubrication (services that are often still under warranty) are falling behind as manufacturers face similar resource struggles related to the shortage of qualified technicians.

Educational Requirements

The job of a wind energy technician requires the ability to understand and troubleshoot complex equipment, predict and prevent equipment failure, and work as a team member with minimal supervision. Employers are looking for technicians who have the training to apply scientific and theoretical principles along with hands-on skills. Neither a Bachelors nor an Associate's degree is required for employment. Skills and knowledge from a vocational or certificate program, coupled with relevant previous experience, are sufficient.

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[63] 20% Wind Energy by 2030, U.S. Department of Energy
[64] Survey of Attendees, 2008 WindPower Conference, Houston TX
[65] Techniques Magazine, p. 52 (April, 2008); www.acteonline.org

Traditional vs. New Skills for Wind Turbine Technicians

Traditional: Good physical condition for ladder climbing and occasional heavy lifting; meteorology; basic math; ability to work comfortably at heights up to 350 feet; safety certification; experience using hand and power tools; electrical; basic engineering skills; mechanical, hydraulic, and electrical maintenance repair and troubleshooting experience.

New: Understanding advances in technologies and turbine designs, computer software and computer diagnostic systems, testing equipment, and schematics. Technicians should be knowledgeable in mechanics, hydraulics (these systems control the pitch of the blade), and electricity (technicians need to understand control systems, and how power is generated and connected to the power grid).

Appendix G: Model Community College Programs

Following are descriptions of current programs from across the nation that may serve as models for community colleges contemplating the development and implementation of wind turbine technician programs.

Iowa Lakes Community College

Launched in fall 2004, the first Wind Energy Technician training program in the country was located at Iowa Lakes Community College in the rural, northwestern part of the state. The program coordinator Al Zeitz, who formerly worked for GE Energy, created an Associate's degree program with 81 credit hours of study that has quickly become the model wind technician program nationwide. Enrollment is capped at 30 students per class due to limited classroom space and there are two dedicated faculty members to run the program. Iowa Lakes also erected a turbine on their campus, which was funded by a federal grant. "We have students from California, New York and Florida," Al Zeitz says, noting that he has fielded calls from across the U.S. as well, from colleges looking to start their own programs.[66] The college's Board recently approved a $1.25 million, 7,000 square feet classroom and lab addition specifically for their wind energy and turbine technology program. Construction is planned to begin in Spring 2009.[67]

Wind students at Iowa Lakes Community College have "two to three job offers each" by the time they complete the two-year program, according to spokeswoman, Angie DeJong.[68] The college currently enrolls approximately 102 students in their program.

Iowa Lakes Community College
300 S. 18th St.
Estherville, IA 51334
(800) 242-5106
www.iowalakes.edu

Al Zeitz
(712) 362-8374
azeitz@iowalakes.edu

Columbia Gorge Community College

The third program developed in the nation is at Columbia Gorge Community College in Oregon. The only program in the Northwest, the college offers both a one-year certificate and a two-year AS degree in Renewable Energy Technology. Seventy-two (72) first year students are admitted each year (at two entry points). According to their instructor, Tom Lieurance, an average of 32 are retained into the second year of the program pursuing the AS degree. The program encourages internships and concurrent employment during the second year of the program.

Columbia Gorge Community College
400 East Scenic Drive
The Dalles, OR 97058
www.cgcc.cc.or.us

Kristen Kane
(541) 506-6011
kkane@cgcc.cc.or.us

Mike Taphouse
(541)506-6011
mtaphouse@cgcc.cc.or.us

[66] Opalka, W. "Colleges Jump into Wind Operator Training," *North American WindPower* newsletter, March 2006 (Volume 1, Issue 1).
[67] "College Expands Wind Program," *North American WindPower* newsletter, November 2008 (p. 19).
[68] Dickerson, M. "Jobs with a Rush," *Los Angeles Times*, March 1, 2009 (p. A1).

Cerro Coso Community College

Cerro Coso Community College, part of Kern Community College District, has developed an Industrial technology program to allow students the opportunity to enter the industrial setting in the areas of renewable energy (wind/solar), engineering technology, or electronics. Students exiting the program will complete 19 units of core skill sets and choose an emphasis in Energy Technology (Wind Tech/Solar Tech), Engineering Technology, or Electronics Technology. Completers can expect to gain employment in the renewable energy, aerospace, mining, or manufacturing industries.

Industrial Technology Associate of Science Degree: 60 units
Industrial Technology Certificate: 18 units
Industrial Technology – Energy Technician Certificate: 12 units
Industrial Technology – Engineering Technician Certificate: 18 units
Industrial Technology – Electronics Technician Certificate: 18 units

Cero Coso also offers a contract education program for wind technicians, charging approximately $1,750 in tuition per person. The college filled the 15 slots in their boot camp within hours of the course being made available in 2008. They have 3 additional courses scheduled, all of which are full as of summer 2009. "This is going to be ground zero for alternative energy in California," said Jim Fay, Vice President of Academic Affairs at Cerro Coso Community College.[69]

Cerro Coso Community College
3000 College Heights Blvd.
Ridgecrest, CA 93555
www.cerrocoso.edu

Valerie Karnes
Dean, Career and Technical Education
(760) 384-6258
vkarnes@cerrocoso.edu

Laramie County Community College

Associate of Science Degree in Wind Energy (83 credits including internship)
This degree provides the industrial maintenance courses, specialized wind power maintenance skills courses, and on-the-job experience that our industry partners need. This associate degree also includes additional advanced technical courses, and the general education courses required in the degree program were specifically selected for transferability.

The college offers a credited Climb, Safety, & Rescue course. During the second week of class, students climb up a turbine shaft into a nacelle to experience the height and physical issues associated with the career to determine if it is not a good fit before they invest significant time and effort into the program.[70] Interestingly, in the fall of 2008, among the 20 students in their program, only one was a traditional student. The other 19 were non-traditional community college students (i.e., 25 to 65 years old) seeking a career change; some of whom already had a BA degree. This indicates that wind energy occupations may provide suitable re-training opportunities for displaced workers.

Laramie County Community College
1400 East College Drive
Cheyenne, WY 82007
www.iccc.cc.wy.us

Mike Schmidt
Program Developer/Instructor
(307) 432-1639

[69] Dickerson, M. "Jobs with a Rush," *Los Angeles Times*, March 1, 2009 (p. A1).
[70] Schmidt, Michael, LCCC. Wind Energy Webinar, February 27, 2009.

Cape Cod Community College

The college offers a Small Wind Technology certificate program that provides a solid understanding of small wind technology, site analysis, system design, and installation methods. This certificate appeals to anyone interested in learning more about wind energy and applying that knowledge to their home, business or career. A person with this certificate has basic knowledge of small wind-electric systems, suitable for a supervised, entry-level position with a dealer/installer, or other small wind industry company or organization. Professionals in building trades can gain the knowledge necessary to expand their services to include small wind system design, consulting, specification, and installation.

Upon completion of the Small Wind Technology Certificate, students are able to:

Conduct a basic home energy audit and make energy efficiency and conservation recommendations.

Conduct a wind energy site assessment and quantify the amount of wind energy available at a particular site.

Properly site, size and design a residential scale small wind system for both on and off grid applications.

Accurately explain the benefits and limitations of wind-electric systems.

Conduct an economic and environmental assessment of proposed small wind systems.

Cape Cod Community College
2240 Iyannough Road
West Barnstable, MA 02668
(877) 846-3672
www.capecod.edu

Stephanie Brady
(508) 362-2131 x4468
sbrady@capecod.edu

Appendix H: Potential for Wind Turbine Technician Programs

The following tables list programs currently at community colleges in TOP codes identified as having the potential to train wind turbine technicians.

TOP Code: 0934.00 **Program Title: Electronics and Electric Technology**	
College(s) and (Program Name)	**Program Description**
Allan Hancock College (Electronics technology, mechatronics, basic electronics training) **American River College** (Mechatronics) **Antelope Valley College** (Electronics technology) **Bakersfield College** (Industrial technology) **Barstow College** (Electronics technology) **Cerritos College** (Electronics technology) **Cerro Coso Community College** (Electronics technology) **Citrus College** (Electronics technician) **Coastline Community College** (Electronics) **Cuesta College** (Electronics technology) **Diablo Valley College** (Electricity/electronics) **El Camino College** (Electronics and computer hardware technology) **Fresno City College** (Electrical Systems technology) **Fullerton College** (Electronics) **Glendale College** (Electronics engineering technician) **Hartnell College** (Electronics technology) **Irvine Valley College** (Electronics technology) **Long Beach City College** (Electrical technology) **Los Angeles City College** (Electronics, electronic systems) **Los Angeles Harbor College** (Electronic engineering technologist) **Los Angeles Pierce College** (Electronics and electric technology) **Los Angeles Southwest College** (Electronics technology) **Los Angeles Trade Technical** (Electronics engineering technician) **Los Angeles Valley College** (Electronics technician) **Los Medanos College** (Electrical technology) **Merced College** (Electronics technician) **Mount San Antonio College** (Electronics technology) **Orange Coast College** (Electronics technology) **Oxnard College** (Engineering technology) **Palomar College** (Advanced electronic technician) **Pasadena City College** (Electrical technology) **Rio Hondo College** (Electronics technology) **Riverside City College** (Electronics technology) **Sacramento City College** (Electronics mechanic) **Saddleback College** (General electronic technology, analog and digital circuit electronic technology) **San Bernardino Valley College** (General electrician, electronics technology) **San Diego City College** (Electronics) **San Joaquin Delta College** (Electrical technology) **College of San Mateo** (Electronics and electric technology)	Theory and application of electric and electronic systems and components, including circuits, electro-magnetic fields, energy sources, communication devices, radio, and television circuits, computers, and other electric and electronic components and devices.

TOP Code: 0934.00 Program Title: Electronics and Electric Technology	
College(s) and (Program Name)	**Program Description**
Santa Rosa Junior College (Electronics technology) **College of the Sequoias** (Electronic technology) **Southwestern College** (Electrical and electronics technician) **Taft College** (Electronics) **Yuba College** (Electronics technology)	

TOP Code: 0934.20 Program Title: Industrial Electronics	
College(s) and (Program Name)	**Program Description**
Cerritos College (Industrial electronics) **El Camino College** (Electronics and composition) **Fresno City College** (Automation control technician) **Los Angeles Valley College** (Industrial electronics **Los Medanos College** (Industrial electronics) **Merced College** (Industrial electronics technology) **Modesto Junior College** (Maintenance electrician, electronics technology, industrial electronics technology) **Mount San Antonio College** (Industrial electronics) **Sierra College** (Computer integrated electronics: Mechatronics) **Yuba College** (Industrial electronics technician)	Assembly, installation, operation, maintenance, and repair of electronic equipment used in industry and manufacturing. Includes fabrication and assembly of electronic and related components.

TOP Code: 0934.40 Program Title: Electrical Systems and Power Transmission	
College(s) and (Program Name)	**Program Description**
Chaffey College (Industrial electrical technology) **San Bernardino Valley College** (Electrical power technology) **San Diego City College** (Electrical systems and power transmission linemen, electrical control systems, electricity)	Installation, operation, maintenance, and repair of electrical systems and the power lines that transmit electricity. Includes assembly, installation, maintenance and repair of motors, generators, transformers, and related equipment.

TOP Code: 0945.00 **Program Title: Industrial Systems Technology and Maintenance**	
College(s) and (Program Name)	**Program Description**
Cuesta College (Facilities technology management) **Hartnell College** (Industrial technician) **Long Beach City College** (Mechanical maintenance technology) **Los Angeles Harbor College** (Process plant technology) **Los Angeles Pierce College** (Industrial technology) **Los Medanos College** (Process technology) **Merced College** (Industrial maintenance technology) **Modesto Junior College** (General plant maintenance, industrial technology) **Sacramento City College** (Mechanical systems technician) **San Bernardino Valley College** (Mechanical hydraulics/pneumatics) **San Joaquin Delta College** (Fluid power and automation technology, industrial technology) **San Jose City College** (Facilities maintenance technology) **College of the Sequoias** (Industrial maintenance technology) **Solano Community College** (Maintenance technician)	Design, construction, maintenance, and operation of mechanical, hydraulic, pneumatic, and electrical equipment and related systems, such as production machinery. Includes building and plant maintenance.

TOP Code: 0952.20 **Program Title: Electrical**	
College(s) and (Program Name)	**Program Description**
American River College (Residential/commercial electrician trainee) **Antelope Valley College** (Electrical technology) **Cuesta College** (Electrical technology) **Foothill College** (General electrician) **Los Angeles Trade Technical** (Electrical construction and maintenance) **Merced College** (Electrical technology) **San Diego City College** (Construction electronic systems technician) **Santiago Canyon College** (General electrician)	Installation, operation, maintenance and repair of electrical systems in buildings, including residential, commercial, and industrial electric power wiring and motors, controls, and electrical-distribution panels.

TOP Code: 0956.00 Program Title: Manufacturing and Industrial Technology	
College(s) and (Program Name)	**Program Description**
Bakersfield College (Control systems technology, industrial technology) **College of the Canyons** (Manufacturing technology) **Cerritos College** (Industrial technology) **Cerro Coso Community College** (Industrial technology) **Chabot College** (Industrial technology, engineering technology) **El Camino College** (Manufacturing technology) **Fresno City College** (Computer aided manufacturing) **Fullerton College** (Manufacturing technology) **Glendale College** (Electro/mechanical fabrication technician) **Las Positas College** (Industrial technology – courses only) **Los Angeles Valley College** (Engineering technology) **Mission College** (Semiconductor manufacturing training, industrial technology) **Modesto Junior College** (Industrial technology) **Mount San Antonio College** (Manufacturing technology) **College of the Redwoods** (Manufacturing technology, CADD/CAMM design & manufacturing) **Riverside City College** (Manufacturing technology, automated systems technician, manufacturing management) **Saddleback College** (Rapid digital manufacturing) **San Bernardino Valley College** (Computer numerical control CAD/CAM) **San Diego City College** (Fabrication manufacturing, electronics manufacturing, manufacturing engineering technology) **Santa Ana College** (Manufacturing technology, engineering industrial technology) **Sierra College** (Welding technology) **Yuba College** (Manufacturing technology/machining)	Engineering principles and technical skills for the manufacture of products and related industrial processes. Includes shaping and forming operations, materials handling, instrumentation and controls, and quality control. Includes Computer Aided Manufacturing and Robotics. Also includes optimization theory, industrial and manufacturing planning, and related management skills.

TOP Code: 0956.30 Program Title: Machining and Machine Tools	
College(s) and (Program Name)	**Program Description**
Allan Hancock College (Machine technology) **Cerritos College** (Numerical control machine operator, machine tool technology, machinist) **Cerro Coso Community College** (Machine tool technology) **Chabot College** (Machinist, machine tool technology, numerical control) **De Anza College** (CNC research and development machinist, machining and machine tools, machinist) **Diablo Valley College** (Machine technology) **El Camino College** (Machine tool technology) **Fullerton College** (Machine technology, computer numerical control) **Glendale College** (Computer numerical control, machine and manufacturing technology)	Fabrication, assembly, and repair of parts and components or systems on machines, such as lathes, grinders, drill presses, milling machines, and shaping machines. Includes Computer Numerical Control and tool design.

TOP Code: 0956.30 Program Title: Machining and Machine Tools	
College(s) and (Program Name)	**Program Description**
Laney College (Machine technology) **Long Beach City College** (Machine operator, machine tool technology) **Los Angeles Pierce College** (Numerical control programming, machine shop technology) **Los Angeles Trade-Technical** (Machine shop, CNC) **Los Angeles Valley College** (Manufacturing technology) **College of Marin** (Machine and metals technology) **Modesto Junior College** (Machine tool technology) **Napa Valley College** (Machine tool technology) **Orange Coast College** (Machine technology) **Pasadena City College** (Machine shop technology) **College of the Redwoods** (Manufacturing technology) **Reedley College** (Manufacturing technology, machinist, machine tool technology) **San Bernardino Valley College** (Machinist, machine technology, tool and die) **San Diego City College** (CNC technology, machine technology) **San Joaquin Delta College** (Machine shop technology) **San Jose City College** (Machine technology, machinist, CNC machine operator) **Santa Ana College** (Manufacturing technology) **Santa Rosa Junior College** (Machine tool technology) **Ventura College** (Machine technology)	

TOP Code: 0999.00 Program Title: Other Engineering and Related Industrial Technologies	
College(s) and (Program Name)	**Program Description**
Coastline Community College (Process technology) **Golden West College** (Technology) **Los Angeles Trade Technical** (Process technology) **Orange Coast College** (Industrial technology) **San Joaquin Delta** (Technical education) **Shasta College** (General studies) **Taft College** (Industrial technology)	Includes emerging occupations.

Appendix I: Statewide Internal Scan

College Response and Issues

To assess the capacity of the California Community Colleges to prepare the needed workforce identified in this scan, the following section details what current education and training programs related to wind energy exist or will be offered in the near future. This section does not include colleges that offer a more general course or certificate in alternative or renewable energies which may include some wind related content.

Colleges Planning to Offer Wind Technician Training

Only one community college in the state, Cerro Coso Community College located in the Central Region, is currently offering an approved for-credit wind technician training program. Their program leads to an Industrial Technology certificate with a Wind Energy Technology emphasis or an Industrial Technology Associate of Science Degree.

Five Bay Area community colleges (Solano, Las Positas, Ohlone, College of San Mateo, and West Valley) were identified as planning to offer wind technician courses and/or programs in the near future. College of San Mateo also offers an overview of wind energy systems in a course entitled “Power for the Future.” The course covers comparisons of renewable and non-renewable energy sources and their impact on global warming and the environment.

In Southern California, both College of the Desert and Cerritos College plan to offer the ATTEi wind technician training curriculum (not-for-credit via contract education) in the near future. In addition, Cerritos College has already begun to offer a Wind Turbine Blade Repair & Maintenance class building upon their existing Plastics and Composites courses.

Planned College Programs in Wind Energy,
Planned Enrollments/Start Date, and College Contacts

College	Planned Courses/Program	Planned Enrollments/Start Date	Contact
Cerro Coso	Industrial Technology certificate with a Wind Energy Technology emphasis and AS degree Wind Technician Boot Camp	Enrollments: 80-90 total next 12 months for Boot Camp (currently 84 enrolled). Enrollments: Unknown for AS degree program. Start Date: Aug 2009, October 2009, January 2010 for Boot Camp Start Date: Spring 2010 for AS degree program.	Valerie Karnes, Dean, CTE vkarnes@cerrocoso.edu (760) 384-6258
Cerritos	Wind Turbine Blade Repair & Maintenance class (Prepares for the sub-specialty of Blade Repair Technicians) Wind technician Boot Camp (offered through Contract Education)	Enrollments: 30-40 total in the next 12 months Start Date: ongoing (one class completed) Enrollments: unknown Start Date: Spring 2010	Ray Elledge, CACT Program relledge@cmtc.com (310) 984-9734
College of the Desert	Wind Technician Boot Camp (offered through Contract Education)	Enrollments: 11-12 per class. Planning 3-4 classes per year Start Date: Summer 2009	Larry McLaughlin, ATTEi Director lmclaughlin@collegeofthedesert.edu (760) 773-2595

College	Planned Courses/Program	Planned Enrollments/Start Date	Contact
Solano	Wind Technician Certificate with Mechatronics Certificate/Degree as Core Program	Enrollments: unknown Start Date: Spring 2010	David Redfield, Dean of Math & Science dredfiel@solano.edu (707) 864-7110
Las Positas	Wind Technician Certificate/Degree, (plan is to offer one wind related course per semester)	Enrollments: 25-30 per class Start Date: Spring 2010	Scott Miner, Welding Instructor sminer@laspositascollege.edu (925) 424-1134
Ohlone	Wind Technician Course; "Wind Design and Development"	Enrollments: 24 per class Start Date: Spring 2010	Narinder Sansal, Instructor Environmental Studies nbansal@ohlone.edu (510) 742-2360
College of San Mateo	Wind Technician Course; "Wind-Hydro-Geothermal Systems"	Enrollments: 25-30 per class Start Date: Fall 2009	Tom Diskin, Instructor Electronics Technology (650) 574-6133 diskin@smccd.edu
West Valley	Wind Technician Short Course (offered through Community Education – non-credit, $295 fee)	Enrollments: 20 per class Start Date: Fall 2009	Melissa Ceresa, Coordinator Melissa_ceresa@wvm.edu (408) 741-4694

Finding Faculty

Colleges don't anticipate having difficulty finding qualified faculty to teach wind courses. They will draw instructors from existing faculty in related programs – especially renewable energy programs when available, as well as part-time instructors from industry. The colleges who plan to develop courses/programs cite good connections with industry, or realize they will need to connect with industry to secure part-time faculty and equipment for hands-on training.

Equipment Needs, Outreach to High Schools, Industry Partnerships and Advisory Boards

Most colleges stated that getting relevant wind turbine components/equipment from industry will be a significant challenge. (Note that Cerritos College already owns a small residential turbine). All agreed that hands-on training and familiarity with wind turbine components will be necessary in a lab environment. Many colleges engage in outreach activities to their local high schools and will be promoting their wind technician courses to high school students and teachers. All colleges either have, or are in the process of recruiting, well-developed advisory boards comprised of a variety of industry and business entities that will guide program development.

Appendix J: Advanced Transportation, Technology and Energy (ATTE) Initiative

The ATTE is an initiative of the Economic and Workforce Development Program of the California Community College system. In partnership with industry representatives, the ATTE initiative has developed curriculum and training modules entitled "Utility Wind-Generation Technician Training." The training is designed to be delivered in 13, 2-day modules. The breakdown of the topics and corresponding hours are below.

Class 1 -- 16 hours

1. Introduction to the Wind Industry 2 hours
   A. The wind industries history 1980 to present
   B. Where the industry is today and estimated growth
   C. Production Tax Credits

2. OSHA required safety 14 hours
   A. Electrical Safety
   B. Safe Lifting back injury prevention
   C. How to Prevent Slips Trips and Falls
   D. Climbing and Fall Protection Safety
   E. Crane, Rigging, chains, slings and hoist safety
   F. Fire Prevention
   G. Hand and Power Tool Safety
   H. Confined Space Safety
   I. Machine Guarding Safety
   J. Eye, Hand, Hearing Safety
   K. Respiratory Safety
   L. Blood Borne Pathogens
   M. Lock Out Tag Out
   N. Hazardous Materials
   O. How to Investigate and accident

Class 2 -- 16 hours

1. First Aid and CPR 6 hours
2. Tower Rescue 6 hours
3. Wind Turbine and site safety 4 hours

Class 3 -- 16 hours

1. Direct Current Theory 16 hours

Class 4 -- 16 hours

1. Alternating Current Theory 16 hours

Class 5 --- 16 hours

3. Multi Meters and Voltage Test Equipment 16 hours
   - A. Amp Clamps
   - B. Voltage Pens
   - C. Megohmmeters
   - D. Infrared Testers
   - E. O Scopes

Class 6 --- 16 hours

1. Voltage Test Procedures 50 volts or Higher 4 hours
2. Electric Static Discharge (ESD) 4 hours
3. Basic Hydraulics 8 hours

Class 7 --- 16 hours

1. Concepts of Electronics 10 hours
2. Fiber Optics 4 hours
3. Soldering 2 hours

Class 8 --- 16 hours

1. Control Algorithms/Programmable controllers 8 hours
2. Substations & transformers/Power Distribution 8 hours

Class 9 --- 16 hours

1. Wind turbine Mechanical systems 6 hours
   - A. Tower, Rotor, Mainshaft, Gearbox, & Generator
2. Torquing, Fasteners and Torque equipment. 4 hours
3. Wind Turbine Electrical systems 6 hours
   - A. Controller systems, Pitch systems, Yaw Systems, Generators, & Collection systems

Class 10 --- 16 hours

1. Turbine Maint and Service practices 8 hours
2. Trouble shooting techniques and procedures 4 hours
3. Service Reporting and Computer training 4 hours

Class 11 --- 16 hours

1. Rotor construction / Airfoils 6 hours
2. Fiber Glass repairs 6 hours
3. Blade Pitch and Balancing 4 hours

Class 12 --- 16 hours

1.	SCADA and Data Analysis	6 hours
2.	Meteorology	6 hours
3.	Wind Turbine Power Curves	4 hours

Class 13 --- 16 hours

1.	Class Summary and final exam	16 hours

For additional information contact:

Peter Davis, ATTE Statewide Director
(619) 473-0090
outrchpd@me.com
www.attecolleges.org

Appendix K: Wind Turbine Technician Course – Master Tooling and Material List

Airstreams Training Service Wind Turbine Technician Course Master Tooling and Material List 2008							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	2	www.grainger.com	$392.75	$785.50	
Variable AC Power supply	B&K PRECISION	1T201	1	www.grainger.com	$349.00	$349.00	AC Power Supply, Variable Transformer, 0-150 VAC
Function generator	B&K	5BB58	1	Grainger	$285.00	$285.00	
24Vdc power supply	directlogic	PSM24-180S	2	automationdirect.com	$135.25	$270.50	
Windvane / Anemometer mast			1	NRG systems		$0.00	
phase rotation meter	Ideal	1RH10	2	Grainger	$119.05	$238.10	
PLC simulator	DirectLogic06		1	Automationdirect	$821.95	$821.95	
Amp Clamp	Fluke	1GAH7	2	Grainger	$230.00	$460.00	
Megger	Megger	4VV59	2	Grainger	$354.80	$709.60	
Infrared Gun	Fluke	1PEK8	2	Grainger	$157.50	$315.00	
Oscilloscope/Scopemeter	Fluke	123	1	Grainger		$0.00	
Fluke Voltage Pens	Fluke	2KU25	2	Grainger	$27.15	$54.30	
EZ stop II shock absorbing Lanyard	DBI/SALA	1220006	2	http://fallprotectionusa.com/DBI/Lanyards/1220006.htm	$62.00	$62.00	
Ladsafes	DBI/SALA	6116502	2	http://www.dbi-sala-safety.com/Lad-Safe	$320.00	$640.00	For use with 3/8&#34 dia. 1x7 or 7x19 solid core cable
ExoFit Harness	DBI/SALA	108525	1	http://fallprotectionusa.com/DBIHarness/Exofit/1108525.htm	$200.50	$200.50	
Saflok Carabiner	DBI/SALA	2000114	2	http://fallprotectionusa.com/DBI/Anchors/2000114.html	$67.50	$135.00	2-3/16" gate opening
Tic Tracer	Amprobe	TIC 300HV	2	www.professionalequipment	$66.00	$132.00	
250 flb. Torque wrench	Westward	4DA97	1	Grainger	$92.70	$92.70	
600 flb. Torque wrench	Proto	1ARP9	1	Grainger	$181.25	$181.25	
Multiplier 13:1				Grainger		$0.00	13:1 / Specialty tool
Mechanic tool set	craftsman		1	Kmart		$0.00	Should contain all the sockets & wrenches needed up to 3/4 " or 22 mm
Variable DC Power supply				Grainger		$0.00	0-30 Vdc 5 amp

drill/screw set for cordless drill		114 pc set	1	Home Depot	$19.97	$19.97	
cordless drill/driver	Skill	18 Volt	1	Home Depot	$89.97	$89.97	
Wire cutters	XCElite	4CP18	2	Grainger	$6.89	$13.78	
Long nose pliers	Vise Grip	4YU71	2	Grainger	$14.92	$29.84	
Wire strippers	Klein tools	4A856	2	Grainger	$16.03	$32.06	
Soldering station	Weller	5JH82	2	Grainger	$147.35	$294.70	Analog / Temp control
Solder wick		5HZ97	3	Grainger	$3.00	$9.00	
Alcohol dispenser	Menda	WAS-16-69356	1	http://was.stores.yahoo.net/onstainsteel.html	$17.50	$17.50	
Solder (60-40 rosin core solder)				www.wassco.com		$0.00	
Solder sucker				www.wassco.com		$0.00	
Flux remover (isopropyl alcohol)				www.wassco.com		$0.00	
Acid brushes / Q tip swabs				www.wassco.com		$0.00	
Lint free wipes				www.wassco.com		$0.00	
Small circuit board				www.wassco.com		$0.00	
Components for attachment				www.wassco.com		$0.00	
Scotch Tape				www.wassco.com		$0.00	
Circuit board holder (or small vise)				www.wassco.com		$0.00	
Sledge hammer 5lb.			1	Grainger		$0.00	
Hack Saw			1	Grainger		$0.00	
Hammer			1	Grainger		$0.00	
8cal flash kit	Salisbury	5EU46	2	Grainger	$366.50	$733.00	
40cal flash kit / hot stick	Salisbury	6WU89	0	Grainger	$892.00	$0.00	
Hard Hats	MSA	4LN95	25	Grainger	$11.75	$293.75	
Safety Glasses	Conndor	4EY97	50	Grainger	$1.36	$68.00	
HV glove	Salsbury	4T490	1	Grainger	$53.25	$53.25	
Protector / glove	Salsbury	4T560	1	Grainger	$45.40	$45.40	
Glove Bag	Salsbyuryy	4T498	1	Grainger	$34.15	$34.15	
Specialty sockets and wrenches				Grainger		$0.00	should include standard and metric up to 11/2 " or 46mm
1" drive ratchet			1	Grainger		$0.00	Specialty tool
1" drive breaker bar			1	Grainger		$0.00	Specialty tool
Screw driver set			1	Grainger		$0.00	Includes flat and philips heads
Fiber optic fault locator		Visifault	2	Grainger		$0.00	
Fiber optic source and power meter test kit			1	Grainger		$0.00	with proper adaptors

Fiber optic cable for testing			2	Grainger		$0.00	one good and one bad cable
Batteries (9 volt)				Grainger		$0.00	AA / AAA / D cell / 9 volt
Speakers for laptop or desk top			2			$0.00	
Projector			1			$0.00	
Presentation controller with laser			1			$0.00	
Extension cord for safety inspection training			1			$0.00	
Shackles / various sizes			5			$0.00	
Crane Straps / used from crane company			3			$0.00	
Tech Safety Line self egress kit			1			$0.00	
Tech Safety Line assisted egress kit			1			$0.00	
Fluke electrical measurement safety CD			1			$0.00	
DC 50-1 kit (one per student)		EXP 50&1	15	Kits USA		$0.00	
ESD straps			5	Grainger		$0.00	
ESD shipping bags for circuit boards			5	Grainger		$0.00	
Accumulator charging kit			1			$0.00	
Nitrogen bottle with regulator			1			$0.00	
Accumulator			1	Paarker		$0.00	
Oil Sample Kits			15			$0.00	
Lint free wipes / cleaning alcohol				wassco		$0.00	
130-in-1 Electronic Project Lab	Kit USA	MX-906	15	http://www.kitsusa.net/phpstore/html/MX-906-130-in-1-Electronic-Project-Lab-491.html	$34.95	$524.25	
Planetary gear box kit		WW3052408		Sciencekit.com		$0.00	
Training aids for torquing i.e. bolts, nuts, washers						$0.00	
Training aids contactors, relays, fuses & overloads						$0.00	

Introduction to the Wind Industry							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
AWEA The Power of Wind DVD	AWEA	DVD	1	https://www.awea3.org/source/Orders/index.cfm?Section=Store	$20.00	$20.00	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

OSHA Safety							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
8cal flash kit	Salisbury	5EU46	1	www.grainger.com	$366.50	$733.00	
40cal flash kit / hot stick	Salisbury	6WU89	1	www.grainger.com	$892.00	$0.00	
Hard Hats / Class E	MSA	4LN95	15	www.grainger.com	$11.75	$293.75	
Safety Glasses	Conndor	4EY97	15	www.grainger.com	$1.36	$68.00	
HV glove	Salsbury	4T490	1	www.grainger.com	$53.25	$53.25	
Leather Protector / glove	Salsbury	4T560	1	www.grainger.com	$45.40	$45.40	
Glove Bag	Salsbyuryy	4T498	1	www.grainger.com	$34.15	$34.15	
Multimeter	Fluke	1GAH9	1	www.grainger.com	$157.50	$157.50	
EZ stop II shock absorbing Lanyard	DBI/SALA	1220006	2	http://fallprotectionusa.com/DBI/Lanyards/1220006.htm	$62.00	$62.00	
Ladsafes	DBI/SALA	6116502	2	http://www.dbi-sala-safety.com/Lad-Safe	$320.00	$640.00	
ExoFit Harness	DBI/SALA	108525	1	http://fallprotectionusa.com/DBIHarness/Exofit/1108525.htm	$200.50	$200.50	
Saflok Carabiner	DBI/SALA	2000114	2	http://fallprotectionusa.com/DBI/Anchors/2000114.html	$67.50	$135.00	2-3/16" gate opening
Extension cord for safety inspection training			1	Instructor's choice	An old cord that has been taken out of service. The purpose is to show the students what a bad cord will look like.		
Electrical tool for inspection training			1	Instructor's choice	An old tool that has been taken out of service. The purpose is to show the students what a bad tool will look like.		
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Power Point Presentation on Disk	Airstreams		1	Airstreams			
Power Point Presentation on Disk	Airstreams		1	Airstreams			

Safety In The Wind Park							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
8cal flash kit	Salisbury	5EU46	2	www.grainger.com	$366.50	$733.00	
40cal flash kit / hot stick	Salisbury	6WU89	0	www.grainger.com	$892.00	$0.00	
Hard Hats	MSA	4LN95	15	www.grainger.com	$11.75	$293.75	
Safety Glasses	Conndor	4EY97	15	www.grainger.com	$1.36	$68.00	
HV glove	Salsbury	4T490	1	www.grainger.com	$53.25	$53.25	
Protector / glove	Salsbury	4T560	1	www.grainger.com	$45.40	$45.40	
Glove Bag	Salsbyuryy	4T498	1	www.grainger.com	$34.15	$34.15	
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
EZ stop II shock absorbing Lanyard	DBI/SALA	1220006	2	http://fallprotectionusa.com/DBI/Lanyards/1220006.htm	$62.00	$62.00	
Ladsafes	DBI/SALA	6116502	2	http://www.dbi-sala-safety.com/Lad-Safe	$320.00	$640.00	for use with 3/8&#34 dia. 1x7 or 7x19 solid core cable
ExoFit Harness	DBI/SALA	108525	1	http://fallprotectionusa.com/DBIHarness/Exofit/1108525.htm	$200.50	$200.50	
Saflok Carabiner	DBI/SALA	2000114	2	http://fallprotectionusa.com/DBI/Anchors/2000114.html	$67.50	$135.00	2-3/16" gate opening
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

First Aid / CPR							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Props from Red Cross							
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Tower Rescue							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Self egress kit	Tech Safety Line	SRK-11	1	Diane@techsafetylines.com			214-987-4680
Assisted egress kit	Tech Safety Line	ARK	1	Diane@techsafetylines.com			214-987-4680
EZ stop II shock absorbing Lanyard	DBI/SALA	1220006	2	http://fallprotectionusa.com/DBI/Lanyards/1220006.htm	$62.00	$62.00	
Ladsafes	DBI/SALA	6116502	2	http://www.dbi-sala-safety.com/Lad-Safe	$320.00	$640.00	for use with 3/8&#34 dia. 1x7 or 7x19 solid core cable
ExoFit Harness	DBI/SALA	108525	1	http://fallprotectionusa.com/DBIHarness/Exofit/1108525.htm	$200.50	$200.50	
Saflok Carabiner	DBI/SALA	2000114	2	http://fallprotectionusa.com/DBI/Anchors/2000114.html	$67.50	$135.00	2-3/16" gate opening
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Electrical Metering							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Fluke electrical measurement safety CD	Fluke		1	http://us.fluke.com/usen/home/default.htm			
DC 50-1 kit (One per student)		EXP 50&1		http://www.kitsusa.net/phpstore/index.php			
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
Variable DC Power supply	B&K PRECISION	4GA41	1	www.grainger.com	$515.00	$515.00	
Function generator	B&K	5BB58	1	www.professionalequipment	$285.00	$285.00	
24Vdc power supply (0 to 50V	directlogic	PSM24-180S	1	www.automationdirect.com	$135.25	$270.50	for PLC sumulator
Phase rotation meter	Ideal	1RH10	2	www.grainger.com	$119.05	$238.10	
Amp Clamp	Fluke	1GAH7	2	www.grainger.com	$230.00	$230.00	
Megger	Megger	4VV59	2	www.grainger.com	$354.80	$354.80	
Infrared Gun	Fluke	1PEK8	2	www.grainger.com	$157.50	$157.50	
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Tic Tracer	Amprobe	TIC 300HV	2	www.professionalequipment	$66.00	$132.00	
Oscilloscope Fluke-123	Fluke	3LV86	1	www.grainger.com	$1,259.00	$1,259.00	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Direct Current Theory / Schematics							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Variable DC Power supply	B&K PRECISION	4GA41	1	www.grainger.com	$515.00	$515.00	
50-In-1 Training Lab (non soldering kit)	Kit USA	EXP-50B	15	http://www.kitsusa.net/phpstore/index.php	16.95	254.25	
9 volt batteries				Instructor's choice			1 for each DC kit
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Alternating Current Theory							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Variable AC Power supply	B&K PRECISION	1T201	1	www.grainger.com	$349.00	$349.00	AC Power Supply, Variable Transformer, 0-150 VAC
50-In-1 Training Lab (non soldering kit)	Kit USA	EXP-50B	15	http://www.kitsusa.net/phpstore/index.php	16.95	254.25	
9 volt batteries			15	Instructor's choice			1 for each DC kit
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
Oscilloscope Fluke-123	Fluke	3LV86	1	www.grainger.com	$1,259.00	$1,259.00	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Voltage Test Procedures 50 Volts or Higher							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
Variable AC Power supply	B&K PRECISION	1T201	1	www.grainger.com	$349.00	$349.00	AC Power Supply, Variable Transformer, 0-150 VAC
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Tic Tracer	Amprobe	TIC 300HV	2	www.professionalequipment	$66.00	$132.00	
8cal flash kit	Salisbury	5EU46	2	www.grainger.com	$366.50	$733.00	
40cal flash kit / hot stick	Salisbury	6WU89	1	www.grainger.com	$892.00	$0.00	

HV gloves	Salsbury	4T490	1	www.grainger.com	$53.25	$53.25	
Leather Protector / glove	Salsbury	4T560	1	www.grainger.com	$45.40	$45.40	
Glove Bag	Salsbyuryy	4T498	1	www.grainger.com	$34.15	$34.15	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Electro Static Discharge

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
ESD straps			5				
ESD shipping bags for circuit boards			5				
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Compressed Gas Safety & Accumulator Re-charge Procedures

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
Accumulator charging kit			1	www.parker.com			
Nitrogen bottle with regulator			1	On Site Gas			
Accumulator			1	www.parker.com			
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Basic Hydraulics

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
Accumulator				www.parker.com			
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		

Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Fiber Optics

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
Fiber optic fault locator		Visifault	2	Fluke fiber optic visual fault locator			
Fiber optic source and power meter test kit			1	www.tecratools.com	$1,190.00		with proper adaptors
Reference test cables				Grainger	$50.00		One good /one bad
Lint free wipes / cleaning alcohol				www.wassco.com			
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Soldering

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
Wire cutters	XCElite	4CP18	2	www.grainger.com	$6.89	$13.78	
Long nose pliers	Vise Grip	4YU71	2	www.grainger.com	$14.92	$29.84	
Wire strippers	Klein tools	4A856	2	www.grainger.com	$16.03		
Soldering station	Weller	5JH82	2	www.grainger.com	$147.35	$294.70	Analog / Temp control
Solder wick		5HZ97	3	www.grainger.com	$3.00	$9.00	
Alcohol dispenser	Menda	WAS-16-69356	1	www.wassco.com	$17.50	$17.50	
Solder (60-40 rosin core solder)				www.wassco.com			
Solder sucker				www.wassco.com			
Flux remover (isopropyl alcohol)				www.wassco.com			
Acid brushes / Q tip swabs				www.wassco.com			
Lint free wipes				www.wassco.com			
Small circuit board				www.wassco.com			
Components for attachment				Radioshack			
Scotch Tape				Instructor's choice			
Circuit board holder (or small vise)				www.wassco.com			

Projector			1	Instructor's choice			
Laptop			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Concepts of Electronics

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
50-In-1 Training Lab (non soldering kit)	Kit USA	EXP-50B	15	http://www.kitsusa.net/phpstore/index.php	16.95	254.25	
130-in-1 Electronic Project Lab	Kit USA	MX-906	15	http://www.kitsusa.net/phpstore/html/MX-906-130-in-1-Electronic-Project-Lab-491.html	$34.95	$524.25	
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
Oscilloscope Fluke-123	Fluke	3LV86	1	www.grainger.com	$1,259.00	$1,259.00	
Projector			1	Instructor's choice			
Laptop			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.airstreams.com			

Wind Turbine - Mechanical Systems

Item	Brand	Part #	Qty	Vendor	Price ea	Total	Comments
Planetary gear box kit	Tamiya America	WW3052408	15	www.Sciencekit.com	$19.95	$299.25	
Projector			1	Instructor's choice			
Laptop			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Torquing, Fasteners, and Torque Equipment							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
250 flb. Torque wrench	Westward	4DA97	1	www.grainger.com	$92.70	$92.70	Borrow from Rowland
600 flb. Torque wrench	Proto	1ARP9	1	www.grainger.com	$181.25	$181.25	
Multiplier 13:1				www.grainger.com			13:1 / Specialty tool
Mechanic tool set	craftsmann		1	Kmart	Should contain all the sockets and wrenches needed up to 3/4 " or 22 mm		
Training aids for i.e. bolts, nuts, washers				Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

PLC's and Control Algorithms							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor choice			
Speakers for Laptop			2	Instructor choice			
Presentation controller with laser			1	Instructor choice			
Function generator	B&K	5BB58	1	www.grainger.com	$285.00	$285.00	
Oscilloscope Fluke-123	Fluke	3LV86	1	www.grainger.com	$1,259.00	$1,259.00	
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	2	www.grainger.com	$392.75	$392.75	
wind vane / annometer							
inductive sensor				www.automationdirect.com			
pt100 sensor				www.automationdirect.com			
contactors				www.automationdirect.com			
24v relays				www.automationdirect.com			
16 gauge wire (four colors)				www.automationdirect.com			
PLC	direct 6	DO-06DR-D	3	http://web1.automationdirect.com/adc/Home/Home	$239.00	$717.00	
direct soft wear 5 5.0 or later	direct 6	PC-DSOFT5	1	http://web1.automationdirect.com/adc/Home/Home	$395.00	$395.00	
terminal blocks				www.automationdirect.com			
din rail				www.automationdirect.com			
Cable for downloads and programming	direct 6	D2-DSCBL	3	http://web1.automationdirect.com/adc/Home/Home	$30.00	$90.00	
sm screwdriver Phillips/flathead				Instructor choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Wind Turbine Electrical Systems							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Training aids contactors, relays, fuses & overloads				Instructor's choice			
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
muiltimeter	Fluke		1	www.grainger.com			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Substations and Transformers							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Multimeter kit with test leads Fluke-87V	Fluke	4EB18	1	www.grainger.com	$392.75	$392.75	
Infrared Gun	Fluke	1PEK8	2	www.grainger.com	$157.50	$157.50	
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Tic Tracer	Amprobe	TIC 300HV	2	www.professionalequipment	$66.00	$132.00	
Variable AC Power supply	B&K PRECISION	1T201	1	www.grainger.com	$349.00	$349.00	AC Power Supply, Variable Transformer, 0-150 VAC
instrument Transformer				www.automationdirect.com			
Current Transformer				www.automationdirect.com			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Turbine Maintenance and Service Practices							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructors choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructors choice			
Speakers for Laptop			2	Instructors choice			
Presentation controller with laser			1	Instructors choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Wind Turbine Schematics							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Sample Schematics				Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-atreams.com			

Troubleshooting Techniques and Procedures							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
50-In-1 Training Lab (non soldering kit)	Kit USA	EXP-50B	15	http://www.kitsusa.net/phpstore/index.php	16.95	254.25	
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Multimeter kit with test leads	Fluke 87		2	www.grainger.com	$157.50	$157.50	
Phase rotation meter	Ideal	1RH10	2	www.grainger.com	$119.05	$238.10	
Amp Clamp	Fluke	1GAH7	2	www.grainger.com	$230.00	$230.00	
Megger	Megger	4VV59	2	www.grainger.com	$354.80	$354.80	
Infrared Gun	Fluke	1PEK8	2	www.grainger.com	$157.50	$157.50	
Fluke Voltage Pens	Fluke	2KU25	2	www.grainger.com	$27.15	$54.30	
Tic Tracer	Amprobe	TIC 300HV	2	www.professionalequipment	$66.00	$132.00	
Oscilloscope Fluke-123	Fluke	3LV86	1	www.grainger.com	$1,259.00	$1,259.00	
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Service Reporting							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Rotor Construction and Airfoils							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Fiber Glass Repair							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			
Fiber Glass Repair tools and materials				Instructor's choice			
Scottie's Fiber Glass Repair DVD	Scottie's	DVD	1	http://www.scottiescanvas.com/products/other/fiberglass.php	$34.90	$34.90	

Blade Pitching and Balancing							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

SCADA and Data Analysis							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-stream.com			

Meteorology							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Wind Turbine Power Curves							
Item	**Brand**	**Part #**	**Qty**	**Vendor**	**Price ea**	**Total**	**Comments**
Projector			1	Instructor's choice	Tool and vendor are at the discretion of the instructor		
Laptop			1	Instructor's choice			
Speakers for Laptop			2	Instructor's choice			
Presentation controller with laser			1	Instructor's choice			
Power Point Presentation on Disk	Airstreams		1	www.air-streams.com			

Appendix L: Wind Electric Systems Training Programs - Suggested Facilities, Hardware and Materials

Compiled by Roy Butler, Four Winds Renewable Energy, LLC.
Source: Interstate Renewable Energy Council, September 2008

Complete wind system package(s), including a small wind turbine with tilt up tower, ground anchors, inverter and/ or controller, BOS components and documentation. A battery charging turbine is best for keeping cost and complexity to a minimum, but a direct grid-tie system is more representative of the type of system needed for work force training.

Electric winch for raising the tilt tower, 12 volt DC if vehicle mounted or 120/ 240 volt AC for fixed mount. A Griphoist type hand winch can also be used but is much slower and may not be appropriate for some turbine/ tower configurations. Load cell (dynamometer) for determining tower pull up forces.

For the battery charging turbines, several battery subsystems of various types, including flooded and valve-regulated lead-acid technologies. Battery test equipment should include hydrometers and high-rate load testers.

Various UL listed battery-based grid-tie, direct grid-tie and stand-alone inverters.

Micro turbines in the 200 to 750 watt range mounted on portable stands for lab work. Include a portable drill or other means to spin the generator for indoor use.

Basic electrical meters and diagnostic equipment, including volt/ohm/ammeters, clamp-on AC/DC ammeters, power analyzers, conventional and electronic watt/watt-hour meters, insulation resistance tester (megger) and ground resistance testers, wind data acquisition equipment.

Assorted cables, wiring, connectors, terminal blocks, junction boxes, disconnects and over-current devices (fuses and circuit breakers) of various sizes, types and ratings required for code-compliant assemblies of major components.

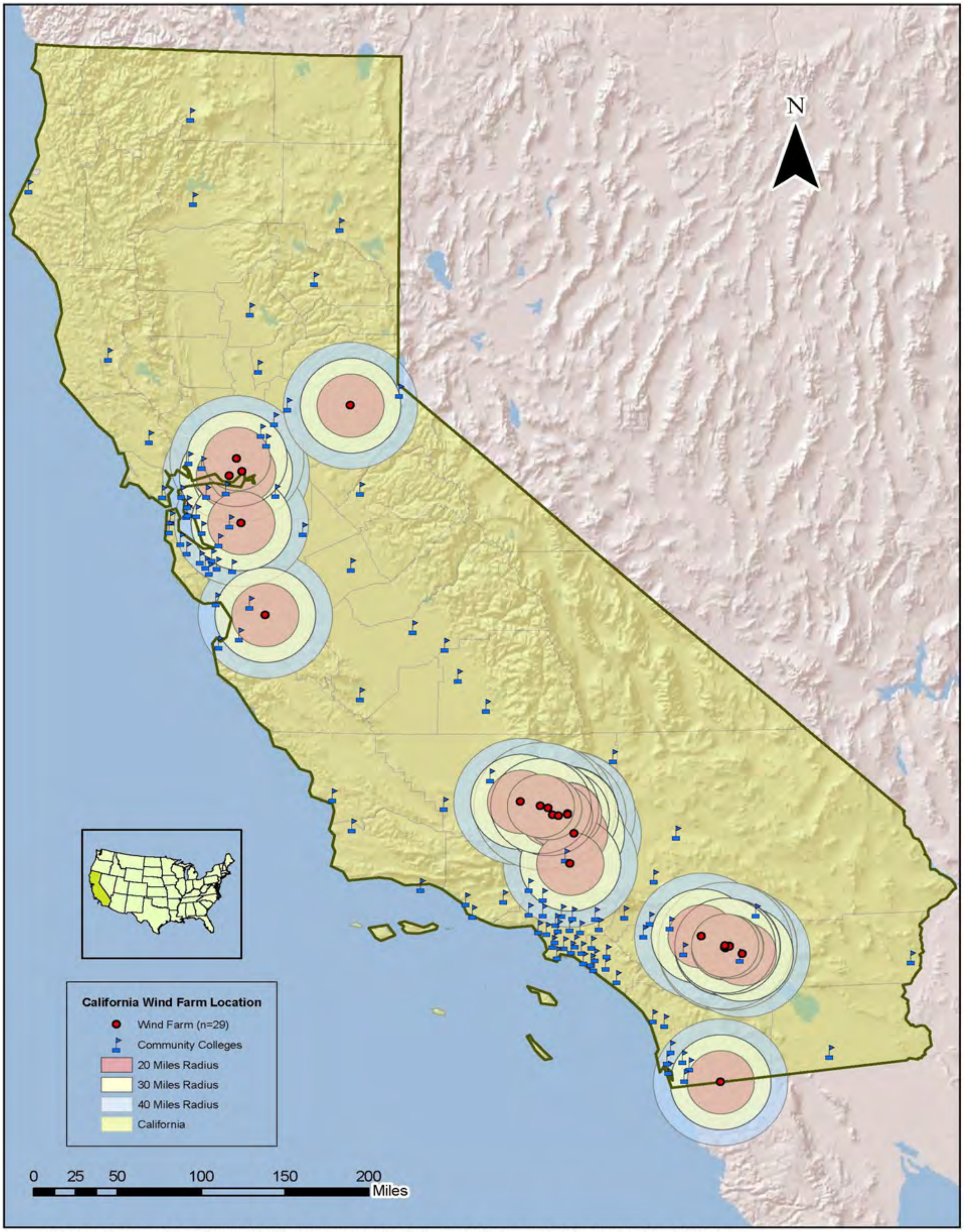
Site survey equipment, including string lines, stakes, marking flags and paint, optical levels and transits, measuring tapes and wheels, handheld GPS units, digital camera, calculators and checklists.

Foundation plans for various types and heights of tower for foundation layout exercises. Topo maps, wind maps, computer based wind speed and turbine energy production estimators.

Typical construction, electrician, rigger and millwright power and hand tools required for wind electric system installations.

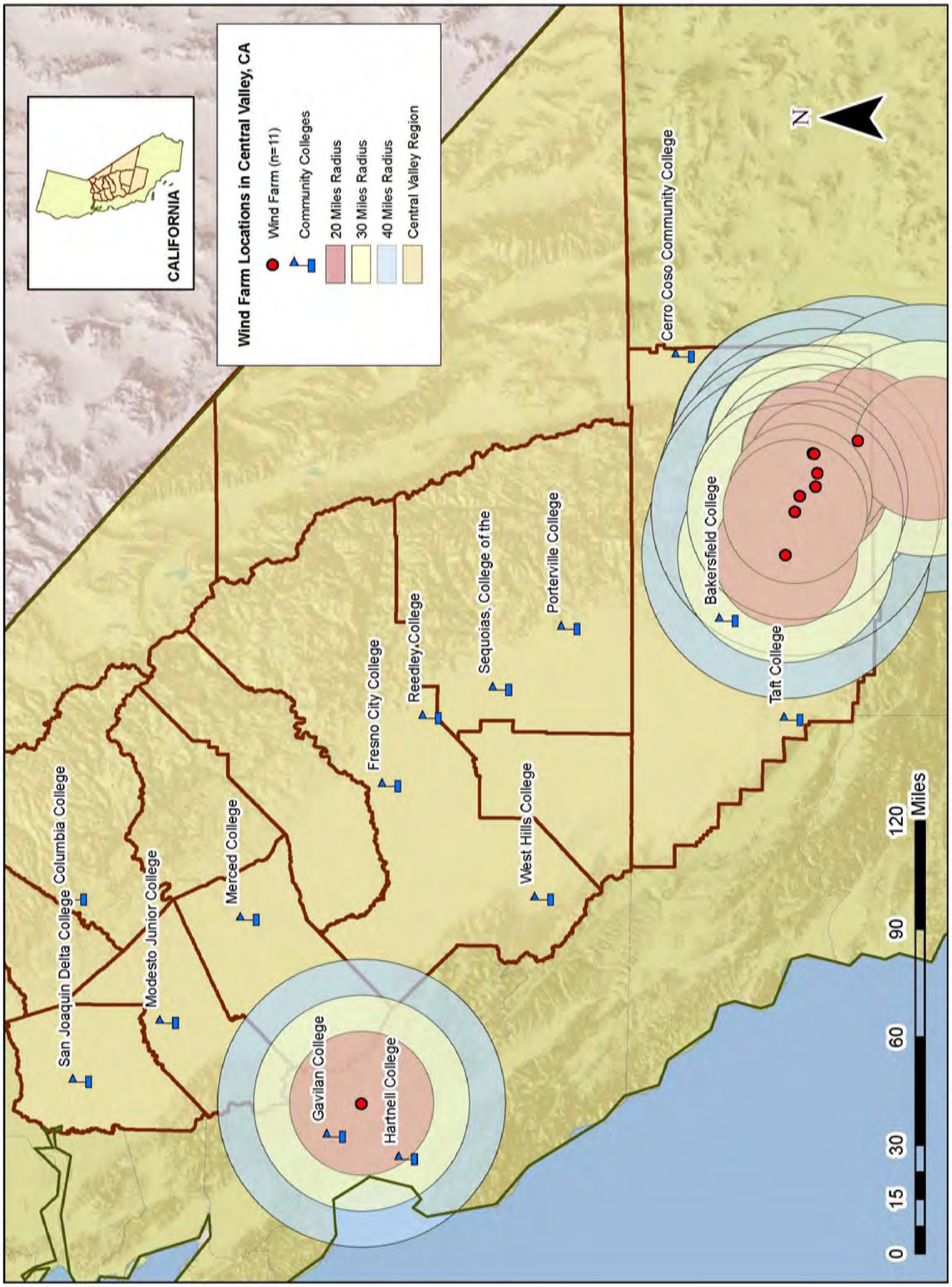
Safety equipment, including warning signs, eye protection and washes, gloves and aprons, first aid kits, lifting equipment, hard hats, climbing gear, life lines, fire suppression equipment and electrolyte neutralizer.

Appendix M: Maps of California Wind Farms and College Proximity



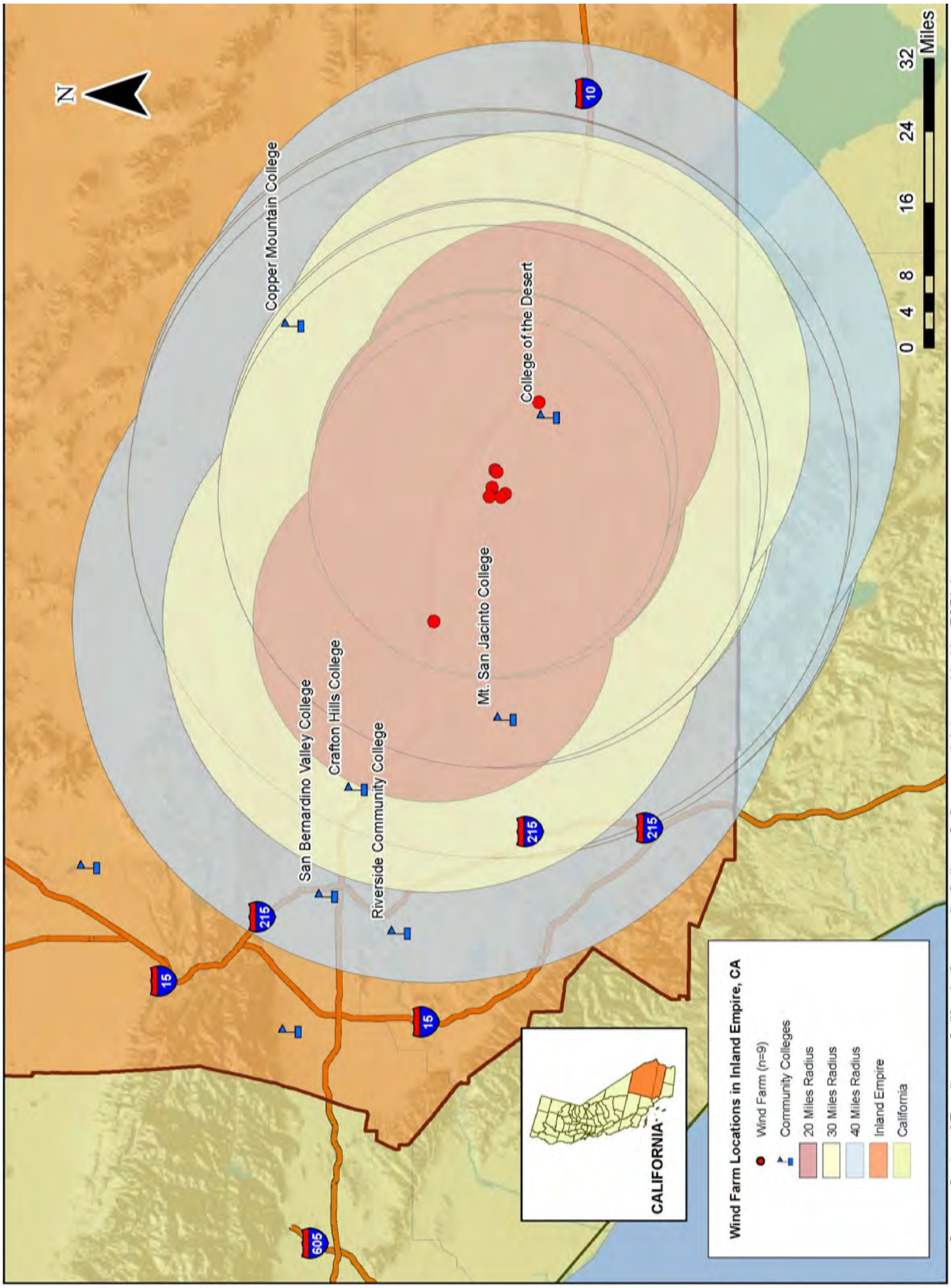
Source: Center of Excellence, California Community College. Software and data provided by ESRI, Inc.

Central Region Wind Farms



Source: Center of Excellence, California Community College. Software and data provided by ESRI, Inc.

Inland Empire Wind Farms



Source: Center of Excellence, California Community College. Software and data provided by ESRI, Inc.